1 Introduction

The term “supply chain management” has become a part of the business lexicon. Younger professionals and students may find it difficult to believe that it was not a widely known term just thirty years ago.

We define supply chain management (SCM) as the integrated management of the business processes (Poirier and Bauer 2000) associated with the direct and reverse (Stock and Boyer 2009) flows of physical goods, financial assets, and information (Elmuti 2002) from the producers of basic inputs to the final consumer’s use (Handfield and Nichols 1999). More recently, supply chain management has also come to include the subsequent destination of goods (Souza 2013) and services. SCM seeks to optimize the creation of value for all customers (intermediary and final) and for other legitimate and relevant stakeholders (Walters and Lancaster 2000) in the chain (shareholders, employees, managers, the community, and the government).

The term was coined by consultants in the early 1980s (Lambert and Cooper 2000) and rose to prominence in the vocabulary of business in the 1990s. In comparison, modern concepts of production and operation management have been around for more than two hundred years, showing that the field of supply chain management is indeed new. What follows is a discussion of the main reasons for the growing interest in supply chain management. Most chapters conclude with a section titled “Implications for Managers.” Chapter 2 embodies these “Implications” throughout and so there is no need for a concluding section.

2 Technological Evolution

Never before has technology evolved at such a fast pace. The technological changes in the industrial world have made it difficult for companies to use their internal resources alone to keep up with developments that influence their products and services. Companies have become increasingly dependent upon more technological specialized and advanced third parties. Therefore, companies now prefer to outsource substantial portions of not only their production operations but also of the development of their products and services and/or their component parts. This change has brought a tremendous increase in both the volume and intensity of trade and the
need for communication and coordination between supplier and customer companies. Trade, communication, and coordination were in turn facilitated by internet and RFID technology. As supply chains have become more complex and information and communication technologies have become more available and affordable, supply chain management has become an important focus point for managers.

3 Today’s Competition: Between Supply Chains, Not Companies

Several authors argue that competition in today’s global market is no longer between companies, but between supply chains (Antai 2011). Some competing supply chains are self-contained and isolated, not sharing partners with the competing chains. One example is the footwear industry. Chinese footwear manufacturers have local supply chains and often do not share partners (except perhaps in retail) with the supply chains of a shoe manufacturer in Brazil. It is worthwhile to analyze the Chinese and Brazilian footwear manufacturers as competing supply chains rather than merely as competing companies.

A less obvious example can be found in the powdered detergent market. Two of the major players in this market are Unilever and Procter & Gamble. These two companies share most of their raw material suppliers in large chemical companies. They also share distributors, wholesalers, and major supermarket chains such as Carrefour and Wal-Mart, which distribute and sell products for both competitors. This could be viewed as evidence that their competition is between companies, not between supply chains.

However, while the two companies share many partners, the ways in which these companies manage their relationships with those shared partners to create greater or lesser efficiency, and better or worse cooperation, can be different and can differentiate one supply chain from the other. Many partner companies may be the same, but their supply chain relations may be different. These differences, for instance, show in terms of how much information is exchanged between the companies and their common distribution channel partners and to what extent decision processes about inventory replenishment are coordinated between the companies and their suppliers—who happen to be the same. Therefore, even in the less obvious case of powdered detergents, competition nowadays indeed is indeed between supply chains and not between companies.

4 Historical Evolution of Supply Chain Management

Knowing the past helps us to understand the present and plan for the future. With this in mind, we will briefly describe the historical evolution of operations and supply chain management.

4.1 First Phase: The Operation Management Scope Is the Production Unit—“One Best Way”

At the turn of the 20th century, steel industry consultant Frederick Taylor (1911) believed that, if his scientific management principles were diligently applied to improve the method used to perform a task, then this process would come together as the “one best way” of realizing it.

Industrialist Henry Ford used the logic of scientific management and added other efficiency improvement techniques such as moving assembly lines to make Ford Motor Co. the greatest car manufacturer in less than twenty years. Nonetheless, this incredible rise in production efficiency came at the expense of product variety. For almost two decades, Ford only produced one model of car: the Model T. Ford, just like other “mass-producers” of the time, also executed most tasks internally. The level of outsourcing was very low and the idea that there was “one
best way” of performing tasks and that efficiency should be sought mainly through economies of scale dominated the mass production era. This approach proved successful in the extremely cost-conscious market of the first part of the 20th century.

4.2 Second Phase: The Operations Management Scope Crosses Borders Between Functions

Nevertheless, markets ripened. Many countries saw their populations become more affluent and their markets more sophisticated in the first decades of the 20th century. Some market segments were willing to pay more for products as long as these offered better performance characteristics in some way, such as a higher quality, more alternatives to choose from, and greater customization. The need to adjust production choices and decisions to focus on the delivery of specific sets of performance characteristics led operations managers to challenge Taylor’s (1911) assumption that there was “one best way” to perform tasks.

Operations managers realized the necessity of crossing the “functional border” between the operations function and the marketing/sales function for a better understanding of what precise combination of performance characteristics (cost, quality, delivery, flexibility, or service) would be needed to produce and deliver to compete in the target markets of the organization (Skinner 1969; Hill 1985). To deal with the required continuous harmonization between operations choices and decisions and the market, the concept of operations strategy was created and developed in the last third of the 20th century (Skinner 1969; Hayes and Wheelwright 1984; Hill 1985).

Operations strategy sought to respond to the need to integrate operations not only with marketing but also with various other functions and face hard choices. In order to do that, operations managers needed to deal with increasingly complex trade-offs when making decisions.

4.3 Third Phase: The Operations Management Scope Crosses Borders Between Organizations—Supply Chains

Throughout the 20th century, technological development and product complexity accelerated at an unprecedented rate (Utterback 1994). Manufacturers started realizing that relying only on internal resources made it very difficult to keep up with the evolution of all technologies involved in their products by relying only on internal resources. Companies began to delegate to specialized suppliers, first for the manufacturing and then for the conception and design of increasing portions of their products (Gottfredson et al. 2005). As the use of outsourcing intensified, operations managers were forced to adapt and learn to cross another border: the border between companies in supply chains (Correa 2014). This is because managers who decide to outsource activities to be performed by third parties (suppliers) need to learn new ways to coordinate the activities that they kept internally with the activities they outsourced across company borders. The scope of operations management widens yet again, the decision trade-offs become more complex and the necessary integration between decision processes of each company in the chain demands more complex management (see Mena et al. 2013).

The alignment of incentives (Narayanan and Raman 2004) between companies with diverse property ownership, for example, became mandatory—new mechanisms are needed to align the interests of the companies in the chain with the interests of the chain itself.

This requires new forms of contracting where risks, costs, and benefits are better and more rationally distributed between partners in the chain, with higher levels of trust, cooperation, and incentive alignment among the chain participants. The fates of all supply chain members are
interlinked. If the companies work together to effectively deliver goods and services to consumers they will all win (Narayanan and Raman 2004, p. 3).

### 4.4 Fourth Phase: The Operations Management Scope Crosses National Borders—Global Supply Chains

Toward the end of the 20th century, the technological developments in telecommunications and transportation, aside from the globalizing actions of governments (reduction of trade tariffs and barriers), made it viable for companies to seek suppliers and other commercial partners wherever they were located (Trent and Monczka 2005). Supply chains became “global supply chains.” While global supply chains promise enormous strategic benefits, managing operations across cultural, economic, and political boundaries is a formidable challenge. The scope of operations activities to be managed is quickly expanding to a worldwide scale. The management of trade-offs becomes yet again more complex. New elements were added to the decision-making scope of operations managers: time-zone differences, working standards, languages, culture, ethical standards, and diverse management systems and practices, among many others. On the one hand, these differences introduced a growing complexity to the necessary integration between the processes of partners in these new global networks. On the other hand, the differences brought great opportunities for significant differentiation in capabilities. Supply chain managers need to be masters in the art of managing complex trade-offs, now more than ever.

### 4.5 Fifth Phase: The Operations Management Scope Crosses the Borders of Organizations’ Global Objectives—The Triple Bottom Line

By the beginning of the 21st century, a substantial change had begun to take shape. Until the 1990s, the management of global supply chains aimed almost exclusively for the economic prosperity of its members. The masters of trade-offs—global supply chain managers—tried to balance various conflicts aiming to increase the economic value of the chains and its members. However, a new widening of scope was occurring. Encouraged by the internet and its instruments, many stakeholders such as NGOs and government bodies, in the name of citizens and progressive shareholders (Wolf 2014), started to demand that corporations and their supply chains assume greater responsibility for environmental sustainability of the planet and for their social impact. As a consequence, many organizations are now adjusting their objectives accordingly.

Moving away from aiming to maximize their results only in the traditional single “bottom line” (profit), these progressive companies are now striving to maximize their performance in the “triple bottom line” (3BL) (Elkington 1997), which consists of 1) economic prosperity (profit), 2) environmental sustainability (planet) and, 3) social responsibility (people) with evident implications to supply chain management (Wu et al. 2014).

Once more, the managers of global supply chains had their scope expanded. Trade-offs became even more complex. Now there is greater need and complexity in the sharing of information and in the integration of decision-making processes involved with the constituents of supply chains. This is the situation that we face today, a situation that brings exciting new challenges and opportunities for operations and supply chain managers and amazing research opportunities for scholars.

### 5 Everyone Wins With Good Supply Chain Management

One of the most attractive characteristics of successful supply chain management is that all parties win by working collaboratively instead of adopting the more traditionally contentious
approach to business, where some members of the chain must lose in order for others to win. Let us look at how this “win-win” potential is possible by analyzing the model of a traditional negotiation.

Frequently, the many organizations comprising a supply chain not only have differing objectives but, more importantly, they have conflicting ones. When the executives of two companies that are part of a supply chain negotiate the purchase and sale of a product or service, each one has an interest in maximizing the financial outcome of the negotiation for their own company. Imagine a price negotiation between a manufacturer and one of its distributors. Because of the conflicting objectives, traditional negotiations are similar to an arm wrestling competition where for one to win the other one has to lose. This simple example of a “win-lose” relationship is called “zero-sum” (e.g., say the loser has to give the winner $10). The zero-sum outcome would be bad enough as a result in today’s extremely competitive world. The situation, however, is worse because the result of the negotiation is not merely zero-sum but a negative sum.

A skilled professional in an arm wrestling-type negotiation will find ways to strengthen his/her metaphorical arm and will become more competitive through time, for example, by creating “information asymmetry.” To do so, the negotiator understands that it is to his or her advantage not to share information. Indeed, some empirical studies suggest that the adoption of win-lose approaches in negotiations actually decrease future intentions to share information (Blome et al. 2014).

Some negotiators go as far as deliberately omitting or even distorting information that they do share or are required to share in order to gain an edge. For the same reasons, the opponent in the negotiation will also avoid sharing information. Since both parties are now avoiding the sharing of information, each makes the other work under greater levels of uncertainty. As a result, efficiency suffers across the board.

With more collaborative relationships where information and decision-making processes are shared and better integrated (Prajogo and Olhager 2012), supply chains perform better because collaboration results in reduced overall uncertainty and volatility. Therefore, this results in lower costs for all companies involved—a win-win situation. To achieve that, a management mechanism is needed through which information is shared, cooperation is fostered, and decisions and actions are both made and taken in a more coordinated fashion. Such a mechanism is supply chain management, and its successful deployment requires replacing zero-sum (win-lose) or lose-lose situations with win-win situations.

6 Supply Chain Management: Some Essential Concepts

Several concepts and effects are essential to understand the main challenges (and opportunities) faced by supply chain managers today.

6.1 The Strategic “Make or Buy” Decision

An important decision a company must make when developing its supply chain strategy is about which activities the company will perform itself and which will be outsourced (Kroes and Ghosh 2010). Traditionally, the decision to “make or buy” was based only (or predominantly) upon the costs incurred by one strategy as opposed to the other. The philosophy that cost should be the only factor in the decision to make or buy is a risky one. Now, it is widely understood and accepted that, in supply chains, the “make or buy” decision has strategic implications that are too serious to ignore. At least two bodies of knowledge are considered essential in supporting the
make or buy decision in supply chains: transaction cost economics and the resource-based view of strategy (McIvor 2009).

### 6.1.1 Transaction Cost Economics

The area of economics that deals with transaction costs originated from the seminal work of Coase (1937), which aimed to understand why firms do things instead of purchasing them from third parties.

One transaction is the transfer of a product or service between technologically separated operating units. Transaction costs exist only because markets are imperfect. For example, market information is not 100% available, and people are not 100% effective or rational in their ability to analyze information and arrive at proper conclusions. Transaction costs include the cost of searching for information about a supplier, the cost of not perfectly understanding the information obtained, the cost of generating a quote, the cost of drawing up contracts, and the possible judicial costs to have contracts enforced.

Transaction analysis seeks efficiency in the management of such transactions or, in other words, it seeks to minimize transaction costs. According to industrial organization theory, transaction costs are driven by at least four factors (McIvor 2009):

- Asset specificity in the transaction
- Number of potential suppliers
- Overall uncertainty surrounding the transaction
- Frequency of transactions.

Transaction costs increase with asset specificity in the transaction. For instance, if I have a machine that can only process the raw material that I buy from a (specific) supplier, the supplier will likely adopt an “opportunistic” stance. The supplier will likely increase prices because he/she knows that I will think twice before buying raw material from a different supplier—because I would have to replace my current machine to be able to process the new supplier’s raw material. The supplier’s increase in price reflects an increase in my transaction costs.

In terms of the number of potential suppliers, fewer potential suppliers mean that these suppliers will likely use their “quasi-monopoly” condition to opportunistically increase their prices—and, again, a supplier’s increase in price is directly reflected in the customer’s increased transaction costs.

Transaction costs also increase with the level of uncertainty surrounding the transaction. If I do not have “perfect information” about many alternate potential suppliers, the few suppliers that I know will likely use opportunism to increase their prices, again reflecting in an increase in my transaction costs. As per the frequency of transactions, the more frequently a transaction occurs the higher the overall transaction costs incurred.

To summarize, the greater the level of asset specificity and uncertainty involved in a transaction, the frequency of transactions, and the presence of fewer potential suppliers in a market are all drivers of higher transaction costs between a company and a supplier.

The economic theory behind the analysis of transaction costs suggests that, when transaction costs rise, companies will attempt to mitigate those rising costs using vertical integration (“make”). In the same way, when the transaction costs are lower, there is an increased likelihood that companies will purchase (“buy”) the item.

Considering transaction cost is a necessary but not sufficient part of this analysis (McIvor 2009). It is also necessary to consider the concepts related to the resource-based view of strategy.
6.1.2 Resource-Based View of Strategy

Resource-based theorists view the firm as a unique bundle of assets and resources that, if employed in distinctive ways, can create competitive advantage (Barney 1991). One of the most prominent concepts derived from the resource-based view of strategy is that of “core competencies.” Hamel and Prahalad (1994) define competencies as a set of skills and technologies rather than a single skill or technology. A competence comprises the combined learning of teams and units across a broad range of company functions and therefore is rarely confined to a single unit or team. Hamel and Prahalad (1994) define three characteristics required for a specific competence to be labeled a core competence. This definition is important because core competencies are, according to the authors, the most valuable sources of sustainable competitive advantage for a company.

A core competence must provide a disproportionately large contribution to the value perceived by the final customer. In addition, a core competence must be competitively unique—a competence held in common by an entire industry should not be considered a core competence. Finally, a core competence should be able to enable the company that possesses it to open doors to future markets.

The notion of core competencies supports the idea that a company should not internally produce everything it sells. According to the resource-based view of strategy, items (goods or services) related directly to core competencies in an organization should not be outsourced. Other, non-core competence related activities can and, some authors suggest, should be outsourced to allow for the company to really focus on what it considers to be “core.”

6.1.3 A Framework for the Strategic “Make or Buy” Decision

As discussed above, there are two main conceptual contributions to be considered when a company decides whether to make or buy (outsource) a certain activity related to the production of goods or services: transaction costs and core competencies. Figure 2.1 shows a simple framework for the making of make or buy decisions that takes both contributions into account.

![Figure 2.1 The “Make or Buy Decision” in Supply Chains](image-url)
Quadrant I. Make or control 100%—In principle, activities within this quadrant should not be outsourced. These activities should be performed internally because they relate to one of the company’s core competencies and is therefore crucial to its future competitiveness. Furthermore, because of the high transaction costs involved, outsourcing the activity could make the company vulnerable to opportunistic behavior on the part of its suppliers. This quadrant includes, for example, activities related to logistics intelligence within FedEx and integrated circuit design within Intel.

Quadrant II. Make or control (less common scenario)—In this quadrant, the activities are considered related to core competencies, but the transaction costs involved in outsourcing them are low. This should not be a common situation since by definition the skills needed to perform activities that are considered core competencies cannot be widely spread. Only a handful of companies are likely to face this situation. For example, McDonald’s requires just the right variety of potato for its French fries and requires those potatoes to meet strict quality standards. McDonald’s French fries are world-famous, and maintaining their consistent quality is a core competence. However, when McDonald’s expands into new countries, the company must create partnerships with local producers to cooperate in the cultivation of the proper type of potato, adapted to local conditions. In these situations, the outsourcing of the potato supply development takes the form of close partnerships. McDonald’s is aware of the importance of keeping as much control as possible over this core process; however, the company is not interested in growing its own potatoes.

Quadrant III. Outsourcing with little control—This quadrant is where outsourcing is the simplest and most direct. Here, the outsourced activity does not directly involve core competencies and comes with low transaction costs when outsourced. These are nearly perfect market conditions for outsourcing, many competitors fighting for the preference of clients with comparable products. This outsourcing should also not require a high level of control by the company over the suppliers.

Quadrant IV. Outsourcing with high control—The activities here do not involve core competencies and, in principle, would not be candidates to be performed internally. However, the transaction costs are high. Imagine a microcomputer manufacturer such as HP or Dell. Producing operating system software for their computers is not among these companies’ core competencies; however, their machines certainly require an operating system in order to function. There are few acceptable suppliers of operating systems (for example, Microsoft or Linux) for microcomputers. This means that, at least from the perspective of potential suppliers and asset specificity, the transaction costs are high. Microcomputer manufacturers such as Dell and HP outsource this non-core activity. However, the level of control over the outsourced processes (Wiengarten et al. 2013) that applies here is much higher than that of Quadrant III, because of the higher risk of the company becoming a victim of opportunism by the few available suppliers.

In supply chains, more than simply deciding whether to “make or buy,” it is also essential for a company to elaborate on the nuances of its relationships with potential suppliers. Some recent studies have explored the changing role of supply chain managers as managers of relationships with partners in the chain (Wilson and Barbat 2015).

6.2 Supply Chain Segmentation

As discussed in the introduction to this chapter, there is no single best way to perform operations activities. This is because there is not a single way to compete in the marketplace. For the same reason, there is no single best way to design, manage, and perform supply chain activities. The development of a supply chain strategy must support, and be consistent with, the competitive market strategy of the business unit.
6.2.1 What Is the Right Supply Chain for Your Product?

Fisher (1997) argues that, when analyzing potential supply chain strategies, a company should first categorize its products and markets according to types. According to Fisher, the pattern of demand for a product is the most important variable to consider when categorizing products and markets served by a supply chain. According to this notion, product demand patterns determine the classification of a product as either functional or innovative.

Functional products are purchased by customers in their day-to-day lives from retail outlets such as supermarkets, convenience stores, and gas stations. These products meet basic needs that do not change frequently and generally have long life cycles and predictable demand. Functional products are less differentiated, and therefore, highly subject to price competition and to the use of low-cost competitive strategies (Porter 1980). These factors result in modest profit margins. With modest profit margins and price competition, these products require low production and delivery costs but high volume of production.

In an effort to avoid the uncomfortable situation of living with modest margins, many companies focus on introducing innovative products instead.

Innovative products, according to Fisher (1997), are differentiated products with more frequent product launches, shorter life cycles, and less predictable demand. Low price is not the primary motivation behind customers’ interest in acquiring innovative products. Electronic products such as Apple’s innovative lines of iPads, iPhones, iWatches, and Mac computers often fall into this category. It is not rare for the profit margins on innovative products to be in the range of 20% to 80% or even more. Innovative products can potentially increase profitability, but constant innovation makes demand much less predictable and frequently leads to product shortages or excess inventory that may require markdown sales at the end of the season. These products usually compete using Porter’s (1980) differentiation strategy.

The strategic supply chain characteristics necessary to produce and deliver innovative products are fundamentally different from the supply chain characteristics necessary to produce and deliver functional products (Fisher 1997).

One of the most important objectives of supply chain management is the continuous reconciliation of supply and demand. When demand is more stable and predictable, this reconciliation is usually easier. With unpredictable demand, companies must carefully manage their resources in order to be able to respond quickly to unexpected factors that cause imbalances between supply and demand. For products with consistent and predictable demand, there is less need for rapid response and their supply chains can concentrate their efforts on maintaining a continuous, uninterrupted, and efficient flow of products from producers to consumers.

The ways in which supply chain resources must be managed in order to handle functional products and the ways in which resources must be managed to handle innovative products are not only different but also often conflicting. That is why many companies are starting initiatives to segment their supply chains. For functional products, strategic supply chain management must emphasize efficiency. This keeps the costs of functional products low. For innovative products, the emphasis must be on responsiveness and flexibility in order to be able to quickly and dynamically match supply to unpredictable demand.

Figure 2.2 describes the strategic characteristics required for the efficient supply chain and the responsive supply chain.

When analyzing functional and innovative products and efficient and responsive supply chains, there is a natural match between the type of product and type of supply chain required, according to the matrix in Figure 2.3.
Global Supply Chain Management

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Efficient supply chains</th>
<th>Responsive supply chains</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td>Supply predictable demand efficiently at the lowest possible cost</td>
<td>Respond quickly to unpredictable demand to minimize stock-out, markdowns, and obsolete inventory</td>
</tr>
<tr>
<td><strong>Manufacturing goal</strong></td>
<td>Keep high average utilization rates</td>
<td>Deploy excess buffer capacity</td>
</tr>
<tr>
<td><strong>Inventory strategy</strong></td>
<td>Maximize turns and minimize inventory cost through the chain</td>
<td>Deploy significant buffer stocks of parts or finished products</td>
</tr>
<tr>
<td><strong>Response time</strong></td>
<td>Shorten times as long as costs are not increased</td>
<td>Invest aggressively to reduce lead times</td>
</tr>
<tr>
<td><strong>Choice of suppliers</strong></td>
<td>Select suppliers mainly for cost and quality</td>
<td>Select suppliers mainly for speed, flexibility, and quality</td>
</tr>
<tr>
<td><strong>Product design strategy</strong></td>
<td>Maximize performance and minimize cost</td>
<td>Use modular design to postpone differentiation for as long as possible</td>
</tr>
</tbody>
</table>

**Figure 2.2** Efficient Supply Chains Relating to Functional Demand Patterns and Responsive Supply Chains Relating to Innovative Demand Patterns

*Source: Fisher 1997*

Supply chains planning to compete with functional products should organize their resources and processes according to the characteristics of efficient chains. Supply chains intending to compete with innovative products, however, must organize and manage resources and processes according to the characteristics of responsive chains. This requires extra resources with
correspondingly higher costs, but the higher margins commanded by innovative products allow for that. Although Fisher’s hypothesis (Fisher 1997) has not been fully tested empirically, there are recent empirical studies (for example, Godsell et al. 2011) and numerous anecdotal accounts that confirm the increasing use of supply chain segmentation, at least in the fast-moving consumer goods industry. Further research is certainly needed on this promising concept and its application.

### 6.2.2 Aligning Competences in Supply Chains

One important responsibility of supply chain management is to match the range of skills and capabilities possessed by the different companies within the supply chain with the many activities the chain needs to perform in order to satisfy its customers. An example can illustrate this idea. Think of the relationship between an insecticide manufacturer and a supermarket chain in Calcutta, India—a place that has warm temperatures most of the year.

Managers of the insecticide manufacturer are utterly focused on the insect-control industry. For example, they understand that two days of summer rain followed by two days of harsh sun and heat will lead to a rise in the mosquito population in certain areas of the city—thus increasing demand for bug spray in those areas.

Because the manufacturer’s executives are focused on the industry and have great knowledge of the use of their products, they are adept at identifying patterns and predicting consumer demand trends for their products, maybe more so than retailers who sell their products to end users. When the weather or relevant conditions change, the supermarket manager has to evaluate their effect not for some, but for the around 30,000 items the supermarket sells—continuously!

The manufacturer’s specific knowledge of its own product as well as its position in the supply chain places it in a better condition than the supermarket to forecast short-term sales (and consequently to manage inventory replenishment in the supermarket) of its products.

This means that it can sometimes make sense to reallocate the activities of forecasting consumer sales and managing inventory replenishment polices from the retailer to the manufacturer. This practice, one of the examples of the reallocation of activities to companies that are better positioned in the supply chain to execute them is called vendor-managed inventory, and it is widely used.

Individual companies frequently reshuffle their organizational structures, changing “who does what” inside the organization. What they are doing when they “reshuffle,” is to try to achieve a better match between the capabilities required by certain activities and the capabilities present in the internal areas or departments that are allocated to perform them. Following the same rationale, supply chain activities often can and should be reallocated to companies with better capabilities to carry them out. This is only possible with the approach adopted by supply chain management, which considers the many companies that are required to work together to create and deliver products and services to consumers.

### 6.2.3 Avoiding Incentive Misalignment Among the Constellation of Partners in Supply Chains

One of the most daunting challenges in supply chain management is the challenge of managing a constellation of partners with potentially conflicting interests so that they work toward common objectives; indeed, managers sometimes complain that their partners seem unwilling to pursue the common good, even when doing so has obvious potential benefits for the supply chain.

When this happens, companies are likely to pursue divergent and sometimes incompatible goals. It should never be forgotten that, in a global supply chain, it is essential for the objectives...
and incentives of each partner to be aligned with the best interests of the entire chain, however, partners in the chain will only be interested in adding maximum value to the chain as a whole if they can retain a fair portion of the benefit achieved.

According to Narayanan and Raman (2004), there are three sources of incentive misalignment in global supply chain management:

- **Secret actions**—when a company does not have knowledge of the actions its partners are taking, it becomes difficult to persuade them to do what is best for the chain. Imagine Whirlpool, which needs retail sales clerks from retail chains like HH Gregg to help it sell its products because clerks have the greatest influence on consumers’ buying choices. If secret actions are in place, because manufacturers like Whirlpool do not have the means to closely monitor the efforts the retailer is making to sell its products it is difficult to design effective incentives for the retailer that align the best interests of both companies.

- **No information sharing**—It is difficult to align incentives when there is not enough trust between members of the chain to allow for the sharing of information. When different partners do not know each other’s profit margins, as is usually the case, it is much more difficult to come up with policies and contracts that prompt a fair distribution of benefits and give each company the incentives to behave in the best interest of the partnership and the supply chain as a whole.

- **Poor incentive system design**—Poorly designed performance measurement and incentive systems have the potential to induce dysfunctional behavior that contribute to misalign incentives in supply chains.

### 6.3 The Bullwhip Effect: Caused by Lack of Communication and Coordination Between Partners in Supply Chains

One of the important objectives of supply chain management is to reconcile supply and market demand. In some supply chains, a large part of the demand variation faced by individual supply operations is not caused by actual final consumer demand variations but rather by practices and decisions made by other supply chain participants. When practices and decisions internal to the supply chain cause other supply chain members, especially those upstream, to perceive amplified demand volatility, the result is called the bullwhip effect (Lee et al. 1997). This important effect is found in most supply chains (Mackelprang and Malhotra 2015).

The bullwhip effect is a dynamic phenomenon that causes even small downstream demand fluctuations in a supply chain to become distorted and gradually be perceived as increasingly larger fluctuations as information is conveyed upstream in the chain via customer-supplier relationships, usually in the form of orders.

The bullwhip effect can be seen in the simplified supply chain presented in Figure 2.4.

Imagine for the sake of simplicity that each of the companies in the supply chain in Figure 2.4 has a policy of keeping in inventory the equivalent of one month’s worth of its goods.

![Figure 2.4 A Simplified Supply Chain](image-url)
perceived demand. Imagine that the customer demand perceived by the retailer in this chain has remained stable for several months at 50 units per month. Since the chain works to meet the demand and keeps the equivalent of one month’s worth of demand in stock, all the chain companies have a perceived demand of 50 units during Month 1. They deliver 50 units to their immediate customers, they purchase 50 units from their immediate suppliers, and they keep 50 units in stock.

This is shown in the first row, corresponding to Month 1, in the table in Figure 2.5. This table demonstrates what happens to the immediate demand perceived by each of the companies in the chain when a small variation occurs in demand at the consumer level. This change occurs when demand at the retail level increases from 50 to 53 units in Month 2 and remains at 53 units per month for the remaining 5 months shown in the table. The rows in the table represent months from 1 to 6 and the columns hold order and inventory level data at the end of each month, for each tier in the supply chain.

Observe that, when final consumer demand increases slightly from 50 units in Month 1 to 53 units in Month 2, the new inventory level demanded by the retailer’s inventory policy for Month 2 becomes 53 units. This means the retailer’s order to the distributor in Month 2 will be for 56 units: 53 units to meet consumer demand and another 3 units to increase the inventory level from 50 units to 53. The immediate demand perceived by the distributor in Month 2

| Month | Supplier | | Manufacturer | | Distributor | | Retailer | | Consumer |
|-------|----------|----------|-------------|----------|------------|----------|---------|----------|
| 1     | 50       | 50       | 50          | 50       | 50         | 50       | 50      | 50       |
| 2     | 98       | 74       | 74          | 62       | 62         | 56       | 53      | 53       |
| 3     | 2        | 38       | 38          | 50       | 53         | 53       | 53      | 53       |
| 4     | 74       | 56       | 56          | 53       | 53         | 53       | 53      | 53       |
| 5     | 50       | 53       | 53          | 53       | 53         | 53       | 53      | 53       |
| 6     | 53       | 53       | 53          | 53       | 53         | 53       | 53      | 53       |

*Figure 2.5* Simplified Illustration of the Bullwhip Effect on a Supply Chain with Four Links That Serves the Final Consumer

*Source:* Adapted from Slack et al. 2013
is therefore 56 units. Due to the distributor’s own inventory policy also calling for them to keep one month’s worth of demand in inventory, the distributor’s system determines that its inventory level must increase from 50 to 56 units. To account for that, the distributor places an order to the manufacturer for 62 units: 56 units to meet the retailer’s order and another 6 units to increase their own stock from 50 to 56 units. This distortion of actual consumer demand continues through the other supply chain nodes increasing in amplitude as the distortion moves upstream.

In Month 3, consumer demand is again 53 units. The retailer therefore orders 53 units from the distributor, who redefines the inventory level to be 53 units, causing it to place an order for only 50 units to the manufacturer (because three of the units required are taken from inventory, decreasing the inventory from 56 to 53 units). The effect propagates these new distortions all the way to the end of the chain. This continues to occur in subsequent months until the chain finally achieves stability in the form of the new demand baseline of 53 units that is universally adopted in the sixth month. Figure 2.5 shows how demand volatility (variation) is amplified as consumer demand information travels upstream in the chain as a result of distortions caused by adjustments being made to inventory levels at each stage in the chain. Note that this increased demand volatility must be satisfied by the supply side of each supplier-customer relationship in the chain and that satisfying it demands more resources and increases costs.

This simplified example demonstrates the bullwhip effect but in a much less severe way than what is found in real supply chains (see Wanphanich et al. 2010; Dominguez et al. 2014 for analyses of the bullwhip effect in more complex situations). This is because, in this example, the supply chain works with a single product; there are no competing chains, final consumer demand is relatively stable, and there are no requirements for minimum order quantities to be produced and shipped. In real supply chains, the bullwhip effect and its consequences are much more severe.

Under real-world business conditions, there are five causes of the bullwhip effect that are analyzed below, together with strategies to counter them (Lee et al. 1997; Correa 2014):

1. The first cause of the bullwhip effect is uncoordinated forecast updating between stages of the chain. It is apparent in the example of Figure 2.5 that, when a chain company perceives an increase in its immediate demand, there is a tendency for this increase to be seen as indicative of a trend. This perception causes the company to review its demand forecasting and, based on that, to increase its inventory and place larger orders to its supplier; this behavior tends to flow upstream in the supply chain, perpetuating and increasing the distortion. One solution for this growth in volatility is to increase coordination and information exchange between the chain stages (Ciancimino et al. 2012) so that data about actual consumer demand is shared and therefore, more visible to all links in the chain, similarly to what Wal-Mart practices with its suppliers with its Retail Link tool. Retail Link is a large database of daily sales with great granularity maintained by Wal-Mart and to which suppliers can have access to better forecast demand and plan their operations and inventories. This way, companies upstream work with better knowledge of the (sell-out) market demand.

2. The second is batching in production and/or transportation. Whenever batches form in production and/or transportation, there is distortion in the demand information from customer to supplier. Batch distortion occurs when, for instance, a retailer facing a stable daily market demand pattern for a product orders large replenishment batches from the distributor to save in transportation, say ordering a full truckload whenever the retailer inventory level falls below a certain quantity. The stable market demand is “distorted” when information travels upstream in the supply chain by the ordering policy of the retailer. The consequence is that
the distributor perceives a “lumpy” demand (large quantities ordered at once) coming from the retailer. Fighting to reduce batch distortion can help reduce demand volatility in supply chains. Supply chains can combat batch distortion both in production, via initiatives such as set up reduction (see Shingo 1985 for a good reference), and in transportation, via the use of shipping options that allow for the efficient transportation of smaller and more frequent quantities of products, such as by using third-party logistics providers and/or milk runs. The term “milk run” is a reference to traditional milkmen, who delivered milk to homes every morning. In modern logistics, it refers to a fixed regular schedule of periodic deliveries or pickups (Correa 2014).

• The third cause is related to price fluctuations. When price fluctuations occur, for example, with promotions, products with reasonably stable demand become less stable. For example, when the prices of diapers are reduced in a promotion, demand increases in the short term when the parents stockpile the product, but then demand drops, causing an artificial variation in sales that distorts perceived demand as information flows upstream in the chain. One solution is what retailers like Target do when using “everyday low prices” (EDLP) policies. They limit their use of promotions so as not to distort consumer demand data. The less the supply chain’s demand fluctuates at the consumer level, the less dramatic the bullwhip effect will be for that chain.

• Next, we look at product rationing/opportunistic behavior as a cause for the bullwhip effect. Whenever there is a temporary rationing of a product for some reason, perhaps because of a surge in demand, accompanied by a simultaneous lack of production capacity to meet the surge, suppliers will often deliver only a part of the total orders they receive from each customer downstream in order to avoid leaving any one customer totally without the product. As a natural response, customers will artificially inflate their orders to obtain the full amount needed. This type of customers’ action can distort the number of orders even further, intensifying the bullwhip effect. Supply chain managers need to analyze the chain’s means of dealing with product shortages to ensure that that their policies will not induce undesirable behavior in customers that end up adding volatility to the chain.

• The final cause is related to delays in the flow of materials and information: Supply chains that process physical products depend upon the flow of the materials they require; long lead times to obtain such materials can create difficulties. Delays in information flow can also be problematic. The longer the lead times that are experienced in a supply chain, the greater the bullwhip effect will be in that chain (Saab and Correa 2005). A poorly thought-out decision to replace a nearby supplier with a supplier located on the other side of the world can expose the supply chain to considerable risk because of the longer lead times, both in the flow of information and materials, which increase the bullwhip effect. The solution here is to fight delays and to shorten lead times. This can be done either by maintaining closer (physical or organizational) relationships with suppliers or by increasing the agility with which information and materials flow through the chain.

### 6.4 Risk Assessment in Supply Chains

Risk assessment and risk management have been a matter of concern to global supply chain executives because with increasing complexity and globalization, supply chains have become much more intricate and interconnected. On the one hand, global supply chains offer enormous opportunities for cost reduction and access to talent and resources wherever they are located. On the other hand, risk substantially increases in global chains. Supply chains become longer with
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more inter-dependent links, and links that are potentially more diverse as well, with the result that complexity increases exponentially.

While in the past, supply chain managers were mainly concerned with costs and quality, ensuring a continuous flow of supply is now at least as important.

The vulnerability of a company or supply chain to a risk factor is a measurement of the potential a given risk has to cause significant harm to the organization.

In general, the mechanisms of risk management require some sort of method to evaluate the probability of the occurrence of a risk factor and some way to evaluate the impact of its occurrence considered simultaneously to define which priority actions should be adopted to reduce the probability of the chain being affected by the risk factor and/or to reduce the negative consequences for the chain, in case the factor manifests itself.

The joint consideration of the likelihood and consequence of possible risk factors (later described in this section) can be represented with a graphic as shown in the Vulnerability Map in Figure 2.6 and frequently used to assess the vulnerability of a company or a supply chain to certain risk factors.

In the Vulnerability Map, risk factors for a supply chain are identified and each risk factor is assessed in terms of its likelihood of occurrence and its impact on the supply chain, if and when it occurs. Based on the assessments of likelihood and impact (severity), all risk factors are then plotted on the Vulnerability Map. Then, based on where the risk factors fall on the map, the vulnerability of the supply chain to the risk factor is evaluated and actions are taken to mitigate the overall risk. The four quadrants of the Vulnerability Map are briefly discussed.

**Quadrant 1: High Likelihood–Severe Consequence (High Vulnerability):** Risk factors in this quadrant are those to which the operation is most vulnerable. Imagine that these risk factors could be the seizing of a nuclear power plant in Central Europe following the attacks in the Belgium Airport and Underground in 2016. Motivated by the attention from the Belgium attacks, several terrorist groups became interested in this type of action, increasing its likelihood. Obviously, the effects are almost impossible to calculate with precision, since substantial human losses can be involved, and those losses are also the most devastating. These risk factors deserve priority treatment both in terms of actions to reduce the likelihood of their occurrence via preventive measures and actions and preparations to make sure that the supply chains bounce back as quickly and inexpensively as possible whenever the risk factor in analysis causes a disruption.

![Figure 2.6 The Vulnerability Map](image)
**Quadrant 2: Low Likelihood–Severe Consequence** (Medium Vulnerability): This includes the events with low likelihood but with severe potential impact. Imagine the incidence of a tornado striking a factory in Florida, in the US. Although the likelihood of a tornado hitting a specific location in Florida is low, the damage from an event like that would likely be very extensive, due to the destructive capacity of a tornado. Here, given that the likelihood of occurrence is already low, risk-mitigating actions should focus on increasing ability of the supply chain in analysis to recover once a disruption has occurred.

**Quadrant 3: High Likelihood–Light Consequence** (Moderate Vulnerability): This includes events that companies deal with on a daily basis, making use of their planning and control systems. Examples include moderate delays in the delivery of raw materials, equipment failures, accidents that occur while transporting products to a distribution center, among others. These incidents are likely to happen from time to time in most environments but cause only moderate impact. Companies routinely have safety stocks and other resources and control mechanisms on hand to deal with these issues.

**Quadrant 4: Low Likelihood–Light Consequence** (Low Vulnerability): The risk factors in this category certainly do not rank high in the priority list of risk managers for a supply chain. These are events that are not only unlikely but, should they occur, have a negligible impact. Issues and risk factors in this quadrant are substantially less consequential than risks in other quadrants and should not be priorities in terms of actions to mitigate risk.

### 7 Conclusion and Directions for Future Research

The management of global supply chains do not represent a disruptive change, such as a “volcanic eruption,” but rather, they represent another stage of evolution in the expansion of scope that the area of POM has been experiencing since the beginning of the 20th century. This is important because, as it is an incremental process, this evolution does not require, strictly speaking, a totally new set of solutions but rather many of the solutions developed historically in other stages of this expansion can be used (and/or adapted) to meet current and future needs. This fact became apparent in our discussion of a number of fundamental concepts of supply chain management in the previous sections of this chapter. It is a fact, however, that this evolution is occurring in a more accelerated form than in previous phases, and it is also a fact that the levels of volatility, complexity, and social pressure on supply chains today and in the future do not have historical precedence, requiring all the competencies needed in the previous phases of evolution and some additional ones. Chapter 36 addresses the future research opportunities for POM in SCM.

### Acknowledgements

I would like to thank my Graduate Assistant Bryan Basnight for his help with the literature review and formatting of this chapter.

### References and Bibliography


