



# Supply Chain Complexity – Dealing with a Dynamic System

By Zohar Yami, Golan Meltser and Rotem Greener

Examining how to prevent, reduce and manage the increasing degree of complexity in supply chain

What is our first reaction when we hear about supply chain complexity? If we are honest, the term often conjures up negative connotations and our gut feeling is that this is something to be avoided or neutralized where possible. But what is really behind the mask?

In order to understand what supply chain complexity means, let us first examine the word “complexity”.

Complexity describes a system of multiple parts, interconnected in a non-linear style. In non-formal terms, complexity is:

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

Supply chain complexity is therefore a system with a broad range of variations. A typical example would be a globally operating corporation with multiple production sites, all of which are in contact with numerous distribution centers worldwide, supplying thousands of end points. In an attempt to further examine this dynamic form of business, PRTM launched the 2006 Supply Chain Complexity Study in conjunction with the Supply Chain Council and the MIT Supply Chain Strategy newsletter. The objective of this study was to help companies understand the impact that supply chain complexity has across their supply chains, and to illustrate the measures taken by leading firms to gain an enhanced operational edge in their industries.

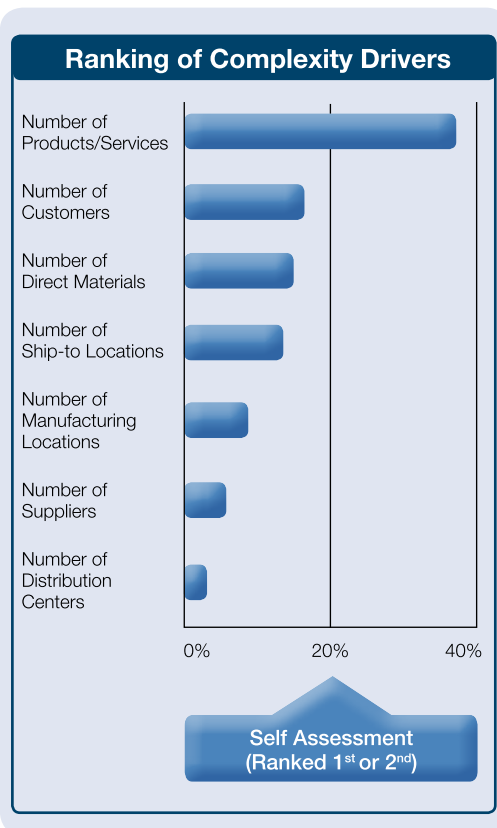
The study revealed that roughly 80 percent of the participating companies believed their supply chains to be highly complex. In addition, almost 60 percent of the participants also thought that their supply chains had a high infrastructure cost basis.

## Product/Service Proliferation as Top Complexity Driver

The study highlights the impact of product and service proliferation across the supply chain as perceived by the participants, regardless of industry or size. Almost 40 percent of all participants identified the number of products and services provided as either their top or second most significant complexity driver.

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

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



However, there is a significant gap between the complexity management practices that companies perceive to be important and their ability to identify and track effective metrics for those practices. Less than 60 percent of the participants currently track the performance of those complexity management practices which they consider to be important.

To help us understand the subject and the options for handling it, we can differentiate between three main aspects of complexity:

- Operational complexity
- Logical complexity
- Administrative complexity

This article will focus on the first two aspects.

### Operational Complexity

Over the last decade, corporate procurement has changed significantly. In the past, companies commonly used decentralized procurement, with each division/factory handling the matter on an independent and local basis.

The next and more advanced step was to create a specialized procurement department for the entire organization. Although this increased complexity, there is no doubt that this generated significant added value and countless benefits, including specialization at an organizational/group level; a broad system-wide view, with enhanced transparency and control; quantity discounts; process standardization and a reduction of internal costs.

Another factor which has contributed to procurement complexity is the borderless global economy, expressed in a multitude of factors:

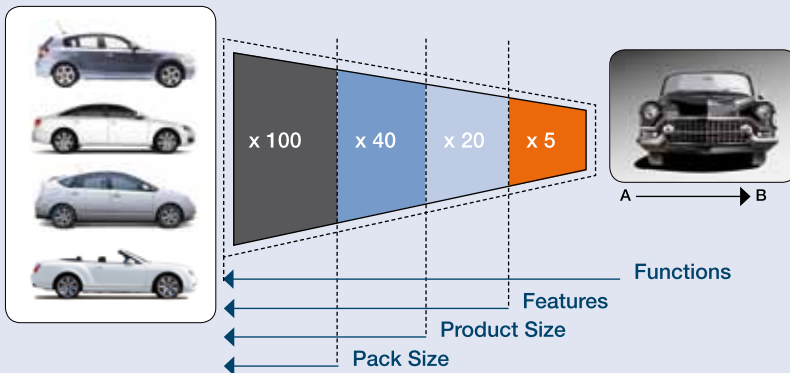
- Diverse logistics with numerous transportation options (sea, land and air), requiring that organizations make daily decisions to remain competitive.
- Unpredictable influences on supply times, such as port strikes, natural disasters, etc., forcing businesses to increase their level of safety stock to maintain the level of service.
- Navigation of foreign regulations and legal restrictions
- The need for professional cultural and linguistic specialization in order to benefit from the opportunities offered by the global economy.

One way of dealing with unpredictability is to increase direct control of the value chain. Over the past decade, corporate mergers and acquisitions have become a popular choice for this reason. However, the drawback is that this only serves to increase supply chain complexity still further, as we see the local character of business giving way to a global identity.

As a result of this globalization trend, single-factory manufacturers have suddenly been faced with the management of several production sites simultaneously, some of which are overseas. The specialization of production centers; a need for customer/supplier proximity in order to minimize transport and distribution costs; risk management and disaster recovery plans are only some of the issues presented by this new level of complexity. Supply chains are flooded with a host of new challenges and a multitude of opportunities, including the logistic complexity of inter-site transport; reduced flexibility in the event of production line failures; planning process complexities and capacity balancing headaches, in order to increase Overall Equipment Effectiveness on the one hand while still minimizing logistics costs on the other; making decisions on what to manufacture, where to manufacture it, and where to source raw materials; not to mention overall management and control of inventories and processes. Although opening up the global market creates a welcome increase in opportunities, corporations are also now suffering from the decision-making battle, which goes along with the benefits.

Another reason for operational complexity is the way in which we manufacture our products. There are four main stages in the product life cycle that increase the number of product

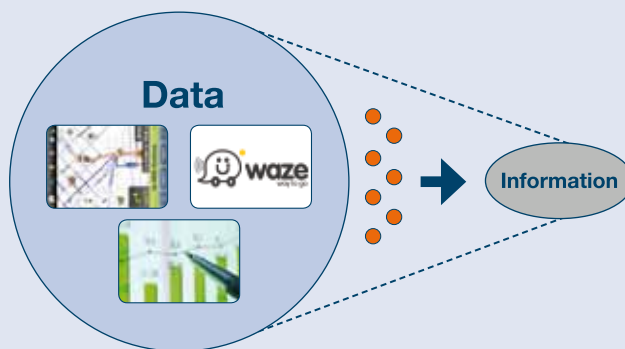
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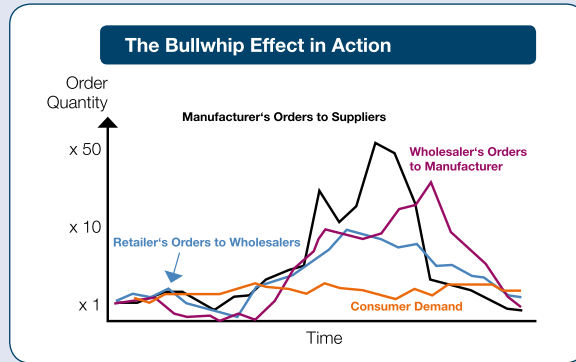


components, thereby directly affecting supply chain complexity: functions, features and attributes, size, and packaging. At each stage of the process, the number of components increases in line with the order of magnitude.

In recent years, customers have become more sophisticated and focused in their demands. Companies are now under pressure to satisfy this changing trend through differentiated products, designed for narrower segments. One example of this has been the mobile phone industry. In the early nineties, when these devices were used as a primary means of communication, the number of these products on the market and the diversity of functions were relatively low.

Today, the mobile phone market is one of the most active and fast growing sectors in the world. Producers need to keep pace with the speed of technology – leading to more features and attributes – while still fulfilling the demand for visual aspects (design, size, color), new trends and differentiation to boost social status. As the number of devices booms, in an attempt to appeal to different markets with their individual cultures and tastes, the complexity of the supply chain has also risen. As if operational complexity was not enough, increased regulatory requirements have also created new constraints. The effects of these on the supply chain can be seen in higher inventory levels (raw materials and finished product), which directly influences chain costs (financing, handling,





management, storage), planning process complexities (build to stock vs. build to order, loss of efficiency due to switching between products), as well as location and display costs in stores.

**Information Complexity**

As technology advances (internet, social networks), we are exposed to a greater volume of data, which needs to be constantly filtered and processed in order to derive useful information

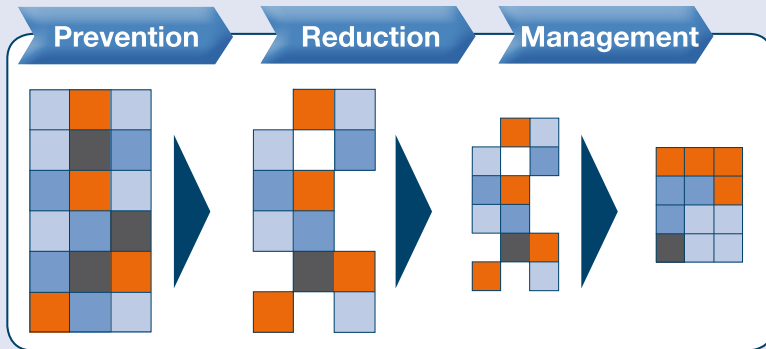
However, in our rapidly changing world, this information is sometimes only valid for a limited time, as in the case of prices, currency exchange rates, weather conditions, etc. The reliability of data may also suffer due to disinformation or manipulation by the information/data provider. When our information is obtained from so many different sources, many of which are beyond our immediate understanding (foreign languages and different cultures), it becomes virtually impossible to always keep tabs on accuracy. Despite this, information continues to play a significant role in corporate decisions and because of this has a profound effect on the complexity of supply

chains. There is an ongoing need to filter and process data into information in order to satisfy the demand for quick decisions and fast response times and to feed the appetite for multi-disciplinary knowledge. The unceasing search for more information forces companies to protect their knowledge databases, leading once again to even greater complexity.

Incorrect or incomplete information can also lead to amplification in demand, more commonly known as the Bullwhip Effect, a phenomenon in which we see the demand grow as we move up the supply chain, due to changes in end-customer consumption.

This phenomenon has many implications for supply chain complexity. Managing demand variance influences the entire chain, from raw material purchasing to production preparations and distribution networks. However, changes in end-consumer consumption and demand are not the only drivers for upstream amplification in the supply chain. A key cause of this problem can often be found in intra-organizational

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processes, involving fragmentation of the value chain into multiple organizations/organizational divisions, all of which are operating in highly-competitive global markets where it is difficult to forecast demand, price fluctuations and sales promotion campaigns. One of the challenges faced by the supply chain is to cope with unpredictable demand at different stages of the chain i.e. between the various organizations involved, leading to high variance and instability in production; increased stock levels/shortages; reduced service levels; erroneous demand forecasts and more.

### Improvement and Management

Complexity will remain an integral part of an organization's commercial activity. However, we need not become its slave. The recommended way to get on top of the challenges it poses is to apply the principle of prevention, reduction, and management.

Prevention of complexity is achieved by analyzing the root causes of complexity and quantifying this as a monetary value, thereby permitting a comparison of complexity costs with the

commercial benefit of each root cause. In cases where the cost of complexity outweighs the benefits, the answer is to avoid the element creating complexity. When it is not possible to avoid complexity at an organizational level within the context of the business environment, we need to find creative ways to reduce complexity by adapting organizational processes and methods. Irrespective of whether we prevent or reduce the complexity, we still need to invest a managerial focus on the subject of supply chain complexity, using control and management tools to monitor and restrict complexity-related damage.

Let us examine how to apply the prevention principle by looking at the introduction of a new product into an existing product line. When introducing another product, we tend to only consider direct costs. However, a full analysis, which also takes complexity into account, could reveal a different picture, even resulting in the product being dropped. Take the example of a company manufacturing toiletries, which decides to add a product variation (cat. no.) to an existing line (for example: a new shampoo scent).

Another way to prevent complexity is at the development stage. Professional planning is one of the key means of preventing future complexity.

Use of the correct metrics to identify complexity as a basis for prevention, reduction and management is the main management tool required.

In addition to direct costs for raw materials and labor, there are additional indirect effects, such as:

- Procurement of specific raw materials in small quantities (high inventory costs, financing costs)
- Indirect chain costs (job order/order line) – QA production planning and control, warehousing
- Marketing – advertising and launch promotion

In addition to the economic analysis and quantification of complexity into a monetary value (financing, procurement and operational costs), we must remember that the new product will also result in cannibalization of existing products, and thus causes loss of revenue. This all needs to be taken into account and weighed up against the expected benefits to be gained from the introduction of the new product.

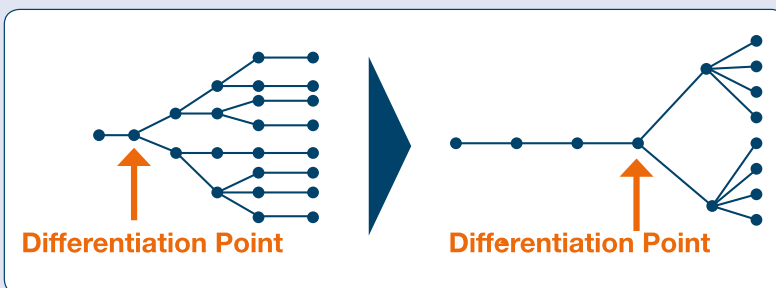
Another way to prevent complexity is at the development stage. Professional planning is one of the key means of preventing future complexity. For example, telephones and advanced electrical appliances include a physical platform for interfacing with additional components, although these features are not enabled when the product is first launched. This forward planning saves recalling products for upgrades or launching new solutions when the feature is required.

Intelligent planning can also reduce maintenance complexity. The fact that the end customer can carry out some of the ongoing maintenance himself, for example replacing the filter on a water dispenser, shows how easy it is to significantly minimize the logistical complexity, which would have been incurred had the filters needed to be replaced at the company’s facilities. Thanks to proper planning during development, this complexity was successfully prevented.

A reduction in complexity can be expressed through a proper balance between centralized and decentralized planning. Total centralization of processes at the organization’s headquarters does not always result in added value. Sometimes, decentralization of processes and use of classic lean systems, such as pull-based raw materials supply planning instead of centralized management by the procurement department, can significantly cut complexity levels.

Another example of how to reduce complexity is by building a streamlined and optimal operational and business model, which pushes the differentiation point upstream, i.e. – use of generic products in processes, pushing the differentiation point to the customer’s order.

In the paint industry, for example, the final color requested by the end-customer is mixed at the



time of sale. Paint companies supply the bases, the colors and the necessary mixing tools, in order to offer a wide selection of colors. The fact that the differentiation point has been pushed to the point of sale itself has significantly reduced the logistic and operational complexity which would have otherwise been required.

Use of the correct metrics to identify complexity as a basis for prevention, reduction and management is the main management tool required. Examples of complexity management can be found in the transfer of assembly responsibility to suppliers and the continuous reduction of “long tail” components, plus reduction of demand variance not caused by the customer and correct management of sub-contractors, resulting in a significant balancing of demand.

## Examples

Southwest Airlines only operates 737s, while American Airlines operates as many as 14 types of aircraft, resulting in a need for 14 kinds of mechanics, pilots etc. Over the past five years, Southwest’s share price has doubled, while American’s has sunk to near zero.

Toyota uses internal standardization techniques to minimize complexity, but it has never eliminated complexity at the expense of a customer’s desire for quality and variety. Toyota currently builds its entire variety of cars and trucks on 13 platforms that can easily be customized. Each platform derives its subassemblies and parts from a book of standardized designs. Toyota’s lower cost basis has allowed the company’s share price to hold steady over the past four years, while Ford lost 75 percent and GM lost 50 percent of its value.

Dell Computer recognized that the increasing number of features had added a layer of internal manufacturing cost, downstream distribution cost and dealer markups. Dell devised a

business model that eliminated the internal complexity that led to high costs, while offering external complexity to provide customers with what they want when they want it. As a result, Dell can produce any model, with any feature, in less than three days, while keeping its total cost to half that of its competitors.

## Conclusion

In the future, globalization and technological advances will cause ever greater complexity in the supply chain. Organizations will have to deal with complexity on a daily and continuous basis in order to remain competitive, keep costs down and raise service levels. Prevention, reduction and management of complexity are key managerial tools which can be used for ongoing and optimal minimization of supply chain complexity, including:

- Reduction of “long tail” customers, cat. nos., suppliers with low sales turnover which increase complexity without adding value
- Continuous examination of item costs along the supply chain (landed cost analysis) and emphasis on local procurement/production decisions, reducing total supply chain complexity
- Pushing the differentiation point, understanding end customer demand, standardization of elements of which the customer is not aware, and involving the supply chain in product development processes, thus avoiding unnecessary complexity along the chain
- Local and lean management versus centralized, multi-system management to reduce supply chain complexity.

Zohar Yami, Partner, Tefen Israel

Golan Meltser, Associate Director, Tefen Israel

Rotem Greener, Project Manager, Tefen Israel