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Chapter 12

Managing Risk in Global Supply Chains

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With supply chains stretched around the globe, how can companies manage the inherent risks of moving raw materials, components and finished products across diverse cultures, currencies, and regulations? This chapter discusses two basic types of risk management issues in global supply chains: matching supply to demand and addressing disruptions to supply chain activity. On the first issue, there is much to be learned from options-based thinking and flexibility/risk-sharing features of contracting theory. Innovations such as B2B marketplaces, in particular, offer opportunities to manage and mitigate risks. On the issue of disruption risks, a body of literature on so-called “operational risks” provides guidelines for best practice in the identification of potential vulnerabilities and an array of response mechanisms for spotting potential problems before they become disasters.

The Taiwan earthquake of September 1999 sent shock waves through the global semiconductor market.¹ The terrorist attack on the World Trade Center on September 11, 2001, also led to significant disruptions of global supply chains in many industries. As supply chains have become more complex and geographically dispersed, the risks of

disruption have increased. In addition, increasingly lean designs and global supply chains, snaking through a network of suppliers to reach dispersed global markets, have created new risks in matching supply and demand.

These two types of risks – disruption and coordination (supply/demand matching) – have become increasingly important and complex in global markets. How can companies identify and better manage these risks? In this chapter, we examine the emergence of supply chain management, the nature of these risks, and strategies for addressing them.

GLOBALIZING SUPPLY CHAINS

Globalization has made supply chains more complex, with significant implications for design and risks. Up until the late eighties, the emphasis was on manufacturing and selling products to rather protected markets, but the creation of common markets and regional regulations in Europe and other parts of the world led companies to centralize and rationalize their products and production networks to increase standardization and achieve economies of scale. Manufacturing plants now had to produce a specific product line for multiple countries and markets.² Manufacturing turned from being focused on technology between four walls to becoming supply chain-centric, legitimating its existence by playing an integrated role in the supply chain and new product introduction network of the company.

Parallel to the above evolution in the role of plants, in the late 1980s and early 1990s, we saw an evolution from logistics as an activity (i.e., bring products from point A to point

B) to supply chain management as a necessary function to integrate complex global networks of design, procurement, manufacturing, distribution, and sales. This occurred in parallel with increasing outsourcing of logistics activities to third parties for reasons of cost as well as scope (“logistics is not our core competence!”). Simultaneously, globalization trends pushed companies to look outside the box of their own company limits and pay attention to better coordination and integration of all activities along the total value chain. With globalization and increased outsourcing, the number of parties involved in bringing a simple product to a final consumer had significantly increased. Companies also started to recognize that all those parties contributed to the final customer experience in terms of costs, quality, speed, variety, and innovation. The pieces of this now more complex puzzle needed to be coordinated. End-to-end supply chain management was born.

THE EMERGENCE OF SUPPLY CHAIN MANAGEMENT

With the emergence of supply chain management came a broader view of the supply chain. A supply chain is essentially a network consisting of suppliers, manufacturers, distributors, retailers, and customers (Figure 12-1). The network supports three types of flows that require careful design and close coordination:

- 1) ***material flows***, which represent physical product flows from suppliers to customers as well as reverse flows for product returns, servicing, and recycling;
- 2) ***information flows***, which represent order transmission and order tracking, and which coordinate the physical flows; and

3) *financial flows*, which represent credit terms, payment schedules, and consignment arrangements.

These flows are sometimes referred to as the “3Bs” of supply chain management: boxes, bytes and bucks. Although, traditionally, the emphasis has been on “boxes”, the physical flows in the supply chain, all three flows are equally important. From a risk management perspective, disruptions can easily occur in any one of them. For example, a regional financial crisis could have a significant impact on supply chains that flow through the region even without a direct physical disruption in the flow of materials.

As shown in Figure 12-1, the supply chain is supported by three pillars: (a) processes, encompassing such value-adding activities as logistics, new product development, and knowledge management; (b) organizational structures, encompassing a range of relationships from total vertical integration to networked companies as well as performance management and reward schemes; and (c) enabling technologies, encompassing both process and information technologies.³

From the Backroom to the Boardroom

Logistics (the term comes from the French “maréchal de logis,” the military officer responsible for organizing all camp facilities for troops at war), traditionally focused on the physical management of material flows. New supply chain designs and a more strategic view of the supply chain in the organization placed a greater emphasis on

information and financial flows, and the critical role of the supply chain in market mediation (matching supply and demand).

There has been increasing strategic attention to effective supply chain management.

While this issue has not yet reached C-level attention in many companies, supply chain management in many industries has moved from the backroom to the boardroom. In the PC business, for example, razor-thin margins are forcing producers to give meticulous attention to costs. Stock market pressures have driven companies to improve their asset management. While supply chain management originally was considered a low-level, operational issue of making the goods available at minimum cost, it has evolved into a broader view of demand-supply matching, especially for dynamic, high-margin markets requiring responsive supply chains. Supply chain management has come a long way since the maréchal de logis in Napoleon's army.

There is increased recognition of the relationship between supply chain management and return on assets (ROA). Figure 12-2 illustrates how supply chain variables impact ROA. Traditional supply chain management would only consider costs as reflected by materials and manufacturing overheads, freights and duties, and conventional warehousing costs. With increasing internationalization, companies also started to look at site location for tax purposes and other benefits such as labor cost savings. Increasing risk of supply-demand mismatches led to more attention to inventory-driven costs. The latter are the costs of having the wrong inventories at the wrong time at the wrong place. Finally, Figure 12-2 shows the impact of supply chain management on assets. Decisions about what to keep

in house and what to outsource or send offshore influence facility ownership costs, and so do decisions on what technologies to use and where to locate facilities.

New Risks

While supply chain management is receiving increased attention on the corporate agenda, the new risks resulting from supply chain innovations have not been adequately recognized. The modern supply chain challenge is to strike the right balance between product availability, cost, and asset management (see Figure 12-3), and there are risks that are inherent in striking this balance. Small inventories in lean supply chains are vulnerable to disruptions in revenue while large inventories (fat supply chains) are vulnerable to high inventory-driven costs (such as obsolescence). The risks from the rise of outsourcing and pressure on asset base reduction in recent years have not been fully understood. These complex, lean, and global supply chains are often more vulnerable to major natural and man-made disasters and altered power balances. In the following sections, we examine two of these risks in more detail: supply-demand coordination and supply chain disruptions.

STRATEGIES FOR ADDRESSING SUPPLY CHAIN RISKS

Strategies for managing the risks of supply and demand coordination and disruption draw upon three general approaches that global companies have typically used to address supply chain risks:

- ***Supply chain design:*** Design issues include facility location and sizing, product allocation, inventory points and logistics and using contracting innovations to better manage volume and price risk along the supply chain. Redesign activities to decrease cycle times and waste (usually in the form of excess inventory, equipment or facilities) from supply chains have been the chief preoccupation of Operations Management researchers and practitioners throughout the 1990s. The key risk management question is: What is the appropriate balance between leanness and robustness to disruptions?
- ***Contracting:*** There has been a veritable revolution in the literature and practice of contracting in supply chains, through both innovations in standard, negotiated contracts between individual buyers and sellers, as well as via B2B and B2C exchanges.⁴ Contracting and market instruments have been developed to convey better information on supply and demand, including price discovery and reduction of transactions costs of Buyer-Seller interactions. From a practitioner's point of view, the integrated use of these Internet-based contracting mechanisms, as facilitated by the new exchanges, represents a real opportunity for improved risk management of the supply chain.⁵
- ***Risk management systems:*** The disciplines for analyzing, quantifying and managing disruption risks also have matured significantly in the past three decades. The field of risk analysis/management in industrial contexts consists of four integrated processes: (i) identifying underlying sources of risk and

determining the pathways by which such risks can materialize, (ii) estimating the potential consequences of these risks under various scenarios, and (iii) mitigating these consequences and providing financing for residual risks; (iv) designing appropriate emergency response and crisis management systems. This chapter will be concerned primarily with the first three of these processes.

These three general approaches to managing supply chain risks have been applied to the specific challenges of supply-demand coordination and disruption, as discussed below.

MANAGING SUPPLY-DEMAND COORDINATION RISK

Arguably the central problem in supply chain management is efficient coordination of supply and demand, including price discovery and reduction of transactions costs of buyer-seller interactions. In particular, a key concern of supply chain management has been avoiding the “bullwhip” phenomenon – in which delayed or distorted information has led to amplification of demand volatility moving upstream along the supply chain from the market – which can lead to costly mismatches between demand and supply (shortages, obsolescence, poor capacity utilization).⁶

Technologies such as web-based tools have helped improve coordination and remove information distortions. Effective supply chain contracts have also helped align incentives to mitigate mismatches between supply and demand.⁷ These innovative designs have increased transparency and coordination. A classic example of the latter is the collaboration between Wal-Mart and Proctor and Gamble leading to the now widespread

practice of Vendor-Managed Inventory. Other innovations included Efficient Consumer Response and systems to support Everyday Low Pricing. Companies also developed modular products and processes to manage product variety and used late product differentiation or postponement to reduce demand-supply mismatches.

New technologies also have increased “clockspeed” of supply chains in many industries,⁸ but these faster speeds have also increased risks. These technologies have drawn many companies in many sectors into a higher-risk, higher-revenue situation. The stakes increase, and the tolerance for error decreases. Both clockspeed and bullwhip effects can jeopardize capabilities to react to sudden demand shifts and therefore entail high risks of costly demand-supply mismatches.

Leaner supply chains also increase these risks. Implementation of powerful information systems linked across supply chain partners (web-enabled ERP systems) and efforts to reduce supply chain costs led to smaller inventories and, in general, to leaner supply chains. While these leaner supply chains reduce inventory costs, companies have started to experience some of the negative consequences of leanness when their efficiency-based supply chains were not able to react to changing market demands and led to severe service deterioration. With increasing industry clockspeed, globalization, decreasing product lifecycles, overcapacity and maturing markets, the efficiency of supply chain management had often become less important than its effectiveness in demand-supply matching. Increasing complexity, more demanding customers, and low margins were increasingly making supply-demand mismatches extremely expensive (lost sales,

obsoletes, idle capacity, high inventories), and many of the cost-squeezed lean supply chains were not exactly robust to even moderate environmental changes.

Strategies for Managing Demand-Supply Coordination Risks

This again prompted some companies to revisit their lean supply chains, with a resulting set of innovations, including three-dimensional concurrent engineering for better supply chain design,⁹ dynamic demand-supply balancing to reduce mismatches (particularly in fast-clockspeed industries), closed-loop supply chains for customer return and end-of-life management dictated by environmental regulations, and the revolution in B2B markets and exchanges. Let us briefly consider each of these major trends in supply chain innovations.

(1) Three-dimensional concurrent engineering

Three-dimensional concurrent engineering (3D-CE) is a framework for dynamic supply chain design.¹⁰ It acknowledges that with today's fast industry clockspeeds, every new product constitutes a high-risk, short-life project that should be designed as such. Hence, 3D-CE encourages concurrent design of the product, the (manufacturing) process and the supply chain, and explicitly considers the interfaces among these three dimensions (Figure 12-3). Such concurrent engineering is, in turn, enabled by the architecture of the products, processes and supply chains. Design choices can make products integral (e.g., an aircraft wing) or modular (e.g., a PC). Manufacturing choices can make processes dedicated (e.g., catalytic crackers) or flexible (e.g., flexible manufacturing cells). Supply chain choices can make supply chains integral (e.g., oil refineries) or modular (e.g., PCs).

These choices support or hinder the dynamic evolution of supply chain designs as a company faces new competition, technologies or legislation.

Concurrent product/process design is by now a well-accepted concept with a vast literature on design-for-X, where X could stand for manufacturability, assembly, or disassembly. The product/supply chain interface has recently been highlighted through the market mediation role of supply chains.¹¹ A “functional product”, e.g., a tube of toothpaste, with a stable demand pattern but with thin margins would necessitate a cost-efficient supply chain, while an “innovative product”, e.g., a ski parka, with a highly unstable and short demand but attractive margins, would require a responsive supply chain. While cost reduction is the overriding concern in the former family of products, agility is vital for the latter, so the approach that works for one supply chain might be counterproductive for another. For example, implementing an *efficient* supply chain for a product requiring an *effective* supply chain may lead to low cost but it may also have very expensive consequences in terms of missed margins through lost sales.

(2) Dynamic demand-supply balancing

Demand-supply mismatches are increasingly expensive. The name of the game is to have the right product at the right place at the right time with minimal inventories in the supply chain. Customers will happily switch to a competitor’s product if the latter has the same functionality and price and if it is readily available. Customer loyalty is increasingly a thing of the past.

However, perfect demand-supply balancing is incredibly difficult in a world where, on the one hand, the supply base contains some single-source suppliers with long lead-time items and, on the other hand, technology and customer preferences change daily.

Forecasting the right quantities of the right components is close to impossible. The game then becomes one of dynamically determining what product versions can be assembled with available components and matching that with what product versions can be sold at what prices. This is a game that companies like Dell have elevated to an art. Note that dynamic demand-supply balancing requires close collaboration between designers, buyers, production engineers, supply chain experts, finance and accounting staff, and sales and marketing people. Under dynamic demand-supply balancing, the supply chain becomes a central business process, or as an executive from Zara (another expert at this game) put it to us, “The supply chain is the business model.”

It should also be clear that even when the supply-demand balancing process works well, mismatches still frequently occur. Since they are expensive, they represent substantial risks to the company’s bottom line and require fast and adequate decision-making (e.g., in selling excess stocks of components through Internet auctions). Stated differently, dynamic supply-demand balancing is just as much about trying to get it right as it is about quickly repairing mistakes. It requires a nimble business process keeping everyone’s eye on the ball continuously.

(3) Closed-loop supply chains

If one combines smaller product margins with short lifecycles and increasing environmental concerns, it becomes clear that perfect supply chain design and

coordination may not be sufficient. The small margins in the forward supply chain may easily be offset by the increasing costs of product returns. The latter may take various forms from consumer convenience returns, to repair and maintenance returns, end-of-use and end-of-life returns.

Although consumer return policies have traditionally been much more liberal in the USA, the emergence of Internet sales and the increasingly global footprint of retailers such as Wal-Mart are quickly spreading these practices globally. Wal-Mart encourages customers in the United States to return their products within 90 days of purchase if they are not fully satisfied, and there is every reason to believe that they will soon export this policy to Europe. For some Internet sales, convenience returns are as high as 35%, and for many consumer electronics products sold at retailer outlets, returns are between 5 and 10%. Most of these products suffer from large value erosion over time (e.g., a PC's sales price erodes 1% per week) and they are returned in perfect working order. Therefore, in small-margin businesses like the PC industry, being able to quickly resell these products (e.g., via Internet auctions) or to otherwise recover maximum value from them becomes very important for global profitability.

In addition to returns, companies are increasingly expected to take responsibility for the full life cycle of their products, including disposal, effectively extending the supply chain far beyond the purchase. Spurred by NGOs and consumer pressures, regulators have passed Producer Responsibility laws. The European Union, for example, recently adopted the WEEE (Waste Electrical and Electronic Equipment directive) that makes producers

responsible for organizing product take-back from consumers at no cost as well as for environmentally friendly disposal. Companies such as Sony expect that this directive may cost them as much as 1-2% of revenues, which is enormous considering the small profit margins of some of their products.

Hence product take-back, value or material recovery and effective disposal become important considerations in product and supply chain design and management. Note that this evolution again requires much closer cooperation between different functions and (external) partners. Indeed, until recently, neither design nor sales and marketing were interested in or concerned by product returns, even though both functions have a big impact on value recovery (e.g., through facilitating disassembly and pushing sales of recovered products and components).

All of the above reverse product flows need to be integrated in supply chain design and management considerations.¹² Companies will need to increasingly adopt a lifecycle approach to supply chain management and carefully evaluate the corresponding risks. When added to our earlier statement about the need to simultaneously design the product, the process, and the supply chain (3D-CE), this lifecycle argument, which adds all reverse flows to the normal forward supply chain flows, suggests calling this four dimensional concurrent engineering (4D-CE). These return flows (for environmental or other reasons) make supply chains increasingly close to the core of the business (increased complexity, multi-functionality, impact on bottom line, and higher risk).

(4) B2B Exchanges and Supply-Demand Coordination Risk

The development of B2B markets and exchanges has advanced the potential of strategic risk management of coordination risks. These exchanges build upon the developments of Material Requirement Planning (MRP), Enterprise Resource Planning (ERP),¹³ and supply-chain-wide Collaborative Planning Forecasting and Replenishment (CPFR) Systems. These online markets and exchanges enhance normal procurement and negotiated supply relationships with market-based price discovery and fulfillment.

A central feature of B2B, especially for capital-intensive industries with non-scalable production facilities, is that contracting needs to take place well in advance of actual delivery. Failure to do so is a recipe for last-minute confusion and huge excess costs. This has given rise to a general recognition that most of a plant's or service facility's output should be contracted for well in advance. However, there is still a very important role for short-term fine-tuning of capacity and output to contract for, say, the last 10% of a plant's output or a customer's requirements. Doing so requires a conceptual framework, and supporting market instruments, that allows contracting to take place at various points of time, constrained by commitment and delivery options and flexibilities, and mediated by electronic markets where these are feasible.

B2B exchanges create possibilities for integrating contracting and market structure with operational decisions (capacity, technology choice, production) to help manage coordination risk.¹⁴ While there are a variety of options for the design of these exchanges, a common feature of most electronic markets supporting coordination risk management

in global supply chains is the following: Any particular buyer has only a small set of sellers who compete for the buyer's business in the contract market, while still having access to a larger set (sometimes a much larger set) who compete in the shorter-term market (the spot market) and whose actions determine a competitive spot market price. The spot markets serve as a second source of supply as well as a means of evaluating the price levels of contract purchases.

These exchanges have been applied to electric power,¹⁵ commodity chemicals, natural gas, semiconductors and plastics, and many other capital-intensive goods. B2B exchanges provide non-manipulable indices of value for various important operational choices (capacity, utilization, contracting, and technology) so that, for the first time, senior management and the market can see, in the light, how good company capacity, demand management and fulfillment decisions are for sellers and how good procurement strategies are for buyers. Thus, if the historical probability distribution of price for daily or weekly delivered spot price is known, this provides both the means for better management of contracting decisions for this good and a clear benchmark for valuing short and long contract positions by either buyers or sellers. In the resulting integration of spot and contracting markets, contracting serves both the important role of reinforcing price discovery in the spot market as well as the obvious direct role of coordinating capacity commitments with anticipated demand.

Implications for the Management of Global Coordination Risks

What are the key implications of these innovations for global operations and strategy?

The flexibility of three-dimensional, concurrent engineering and dynamic demand-supply balancing can help companies better anticipate and respond to dynamic changes in global supply and demand. The consideration of closed-loop supply chains can help companies address shifts in consumer patterns such as increasing returns or changes in regulations such as those requiring companies to be responsible for the entire lifecycle of a product. The integration of spot markets with global sourcing and contracting is revolutionizing both the valuation of supply chain contracts as well as giving rise to new risk hedge instruments based on spot prices as underlying value indicators. Together these strategies are the bow wave of a revolution to integrate risk management with supply chain operations, procurement, capacity management, and technology choice.

MANAGING DISRUPTION RISK

In addition to the risks of mismatch in supply and demand, disruption is an increasing risk in global supply chains. With longer paths and shorter clockspeeds, there are more opportunities for disruption and a smaller margin for error if a disruption takes place. We will discuss strategies for addressing two fundamental aspects of disruption risk: those arising from purposeful agents, including terrorism risks, and those related to accidental triggers, including natural hazards.

Strategies for Addressing Purposeful Triggers

For purposeful triggers (e.g., those resulting from terrorist acts), a process that has been known in the military for some time is useful, that of role playing or “red-blue teaming”

approaches. Under this approach, a company's own supply chain experts, equipped with whatever information is available, attempt to "attack" the supply chain to cause major disruptions. The Red Team in this exercise generates a set of scenarios that they believe can lead to serious disruptions. The Blue Team attempts to provide mitigation or countermeasures that are cost effective against the Red Team scenarios. A multi-level exercise at each link of the supply chain directed towards uncovering significant vulnerabilities can be very effective both in understanding the vulnerabilities of a supply chain to disruptions as well as in making members of the risk management team aware of what can be done to either mitigate these or at least to be prepared to respond to them. The exercise begins at the process level for critical processes and equipment, proceeds to manufacturing and warehousing sites, and finally to the division or company level. At each level, red-teaming generates vulnerabilities that are either resolved at that level or passed on to the next level for resolution.

In addition to risks such as terrorism, another source of purposeful disruption can come from shifts in regulations. For example, as noted above, the European Union WEEE regulations on product take-back entail huge risks for companies. These shifts in regulation represent significant strategic shifts in the design and operation of supply chains. A similar scenario-based approach to red-teaming can help to assist in the discovery and mapping of regulatory shifts, political risks and associated supply chain strategies. For many global products, global producers simply can not afford to have separate designs for different countries or markets. As a consequence, for example, environmental legislation in Europe will change designs of products sold in the United

States and the rest of the world. Thus, directives like the WEEE are forcing companies to adopt strategic monitoring systems and responsive supply chains to ensure that their processes (and hence products and services crossing the world's borders) can economically anticipate and respond to these product and process constraints imposed by regulation and law.

Strategies for Addressing Accidental Triggers

For accidental triggers, benchmarking (both internal and external) and industry or sectoral studies can provide an on-going basis for understanding the sources of major disruption. The use of external, industry-wide benchmarks for identifying sources of disruption risk is nicely illustrated in the work of Wharton Risk Center on the accident history data reported under 112(r) of the Clean Air Act Amendments. The tragedy at Bhopal in 1984, followed by a subsequent release of the same substance, methyl isocyanate, from a facility in Institute, West Virginia, resulted in great public concern in the United States about the potential dangers posed by major chemical accidents. This public concern was translated into law in section 112(r) of the 1990 Clean Air Act Amendments. This section sets forth the requirement that regulated facilities maintain a five-year history of accidental releases and submit this history to the EPA (beginning June 21, 1999). The data collected have been analyzed in a series of studies by researchers at the Wharton Risk Center, and this research has uncovered key financial and facility factors that appear to be precursors of supply chain disruptions.¹⁶ Data analyses such as those based on 112(r) data and on the corresponding MARS (Major Accident Reporting System) data in the European Union represent a significant step in

understanding the scope of accidents in the chemical and process industries and in promoting more effective accident prevention and mitigation.

When such sector-wide data are unavailable, companies must rely on internal company-centric approaches to identify sources of operational risk and managing accident precursors. Recent work on Near-Miss Management Systems provides a roadmap for designing and implementing such company-centric approaches.¹⁷ As in the quality arena (e.g., ISO 9000), the approach begins with identifying and blue-printing key processes in the supply chain, with appropriate vulnerabilities identified from red-teaming and historical data. Supply chain participants then define metrics for assessing the performance of each of the key processes in the supply chain on selected risk dimensions. Operating personnel use these metrics and their own judgment about observed abnormal conditions to report “near misses” that serve to identify potential vulnerabilities in its sites and overall supply chain. Just as in the quality arena, the key to effective Near Miss Management is committed employees, using appropriate tools to monitor and track key processes, seeing the results of their actions implemented in risk reduction activities over time. Coupling these risk identification and mitigation activities with on-going environmental, health and safety procedures integrates employees and managers into a fertile fabric that generates improved knowledge on their part about the risk precursors in the supply chain and opportunities to mitigate these. Internal or external auditors play an important reinforcing role in assuring compliance with company policies.

Implications of Disruption Risk Management

Companies with hazardous chemicals or with fire or health hazards used to be alone in their concern with operational disruptions. Not so any more. Terrorist attacks, the collapse of major banks through operational failures, accounting scandals, product liability lawsuits, and severe natural catastrophes have had the combined effect of focusing the attention of senior executives in many industries on worst case scenarios that could disrupt normal operations, with potentially disastrous consequences for the company. The result has been a thorough reassessment of companies' ability to assess, mitigate and, if need be, respond to hitherto neglected operational vulnerabilities. Senior risk officers, global supply chain managers, and CEOs have now recognized the critical importance of organizing and managing disruption risks. The classical discipline of risk management, augmented by newer approaches to deal with purposeful agents, has been the starting point for these new initiatives and, thus far, seems to be providing a solid foundation for further progress.

IMPLICATIONS AND CONCLUSIONS

Globalization and the application of new technologies and designs to supply chains have increased risks and made supply chain management a more central strategic concern. The two types of risks considered in this chapter, while important, are not the only risks to global supply chains. Among these other risks are currency and other financial risks, as touched upon by Bodnar, Dumas, and Marston in Chapter 11. There also are risks from changing regulations and flows of information across borders, as considered by Kobrin and Kapstein in Chapter 15.

As discussed in this chapter, there are also a rich set of strategies for addressing these risks. These include both innovations in supply chain design, in market institutions and contracting, and in new technologies and business models designed to address supply chain risks. These risks can also be addressed through management system and planning innovations such as Near-Miss Management Systems and red-teaming for vulnerability assessment. Together, these innovations provide powerful tools for identifying and managing risks of supply-demand coordination and disruption.

While there are no simple approaches to addressing these complex challenges, it is clear that risk management has begun to assume a much more important role in strategy. No longer is it the case that supply design decisions are made on the basis of pure cost and revenue determinants, or even combined financial measures such as ROA. Rather, these simpler metrics are being augmented by detailed risk assessments measuring the impact of supply chain decisions on the entire distribution of profits and returns, including the potential consequences for earnings that might occur through disruptions to normal supply chain operations.

There are a host of interesting implications arising from the above considerations for practice and for research related to improving the practice of risk management of supply chains. These are yet to be explored as we attempt to determine what best practices have emerged in industry related to supply chain risk management, including: organizing to coordinate risk management at the SBU and Corporate levels; new models of

decision making to accommodate/profit from risk; internal and external monitoring and management systems; integration of insurance with operational risk management; and the integration of such practices with existing process management practices and ERP systems. These represent significant challenges in striking the right balance between leanness and robustness of supply chains, to manage the risks and increase the returns of global supply chains.

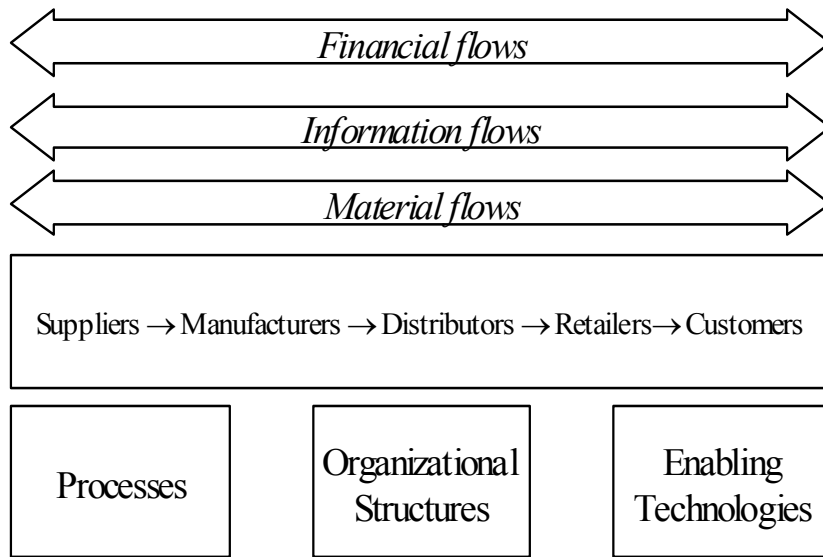


Figure 12-1. The Supply Chain

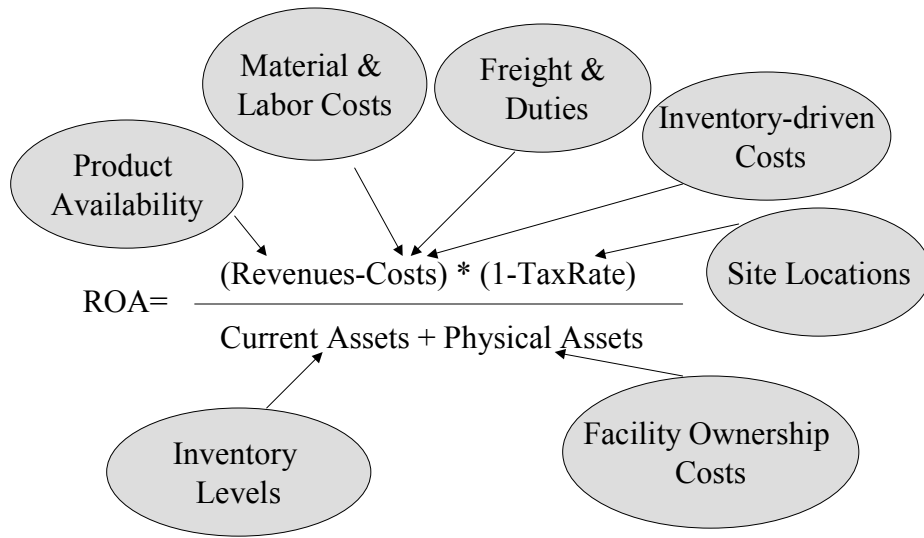


Figure 12-2. The Supply Chain's Impact on ROA

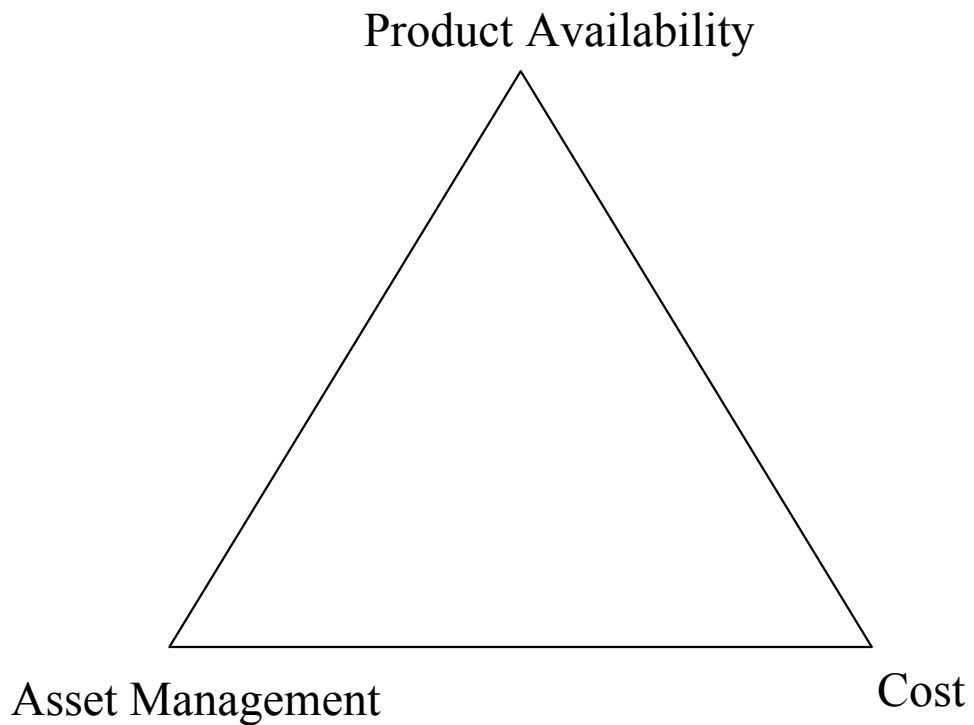


Figure 12-3. The Supply Chain's Balancing Act

NOTES

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