Operations and Supply Chain Strategy

4

Learning Objectives for This Chapter

- Operations strategies and "strategic fit"
- Efficient and effective supply chain strategies
- Bullwhip-effect
- Vendor-Managed Inventory (VMI)
- Collaborative Planning, Forecasting, and Replenishment (CPFR)
- Supply chain resilience and sustainability
- Ripple effect

4.1 Introductory Case-Study "Quick and Affordable": Zara, UNIQLO & Primark

4.1.1 Zara's Three Success Factors: Speed, Speed, and Speed

Zara is a global fashion retailer which sells its goods around the world. The retailer's international footprint proves that national borders are no hindrance to a shared fashion culture. Founded in 1975, the Spanish retailer Zara has stores strategically located in leading cities across the continents (https://www.inditex.com/brands/zara), launches more than 10,000 new designs each year, and is recognized as one of the world's principal fashion retailers. It belongs to the INDITEX Group, which also holds common brand names like Pull&Bear, Bershka, and Stradivarius.

Find additional case-studies, Excel spreadsheet templates, and video streams in the *E-Supplement* to this book on www.global-supply-chain-management.de!

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Zara is well known for its up-to-the minute styles and products. The main key to their corporate strategy is their SC strategy. The following statement by INDITEX gives the first hint of this exclusive strategy: "Our approach to fashion—creativity, quality design and rapid turnaround to adjust to changing market demands—has allowed us to expand internationally at a fast pace and has generated an excellent public response to our retailers' collections" (Inditex 2014).

While many retailers design and produce around 80% of their season's inventory, Zara keeps back 50% to be produced in the middle of the season. This way they can react if, for example, the hot trend of the current season is skinny instead of boot-cut jeans. A full team of fashion experts keeps an eye on upcoming trends in each country on university campuses, night clubs, and fashion shows. All research and design activities are steered from Zara's headquarters in La Coruña in Spain. For production, Zara has its own high tech factories and a number of subcontractors. However, Zara keeps outsourcing to a minimum and produces primarily in developed countries to provide better quality control. To keep responsiveness at the highest level, many garments are kept in a generic unprinted stage. This approach is called postponement strategy, since products can be modified from generic to finished according to customer demand.

Procurement offices in the UK, China, and the Netherlands deal with all purchasing activities. In manufacturing, Zara links the two sites of SC strategies. On one site they import 40% of their products as finished goods from low-cost countries. This strategy is used for "basics," or products that are unchanged by fashion trends such as white and black T-shirts. All other materials are bought from Mauritius, New Zealand, Australia, Morocco, China, India, Turkey, Korea, Italy, and Germany. Zara tries to source locally instead of globally, thus reducing transportation costs.

Short lead times are another key factor for Zara. Where other fashion companies supply every 3 months, Zara replenishes its stores twice a week. The company provides the necessary fundamentals for subcontractors to meet their agreed upon delivery times.

To implement its SC strategy, ZARA redesigned its inventory management. Previously, goods were shipped from two central warehouses to each of the stores, based on requests from individual store managers. These local decisions, when assessed on a global scale, inevitably led to inefficient warehousing, shipping, and logistics operations. Production overruns, inefficient SCs, and an ever-changing marketplace (to say the least) were some of the problems which Zara had to overcome.

A variety of SCOM models was used in redesigning and implementing an entirely new inventory management system. The new centralized decision-making system replaced all store-level inventory decisions, thus providing results that were more globally optimal. Since implementation, having the right products in the right places at the right time for customers led to increase in sales from 3% to 4%.

Inventory at Zara is kept a smidge under the estimated sales levels. For example, if demand increases immensely for clutch purses, they can assign emergency orders. In this way, the company is able to deal with sudden demand changes. However, when the opposite is the case, Zara's management determined that the potentially

lost customers would be less costly than slow moving or last season's products. Speed is Zara's key strategy. All products are to leave the warehouse after a maximum of 3 days. At the end of each season, Zara reduces the price of its products up to 30% to sell remaining stocks.

All items arrive at the stores ironed, on hangers, and with price tags, saving valuable time for staff. Zara's pricing is based not on the classical cost plus margin principle, but on setting prices according to comparable items in the local market. Because of this, it is possible that the same product has a different price in each European country. To make price tagging easier, Zara previously attached a tag on its goods showing all prices and goods could easily be shifted from one country to another with reduced complexity. Today, bar codes are used to tag the products, and these can be read via a scanner, showing the local price in the local store. This also enables Zara to keep up-to-date information about when and where goods are sold. All information is analyzed at headquarters so that particular strategies can be adapted if necessary.

Marketing is minimized, as Zara sees all promotion activities as distracting for the customer. The company has managed to present itself as a fashion retailer with ever-changing and up-to-date styles with good quality at affordable price levels. Customers value exactly these assets—making all additional marketing efforts unnecessary.

4.1.2 UNIQLO: Basic, Casual Wear at Top Quality

UNIQLO does the exact opposite of Zara, but is no less successful. UNIQLO is one of the largest and fastest growing Japanese companies and ranks third among fashion retailers worldwide following Gap and Marks & Spencer. The mother company, FAST RETAILING CO. LTD, which also owns brand names GU and Theory, was founded in 1963 in Japan, where it still has its head office in Yamaguchi-City. High-quality and affordable products are valued more highly than chasing the newest trend.

Products are rather casual and basic, making them occasion- and age-less, but still stylish, using various colors and cuts. As a result, UNIQLO meets customer demand for clothes without presenting them on the catwalk.

UNIQLO has multiple production and purchasing offices in Asia which look after more than 100 suppliers each week. By doing this, the company is able to maintain good quality control over their outsourced partners. If issues concerning quality arise, they are immediately taken to the production units where means for improvements are found. Currently, UNIQLO is seeking to expand their purchasing and production facilities to meet demand in the United Kingdom and the United States.

UNIQLO controls its inventory carefully to maintain optimum inventory levels for each week. At the end of each season, products are sold for 20–30% less than the initial price to get rid of inventory.

Additionally, the fashion retailer has found a new place for selling clothes: railway stations. The concept works fabulously for UNIQLO. Shinjuku Station is Tokyo's biggest rail station and the UNIQLO store there ranks 6th out of 770 UNIQLO stores. Popularity of so-called one-day packs with basics like socks and underwear has also risen.

UNIQLO follows the SPA model (specialty store retailer of private label apparel) which is a specialized model where fashion retailers track all business activities from the point of origin up to the point of sale. This approach enables UNIQLO to improve its business processes quickly and constantly, giving the company an advantage over its competitors. Through long-term relationships with suppliers, UNIQLO is always seeking ways to improve its SC. This affects selling prices. By optimizing its SC, the company has been able to lower prices up to one third compared to its competitors.

UNIQLO promotes its products on posters, flyers, or TV, hinting which items will be put out for sales the following week.

4.1.3 Primark: It's All About Money

A lot for a little is what customers value when visiting Primark stores, leaving with huge bags full of new fashionable clothes which cost not even half of what competitors offer. Primark belongs to Associated British Foods, a company selling food and clothes. Since the first store opened in Dublin, Primark has quickly expanded and today has more than 250 stores all over Europe. In the future, the company plans to open even more stores in more countries.

The product is based on simple designs with fashionable prints. To save costs Primark focuses on selling only the most popular sizes.

Primark's customers demand catwalk fashion items at supermarket price levels. That's why it is all about money for Primark. Primark's products are sourced from more than 600 suppliers, mainly from low-cost countries. Buying and selling in high volumes and using economies of scale allows Primark to cut down selling prices for the customer. The company uses the off-season to produce in advance and uses cheaper production periods. Primark uses a typical and efficient make-to-stock strategy where the focus is to (guess what?) cut costs.

In addition, Primark has little mark-up on their products and avoids marketing efforts, as it trusts to mouth-to-mouth advertising. As a result, prices are comparatively low.

Criticism has risen concerning the sustainability of low-cost retailers, as many workers in low-cost countries suffer poor working conditions. This has also caught the attention of some customers, which is why retailers such as Primark try to counter a negative ethical image, e.g., bus disclosing their suppliers.

Discussion Questions

1. What is the danger of mixing elements ("hybrid strategy") from both agile and lean SC strategies?
2. Contrast and compare Zara, UNIQLO, and Primark concerning their primary goals, product designs, manufacturing, inventory, suppliers, lead times, and pricing strategies.
3. What factors are critical for each SC strategy?
4. What do you think of UNIQLO's decision to open new facilities in UK and US?
5. Which roles does information technology play for SC coordination?
6. How do the SC strategies of Zara, UNIQLO, and Primark support their competitive strategies to achieve "strategic fit"?
7. Are you concerned about sustainability issues in apparel SCs?

4.2 Operations and Supply Chain Strategies

4.2.1 Value Added and Costs

Value added and costs are two basic, dominant factors in SCOM. Value creation can be achieved in different ways, e.g., through innovation, unique service, or quality. Any process has value-added steps, but these require resources which increase the costs. Of course, good processes have to be designed with a high degree of value-adding time and short periods of non-value added time. This increases both *effectiveness* and *efficiency*.

However, in practice the opposite situation often occurs. In many cases, the value-added steps hardly comprise more than 20% of the total time, and more realistically estimations are about 5–7% (Vrijhoef and Koskela 2000; Christopher 2011). This relation between value-added time and costs can be depicted as shown in Fig. 4.1.

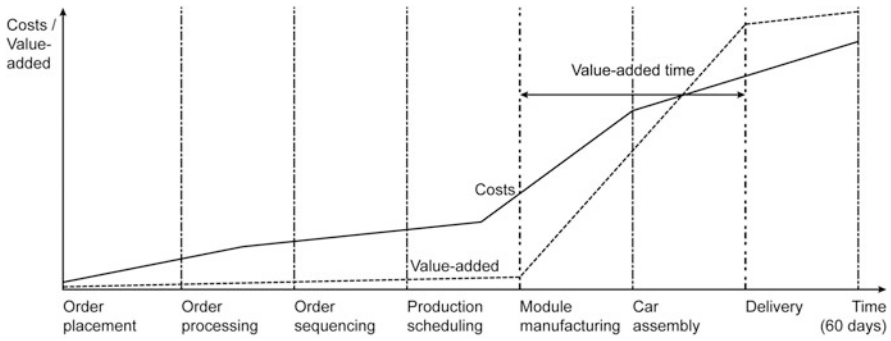

Fig. 4.1 Value-added and costs

It can be observed from the car manufacturing example above that value-added time is short compared to the increase in costs. The general recommendation is therefore to condense the cost creation steps to reduce the lead-time and increase the service level. A nice illustration of this idea is the following: a doctor has to remove a tick, and the act itself takes only 10 s, but the patient will spend at least 10 min in the room since 9 min and 50 s will be required to fill in the numerous forms and medical insurance documents. In this case, the value-added time is only 1.7%.

4.2.2 Operations Strategies

Since different ways exist to create value and reduce costs, different operations strategies can be classified as follows:

- Innovation strategy
- Efficiency strategy
- Quality strategy
- Service strategy

The main driver in *innovation strategy* is great product or service innovation. Creating value through unique product or service properties may significantly increase a company's margins while maintaining cost efficiencies. An example of this is Apple, and its transition from the iPhone3 to the iPhone4. While the manufacturing costs were only slightly increased, the price was almost doubled. SCM with an innovation strategy should enable fast and smooth introductions of new products and sales increases.

In an *efficiency strategy*, price is the main competitive advantage. IKEA is well known for its highly efficient logistics and manufacturing. All the steps in the value chain support the efficiency strategy. Starting with consideration of manufacturing and logistics at the product design stage, the operations at IKEA follow this philosophy in all other areas such as production, sourcing, and shipments (Heizer and Render 2013).

A *quality strategy* ensures a competitive advantage based on superior product properties. "Made in Germany" has been associated with high quality standards for many years. For such products, costs may be higher since in all operational areas decisions are taken in favor of quality. Quality control mechanisms are crucial for ensuring high quality in the SCs.

A service or *responsiveness strategy* means a high priority for customer preferences in operations decisions. Zara is known for its highly responsive operations and SCs. This is possible through sophisticated facility location planning and production in small batches. Both create additional costs, but these are covered by higher value-added activities (Chopra and Meindl 2015).

4.2.3 Supply Chain Strategies and "Strategic Fit"

A SC strategy should correspond to the competitive and operations strategies. Matching enterprise competitive strategy and SC strategy is called "strategic fit" (Chopra and Meindl 2015). *Strategic fit* presumes the alignment of objectives in different departments with the overall SC objectives. For example, typical decisions in marketing relate to product mix and pricing. This should be brought into correspondence with logistics decisions such as transportation, packaging, and transshipment.

▶ **Practical Insights**

Consider an example. Walmart has a marketplace strategy that mainly focuses on the high availability of a variety of reasonable quality products at a lower pricing level. Its products are not differentiated by technological advancement or unique design elements and can be purchased at other retailers as well. The competitive strength of Walmart lies in high availability and low prices which Walmart's customers consequently expect from the mega retailer. In order to be in line with the marketing focus introduced, Walmart has adapted its SC appropriately. For example, Walmart has its own SC infrastructure and all distribution networks are fully owned. In addition, they buy from low-cost producers only. This SC strategy fully supports Walmart's business focus of providing low prices and an everyday guarantee for product availability. Thus, Walmart represents a successful example of strategic fit (Chopra and Meindl 2015).

SC strategies and SC contributions to competitive and operations strategies are shown in Table 4.1. A SC strategy does not often target only one factor. Only decreasing prices to the lowest level may be an option. At the same time, a SC strategy needs to be matched to company and customer requirements. Consider in detail efficient and responsive SC strategies (see Table 4.2). Characteristics of agile SCs are a fast response to customer demand, low inventory, and flexible suppliers. Also, lead times are reduced to enable a swift reaction to demand fluctuations. Margins are comparatively high to suitably fulfill the company's financial needs.

Table 4.1 SCM strategies [based on Cohen and Roussel (2013)]

Strategy	Advantages	Competitive basis	SCM contribution
Innovation	Unique brand or technology	Innovative and high demanded products	Quick introduction of new products and innovation
Costs	Cost-efficient organization	Low prices in product segment	Efficient, lean SC organization
Service/ Response	Flexibility	Customer-orientation	Agile SC is developed from customer point of view
Quality	High-quality products	Unique product properties	Quality control along the SC

Table 4.2 Efficient and responsive SC strategies [based on Fisher (1997)]

Criterion	Efficient supply chains	Responsive supply chains
Primary goal	Supply demand at the lowest cost	Respond quickly to demand
Product design strategy	Maximize performance at minimum product cost	Create modularity to allow postponement of product differentiation
Pricing strategy	Lower margins because price is a prime customer driver	Higher margins because price is not a prime customer driver
Manufacturing strategy	Lower costs through high utilization	Maintain capacity flexibility to buffer against demand/supply uncertainty
Inventory strategy	Minimize inventory to lower cost	Maintain buffer inventory to deal with demand/supply uncertainty
Lead time strategy	Reduce, but not at the expense of costs	Reduce aggressively, even if the costs are significant
Supplier strategy	Select based on cost and quality	Select based on speed, flexibility, reliability and quality

Responsive SCs are best fit where market requirements are unpredictable and changeable.

When looking at lean SCs, almost always the opposite is the case. The market situation is stable in demand and price. The variety of products is also comparatively low. Efficient SCs concentrate mainly on lowering costs via high capacity utilization, minimizing inventory, and contracting suppliers from low cost countries. Accordingly, margins are kept at a low level. Lean SC strategies also try to reduce lead time, but not at the expense of higher costs.

While choosing a strategy, it is sometimes advisable to go for a mixed approach. A poor strategy might endanger the company, perhaps by its not positioning itself prominently enough in the market, with the additional risk of encountering other negative factors. Some situations require a clear position in the lean or agile SC. However, many companies have a wide product range. For some products, market conditions may be stable; for others, however, they may be volatile and unpredictable. For these companies, a hybrid strategy of applying elements of responsiveness and efficiency for their particular products is advisable.

As a part of SC strategy, the definition of pre-assembled components, modules, or systems is paramount. These modules or systems should be pre-tested and should be ready to install shipped directly from the supplier to the point of usage on the shop floor of the producer. Furthermore, early cooperation between the supplier of the modules and its customer will also help to increase the usage of standard parts in higher volumes, which will also result in reduced costs due to economies of scale.

Case-Study: Agile Supply Chain in the Latin American Food Industry

Production companies for consumer goods, distributors, and retailers suffer today from high pressure from competitors. The challenge for SCOM is to respond quickly to market changes and customer demand, while at the same time reducing costs. This

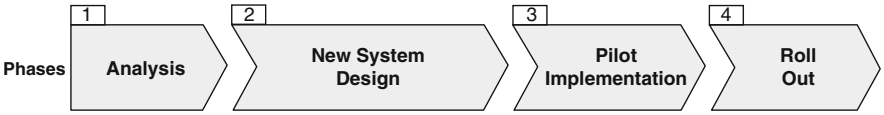

Fig. 4.2 Phases in the supply chain optimization project

case study reviews the main initiatives and the results of a SC optimization project which took place in one of the world's leading nutrition companies for babies and children in Latin America. The underlying company merchandises more than 70 products in over 50 countries. The objective of the SC optimization was to increase SC agility by synchronizing all the processes involved in order to reduce the overall lead time. Every process was redesigned to deliver only what was needed by the next process, and only when the next process needed it.

An agile SC can be defined as a "network of different companies, possessing complementary skills and integrated with streamlined material, information and financial flow, focusing on flexibility and performance" (Costantino et al. 2012); this was also the focus of the initiatives that were implemented in this case study.

The project was implemented in the Latin American division which has its headquarters, production site, and distribution centers in Mexico, and its distributors in eight countries in Latin America. The project was divided into four phases (see Fig. 4.2).

The first phase describes the *Analysis*, where the company's current SC situation was analyzed and defined. The second phase, the *New System Design*, had as its objective the strategic development of new processes to enable SC agility. The third phase, the *Pilot Implementation*, applied the new processes on a representative product family. The last phase, the *Roll Out*, embraces the total implementation of all products and markets.

In the analysis phase, the total lead time (the time from supplier until sale to final customer) was mapped. It indicated 188 days for Mexico and 295 days to export to Latin America (which is the average for all countries). The fairly long lead time was mainly caused by high inventory levels and large production batch sizes. At the same time, fill rates at the retail stores indicated less than 90%, and shelf life varied from 0 (out of stock) to 139 days, mainly caused by poor forecast accuracy and replenishment strategies. Hence, the main obstacles faced at the beginning of the project were high inventory levels, long response, and lead times, all caused mainly by large batch sizes produced at production facilities. The overall number of products was pushed downstream through the distribution channels without alignment with real demand. The distributors, keeping high inventory levels, were also used to push the products to their respective markets. Further downstream, the retailers offered discounts and ran promotions in order to move the inventories pushed on from the distribution channel, generating pressure on sales margins. The pressure on margins is subsequently passed on upstream, since volume discounts usually result in lower margins for distributors and manufacturers (see Fig. 4.3).

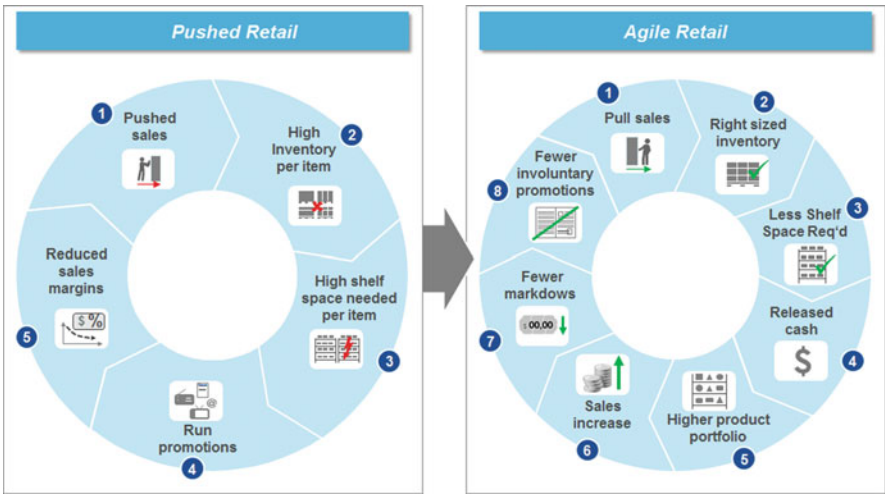

Fig. 4.3 Transition from push to agile SC

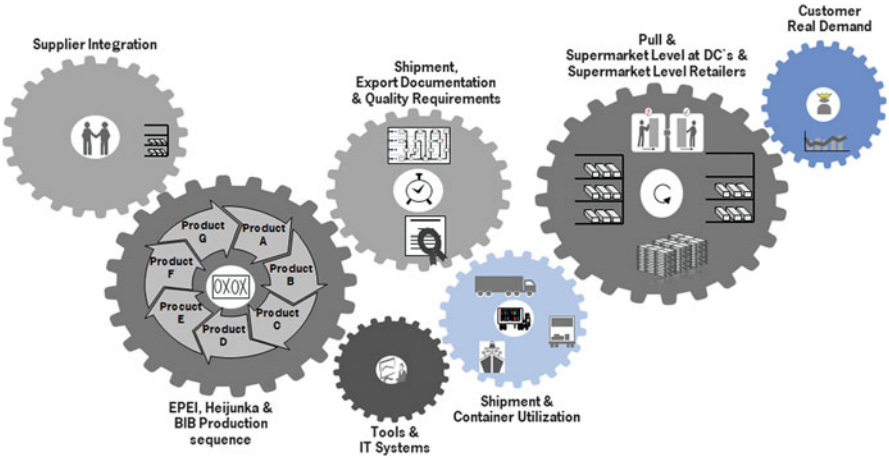

Fig. 4.4 Agile supply chain. *EPEI* every part every interval, *BIB* batch-in-batch

After a detailed analysis of the information and material flows, the future vision and implementation plan were detailed at the second phase of the project: New System Design Phase. The design for installing new processes included synchronization tools for all processes for all points of the SC in order to align production, consumption, and material movements (see Fig. 4.4).

The current information systems also needed to be redesigned in order to handle the new process structures. A very important point was the definition of scheduling methodologies and the definition of production and transportation lot sizes.

At the roll-out phase, the implemented processes needed to be stabilized for all products, markets, suppliers, and customers. As a result, it became possible to decrease lead time by 80% from supplier to local consumers and by 55% from supplier to export markets.

During the pilot implementation, a production plan with a higher "production frequency" and smaller lot sizes was implemented for one production family. Synchronization processes and systems were introduced for the main suppliers and customers. For this product family, 72% of inventory reduction was achieved.

Introducing an "agile SC" concept allowed a reduction in inventory shortages, and decreased lead time, while at the same time reducing inventory levels throughout the entire SC. In the underlying project case, this was achieved by using transparent point-of-sale (POS) data as input, which reflects real customer demand. Consequently, customers find a fresher product, when they need it and where they want it, thus increasing sales, turnover, and revenue all along the SC. The real end-customer demand combined with higher production frequencies allows the adjustment of correct size inventory levels for all points in the SC, be it local or global. Adequate inventory levels and higher production frequency not only reduce lead times, but also allow for a faster response to consumer demand. Hence, replenishments are managed on lower volumes, but with higher frequency.

Implementing agile systems brought various advantages to the SC. Since production responds to real demand, the company is less likely to build up unnecessary inventories, thus freeing up cash, and reducing working capital as well as costs for expensive warehouses, distribution centers, and obsolete products. Sales on the retailers' side also increased as service levels were improved and fresher products were replenished more frequently to fill the shelves to an adequate inventory level.

4.3 Supply Chain Coordination

4.3.1 Bullwhip Effect

The *bullwhip effect* is not a new phenomenon in the industrial world (Forrester 1961). The effect can be explained as the magnification of variability in orders in the SC. In other words, irregular orders in the downstream part of the SC become more distinct upstream in the SC. This variance can interrupt the smoothness of SC processes as each link in the SC will over- or under-estimate product demand, resulting in exaggerated fluctuations (see Fig. 4.5).

Many retailers, each with little variability in their orders, can cause great variability for a smaller number of wholesalers, and even greater variability for a single manufacturer. The main reasons for the bullwhip effect can be divided into behavioral and operational areas (Lee et al. 1997; Sterman 2000):

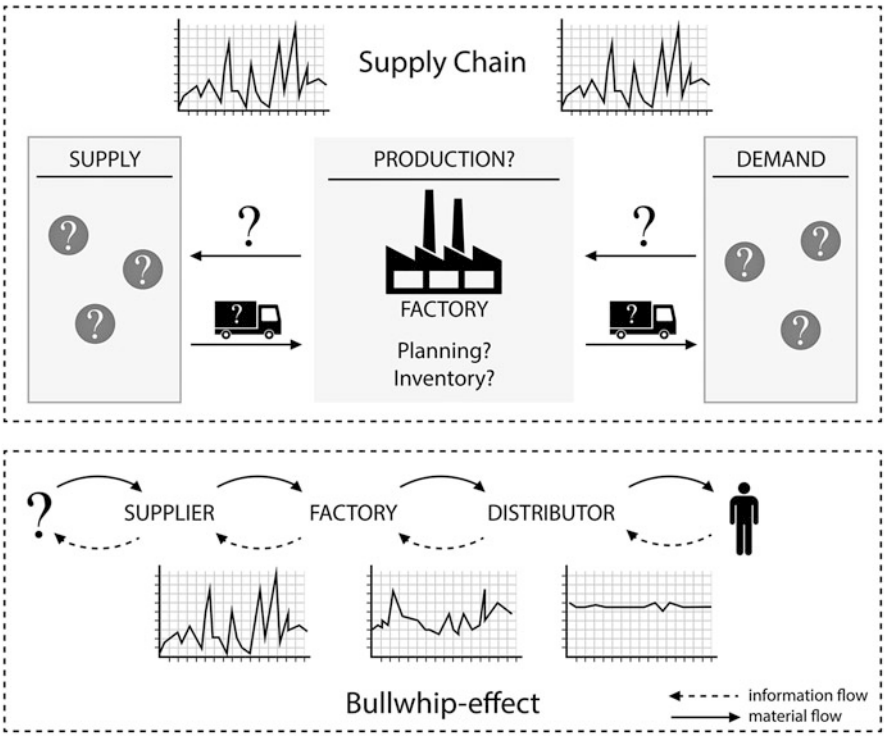

Fig. 4.5 Bullwhip-effect in the SC

Behavioural Causes

- misuse of base-stock policies
- misperceptions of feedback and time delays
- panic ordering reactions after unmet demand
- perceived risk of other players' bounded rationality.

Operational Causes

- dependent demand processing (demand is non-transparent and causes distortions in information in the SC)
- lead time variability
- lot-sizing/order synchronization
- quantity discount
- trade promotion and forward buying
- anticipation of shortages.

Table 4.3 Elimination of bullwhip-effect

Reason for bullwhip effect	Countermeasures
Demand non-transparency	Information coordination
Neglecting to order in an attempt to reduce inventory	Automated ordering and monitoring of inventory in order to avoid overstock or shortage
Order batching	Coordinated and accurate lot size definition
Promotions	Use of everyday low prices (EDLP) instead of promotions
Shortage gaming	Validation of customer demand through historical data of customer ordering
Product returns	Policies to control returns or canceled orders.

Negative consequences, higher safety stocks, inefficient production (surplus or shortage), and low or peak utilization of distribution channels can be recognized. As countermeasures to the bullwhip effect, the following actions can be identified (Table 4.3).

Consider how demand non-transparency leads to the bullwhip-effect.

► **Practical Insights**
In order to reduce bullwhip-effect, it is recommended to avoid panic ordering reactions in the event of unexpected demand fluctuations. It is advisable to take into account time lags between orders and deliveries throughout the SC. It is important to understand where the demand is, where the inventory is, and where the costs are.

Task 4.1 Bullwhip Effect: Focus on Demand Non-transparency
A fast-moving consumer goods (FMCG) company is facing slight demand variation which has led to huge variations in stocks on the supplier side. The company delivers its product to consumers through the manufacturer and three suppliers. Because of the relatively low cost of changing the production rate compared to the cost of carrying inventory, the company has decided to change its production rate in order to reduce the capital commitment in the form of finished product. The task shows the effect on the manufacturer of a 10% decrease in demand from customers.

$$New\ \ order/production\ \ rate = Demand\ \ new - Safety\ \ stock\ \ old + Safety\ \ stock\ \ new \tag{4.1}$$

The initial data for analysis is presented in Table 4.4.

Now, demand has decreased by 10%. Safety stock is 25% of demand and is therefore able to cover demand of 1 week. New demand correlates with the new production rate of the predecessor SC member (see Fig. 4.6).

Table 4.4 Demand data

	Demand old	Order old	Safety stock old
Customer	1200	1200	300
Manufacturer	1200	1200	300
Supplier #1	1200	1200	300
Supplier #2	1200	1200	300
Supplier #3	1200	1200	300

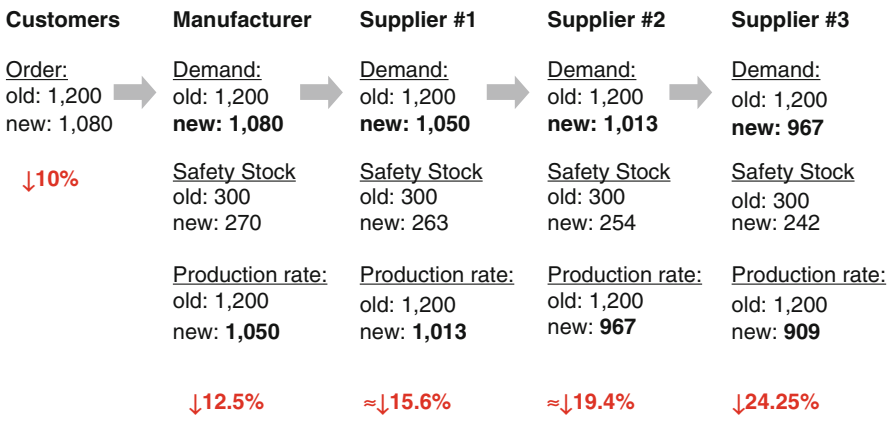

Fig. 4.6 Implications of the demand fluctuations on production rates

Each player in the SC assumes that demand forecast (or orders) for the next period is the same as in the current period. Following this assumption, each supplier will be the same as in the current period, and each supplier will be planning their production rate to cover the demand/order for the next period, which will be equal to the demand/order for the current period (e.g., the new demand of supplier #3 orients itself by the new production rate of supplier #2). The problem is that only the manufacturer can see the changes in demand on the customer side. Other players in the SC cannot see the changes in demand because of non-transparency. For that reason, the players will change their production rate and safety stocks because the predecessor changed his order without pre-informing other SC partners.

We can observe that a lack of demand transparency affects the shortage. For example, supplier #3 will not produce the right amount of pieces for customers' orders to satisfy their demand.

It can be concluded that changes on the customer side increase order quantity through the SC if demand is non-transparent. In general, communication, validation of demand, information sharing, computer aided ordering, and better pricing strategies can help reduce the bull-whip effect in this situation.

4.3.2 Vendor-Managed Inventory

Inventory typically exists to manage uncertainty of supply and demand (safety stock) and to take advantage of economy of scale (cycle inventory). At the same time, modern markets require more flexibility from SCs. Customer orders and demand change frequently. In building up high inventory, companies can increase their flexibility on the one hand. On the other hand, if demand changes, these inventory mountains will lead to losses. Consider a short example: HP and Canon worked jointly on the Laserjet printer production. Canon produced engines for different types of printers. However, HP was able to indicate changes in demand only 3 months in advance. Canon needed 6 months to change its production plans. As demand for Laserjet III drastically decreased, a huge number of engines for this printer type was in inventory and had to be written off (the Laserjet-mountain).

In order to face this challenge, SC coordination strategies extensively use the Internet and new IT. The ideas of these concepts are as follows (Heizer and Render 2013):

- Coordination instead of uncertainty
- "Replace inventory with information"
- Integrated SC
- Transparency of demand and inventory.

At the plant level, inventory is insurance against the unknown; in the SC, this "unknown" became "known" through collaboration. Inventories in SCM are leverage for SC reliability and flexibility rather than buffers against a blind uncertainty.

One of the strategies for SC coordination is vendor-managed inventory (VMI). With VMI, the vendor controls inventory on the buyer side. The buyer provides information on inventory and sales (see Fig. 4.7).

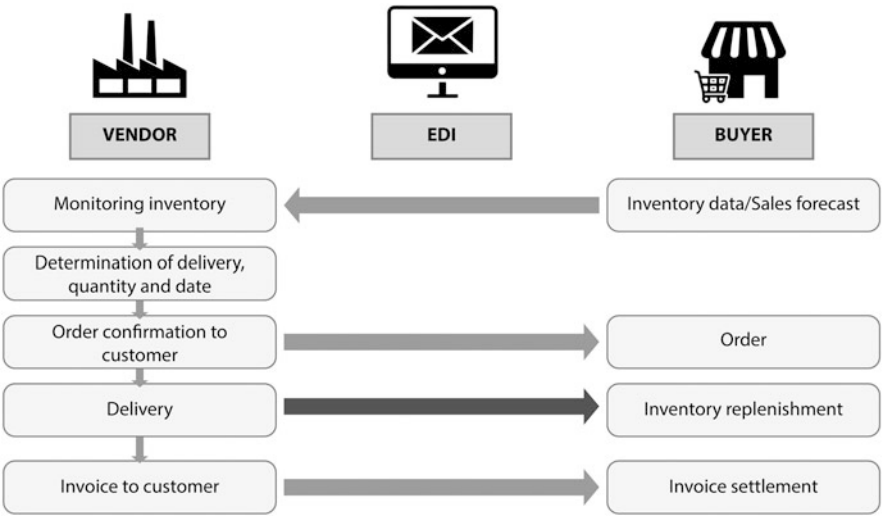

Fig. 4.7 Vendor-managed inventory strategy

VMI is a special concept of restocking and replenishing inventory that originated in retail business, the line of business where stock availability is a significant if not a crucial factor of company's success. The buyer provides certain information to a supplier, and the supplier takes full responsibility for maintaining an agreed upon inventory level, usually at the buyer's consumption location (usually a store). A third party logistics provider (3PL) might be involved to control the required level of inventory by adjusting the demand and supply gaps.

The main advantage of this concept is that the real-time inventory information is made available to the supplier (manufacturer of a wholesaler) and a customer (distributor or retailer) relinquishes control of inventory to them. The vendor reviews every item that a customer carries and is responsible for the inventory plan. Efficiency increases in process activities are based on Electronic Data Interchange (EDI) and collaborative SC organization (see Fig. 4.8).

The supplier receives an insight into stock level and demand forecast and ensures that the stock is within agreed upon limits. Consider an example of the VMI process in SupplyOn (Fig. 4.9).

The following steps are included in the VMI process at SupplyOn (Fig. 4.9):

- agree upon minimum and maximum stock limits;
- demand and inventory is transmitted from the internal ERP system to SupplyOn;
- demand and inventory is shown in the Inventory Monitor, thus the supplier can plan deliveries based on the agreed limits;
- ASN (Advanced Shipment Notification) is entered by the supplier and transmitted to the internal ERP system;
- while the goods are being dispatched, the Inventor Monitor shows them as in-transit quantities;

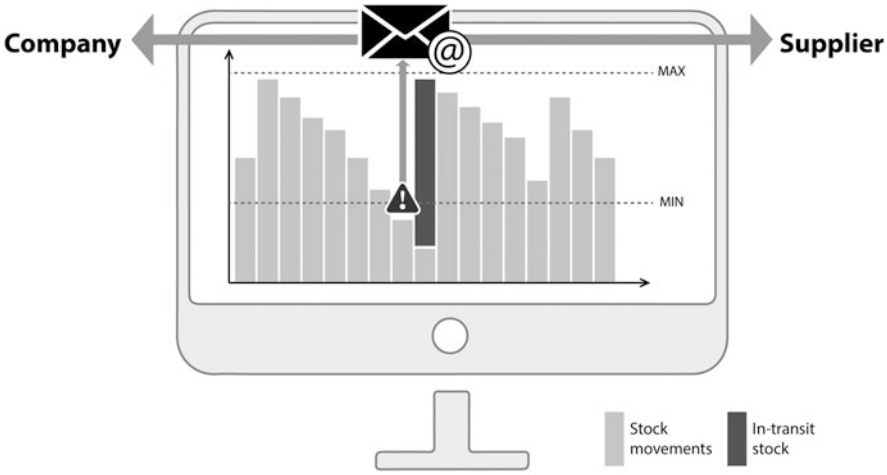

Fig. 4.8 Alerting concept in VMI (based on SupplyOn, used with permission)

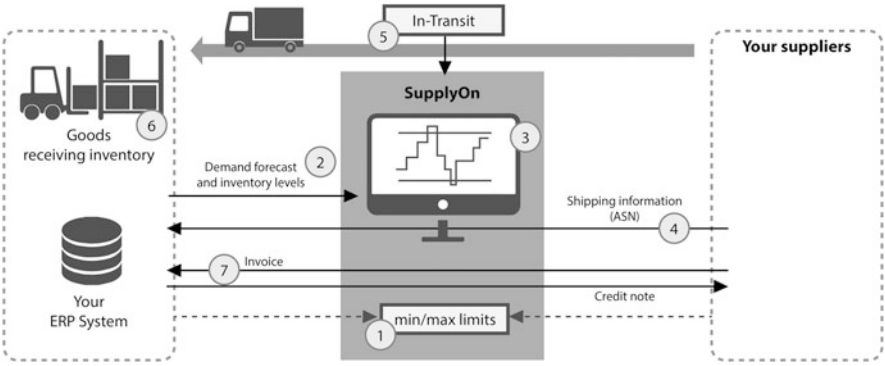

Fig. 4.9 VMI in SupplyOn (based on SupplyOn, used with permission)

- goods are booked into the system upon delivery and become visible in the Stock Monitor;
- an invoice or credit note is generated as soon as the goods have been booked.

Advantages of VMI are as follows:

For the Vendor

- Early recognition of fluctuation in demand
- Optimization of production planning; increased volume
- Enforcement of discipline: measurements and communication
- Better planning and resource use via visibility
- Improved market analysis and elimination of non-value-added activities
- Closer customer ties and preferred status

For the Buyer

- Increase of inventory availability
- Reduction of procurement activities
- Fewer stock-outs with higher inventory turnover
- Optimal product mix
- Lower operating, purchasing, and administrative costs
- SC relationship strategic strength
- Greater customer satisfaction and increased sales

For Overall SC

- Optimization of inventory management and cost reduction
- Decrease of fixed capital (stocks)
- Improvement of financial planning
- Supports long-term collaboration

For End-User

- Increased service level and reduced stock outs

However, it is proven that a sustainable VMI requires trust from both parties and willingness to invest (e.g. switching costs, EDI, etc.). A closer relationship implies more interdependency and cooperation. So, a customer needs to be ready to communicate promotions and other marketing campaigns with the supplier so that additional items can be available on time. Among other limitations of VMI are unforeseeable risks, as employee strikes in the event of stock outs and the risk of customer loss.

The *limitations of VMI* can be stated as follows:

- Trust in the SC should be high;
- High costs of implementation and investments in IT; dependence on EDI;
- Customer loss risk;
- Non-foreseeable risks: employee strikes;
- VMI mostly benefits end user and seller while vendor does most of the work;
- Additional processing activities for vendor (costs);
- Supplier dependent buyer.

The VMI concept has been proven to be efficient in the following cases:

- Items with high a consumption amount;
- Items with a high consumption value (compare with ABC analysis);
- Traditional procurement activities should be changed.

Lastly, VMI is suggested for the lines of business with multiple outlets and with the potential for long-term partnerships between vendor and customer. Simply put, a major retail store chain is more likely to benefit from the VMI and recover the capital invested in switching to VMI than a small family-owned convenient store. VMI is recommended specifically for industries like retail, pharmaceutical, automotive, high-tech, and other industries where inventory expectation is a significant factor in gaining competitive advantage.

4.3.3 Collaborative Planning, Forecasting and Replenishment

Collaborative Planning, Forecasting, and Replenishment (CPFR) aims to integrate and coordinate actors and processes in the SC regarding the planning and fulfillment of customer demand, production, and inventory (see Fig. 4.10). CPFR is the cooperative management of demand and supply through joint visibility and replenishment of products in the SC. CPFR is based on information exchange between suppliers and retailers, which helps in planning and satisfying customer demands through a joint system of shared information. CPFR includes three basic stages:

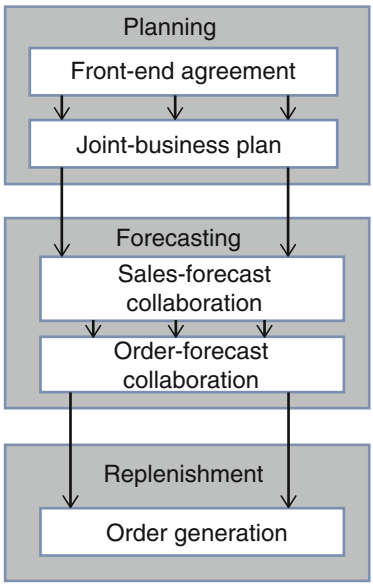

Fig. 4.10 CPFR strategy

In the planning phase, the definition of collaboration areas, responsibilities, and a description of the collaboration mission, objectives, and framework takes place. Trading partners share the business plans and organizational information. Category information, such as definition of roles, strategies, and tactics, needs to be explored. Seasonal events and frameworks for all events should be shared at this stage.

In the forecasting phase, sales and order forecasts need to be performed and shared. Moreover, exceptions for these forecasts should be classified. Events, promotion plans for products, new product information, individual forecast, and forecast constraints related to the sales should be shared.

In the replenishment area, lead time, logistics data, location changes, current inventory levels, inventory in transit, and POS (point-of-sale) data should be shared. In the last phase, a committed order from order forecasts should be generated.

4.3.4 Supply Chain Contracting

A supply contract specifies parameters governing the buyer-supplier relationship (Chopra and Meindl 2012). *Contracts* have a significant impact on the behavior and performance of all stages in an SC. Two groups of contracts can be distinguished:

- Contracts for product availability and SC profit and
- Contracts to coordinate SC costs.

In the first group, the supplier designs a contract that encourages the buyer to purchase more items and increase the level of product availability. In other words,

the supplier shares a part of the buyer's demand uncertainty. In this group, the following contracts are included:

- Buyback or returns contracts (a salvage price is used at which a retailer can return unsold inventory for a certain amount)
- Revenue-sharing contracts (a share of the retailer's revenue is paid to the supplier)
- Quantity flexibility contracts (the manufacturer allows the retailer to change the quantity ordered after observing demand).

Contracts to coordinate SC costs are based on quantity discount contracts. A *quantity discount contract* decreases overall costs but leads by tendency to higher lot sizes. This in turn facilitates higher levels of inventory in the SC. It is typically reasonable for commodity products for which the supplier has high fixed costs per lot. We refer to the textbook by Das (2016) regarding quantitative analysis of the SC contracts.

4.4 Supply Chain Resilience and Sustainability

SCs influence the environment and are influenced by it. In light of ecological problems, natural disasters, and society development challenges, the necessity for new viewpoints on SCM has become even more obvious. The former paradigm of overall and unlimited customer satisfaction has naturally failed because of the limited resources available for this satisfaction.

In these settings, the duality of the main goals of SCM—maximizing service level and minimizing costs—will be enhanced by the third component—maintaining SC *resilience* and *sustainability* (Ivanov 2017). This "triangle" goal framework will build the *new SCM paradigm* that can be formulated as the maintenance of resilience and the harmonization of value chains with possibly full customer satisfaction and cost-efficient resource consumption to ensure the performance of production-ecological systems at an infinite time horizon (see Fig. 4.11).

Fig. 4.11 Supply chain management resilience and sustainability

4.4.1 Supply Chain Sustainability: Examples of Coca-Cola and Mercadona

SC sustainability is based on a triple-bottom-line: "economy-ecology-society". Joint consideration of all these elements is crucial for SCM in the long-term perspective. In SCM such concepts as "Closed-Loop Supply Chain" and "Reverse Logistics" have been developed. They are based on the idea that a SC does not end at the point of sale, but can include the after-sale area. We highlight SC sustainability issues based on two case-studies of Coca-Cola and Mercadona.

Case Study Coca-Cola

The Coca-Cola system created a value chain based on strong partnerships with suppliers, distributors, and retailers. The Coca-Cola Company itself only manufactures the bases of the beverages, such as syrups and concentrates. It then distributes and sells these to their bottling partners (over 250 worldwide), located in every country where the products of Coca-Cola are sold (see Fig. 4.12).

The bottling partners manufacture packages and distribute the drinks as branded beverages to the points of sales (POS). The bottling partners also organize collaboration with suppliers. For example, Coca-Cola Beverages Vienna has had a long-term collaboration with SIG, a leading supplier of liquid packaging materials.

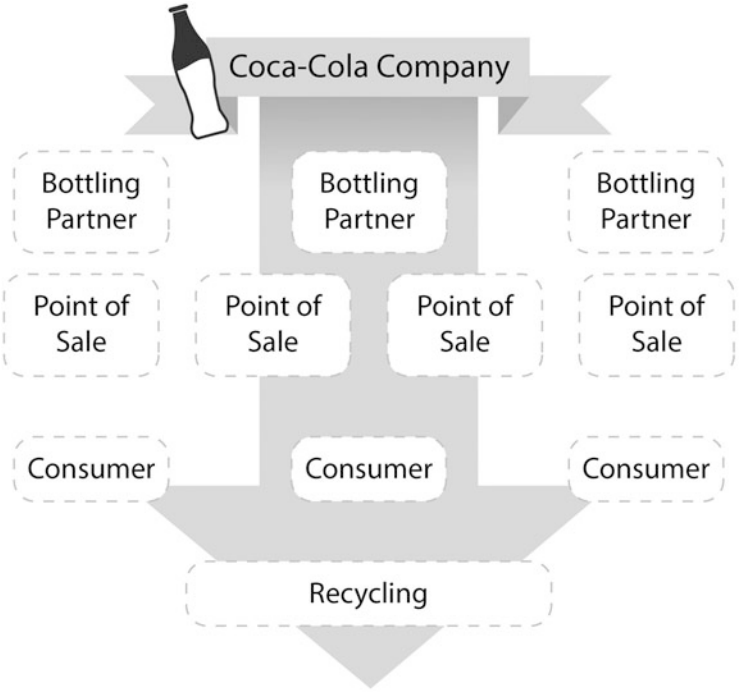

Fig. 4.12 Coca-Cola supply chain

Coca-Cola and SIG have recognized and embraced CPFR (collaborative planning, forecasting and replenishment). SIG has electronic access to inventory levels and sales forecasts at Coca-Cola with no time delay (it was previously up to 15 days late). Coca-Cola receives exact delivery quantities and times. This has enabled Coca-Cola to reduce inventory levels for packaging material by 50%. This drastically reduces the processing time for orders and increases customer lock-in.

The bottling partners stay in close contact with grocery stores, supermarkets, convenience stores, cinemas and all other customers providing drinks from Coca-Cola. After selling the beverages to customers, consumers are able to buy all Coca-Cola products from the different POS. Because every empty Coca-Cola bottle is recyclable it is up to consumers to take responsibility for recycling.

The whole value chain is based on the fact that the company and its suppliers don't go through a process from manufacturing to distributing the products to the consumer, but consider a closed loop, from manufacturing to using, and recovering material again for manufacturing. On the one hand, this minimizes productions costs and, on the other hand, helps protect the environment. For instance, Coca-Cola contributed $2.0B (USD) to the planting of 25,000 acres of orange groves, thereby creating approximately 4100 jobs.

Because water is essential to the health of communities and communities are built by the people who buy drinks from Coca-Cola, the company has to find a way to replenish their water. To provide access to clean water and therefore create sustainable water provision for communities and, of course, the production of beverages, Coca-Cola contributed $18.4M (USD) in 2012 to support 58 water initiatives worldwide.

In addition, supporting different projects on recycling and recovering used material and the development of new technologies plays a crucial role in making the packaging process more sustainable. In 2009, the Coca-Cola system developed Plant Bottle packaging, a polyethylene terephthalate (PET) plastic bottle made partially from plants and that is completely recyclable.

Regarding new technologies and ecological concerns, Coca-Cola also introduced many projects to address climate change. Coca-Cola powers their trucks with a mix of efficient alternative fuels, for instance biodiesel or natural gas. In North America, more than 750 trucks distributing products from Coca-Cola use about 30% less fuel than they would with conventional diesel.

Case-Study Mercadona

The *objective* of this case study is to analyze how a company can efficiently implement a sustainable SC without having a negative impact on turnover. Coordination of the value chain from positions of intermodal logistics and a closed-loop SC makes it possible to decrease costs, improve on-time delivery and company image, and achieve higher customer satisfaction. All these factors have a positive effect on turnover.

Mercadona is a family business founded in Valencia and is the largest Spanish supermarket chain in terms of a turnover of 19.08 million euros in 2012. In 1981, the

company had only eight shops in Valencia. Today this has risen to the considerable count of 1411 stores and 74,000 employees.

Mercadona is called the "Toyota of retail" because of its continuous improvement of *lean processes*. For example, the company packs fruit loosely instead of selling it in containers to save packaging material, sells only a limited number of goods, so it can reduce cost due to the decreased variability, and has redesigned packaging to optimize transportation. Mercadona says profit is not the primary goal, but rather investment in the long-term development of, for example, their employees. Being lean and always one step ahead of their competitors is a part of Mercadona's strategy. The whole SC supports this *strategy* of leanness and innovation to remain both efficient and effective in modern volatile markets. The target of recent years was to find a way to generally become more *sustainable*. The Mercadona Board of Management focused particularly on its SC.

Mercadona initially organized the *transportation* of its products by trucks and collaborated with the logistics company Acotral, which increasingly suffered delays due to road traffic. Since many goods go from the supplier in Sevilla in south Spain to Valencia in the east, usage of rail services for the longest part of the distance was discussed as an option.

Renfe, a former state-owned train company, was suffering immensely from market liberalization. To secure their financial position they were seeking a new strategy. Offering transporting solutions to supermarket chains became an attractive option.

Hence, Mercadona, Arcotral and Renfe arrived at a collaborative agreement to involve rail as a transportation mode. The new *intermodal logistics* process was designed as follows. From the supplier in Seville the products were transported by truck to the rail terminal in Seville. Here the goods were *transhipped*, with Renfe taking the goods on two trains twice a week to Valencia. Of course, this concept only worked for non-fresh goods such as sugar and non-food goods such as batteries. From the Valencia rail terminal, Arcotral picked up the goods and brought them to Mercadona's distribution center to supply the regional supermarkets.

The crucial element of the redesigned SC was *coordination* between the companies. Renfe had to customize its services to be able to transport such a large amount of goods to Mercadona. Moreover, collaborative agreements can be successful only if based on trust and a *win-win* situation for all. As previously stated, Renfe customized their services. Further changes on their side included a *communication* tool which enabled the *tracking* of the product at each stage of the transportation process. Mercadona then incorporated this communication tool into its own system which made it possible to have *visibility* throughout the whole SC. By offering this transportation solution, Renfe developed a new business concept. With such key customers as Mercadona, they resolved their own financial situation and secured a market position. In its turn, Mercadona became less vulnerable to road traffic, and deliveries were rarely delayed. This also saved costs in terms of maintaining safety stocks. While using rail, there were less noise emissions, fewer traffic jams and accidents, 12,000 tons less of CO_2 emissions each year. Mercadona demonstrated a best-practice example of how a company can, when implementing it

correctly, increase sustainability and have positive effects on their business processes and turnover

Discussion Questions

- The case study shows positive, real-life examples which can be applied to other businesses. Even though Mercadona is a first-class example of how to implement sustainability in SCM, where can you see possible limitations of this concept?
- Consider the new SC redesigned within the collaborative agreement between Mercadona, Renfe, and Arcotral. At which point could a reverse flow/closed-loop SC be implemented?
- As stated in the case study, collaborative agreements only work based on "trust and a win-win situation for all." What challenges can you see which could become critical for the SC?

4.4.2 Supply Chain Resilience and Ripple Effect

This sub-section briefly introduces the SC risk area. In Chap. 16, we will elaborate on different espects of SC risks, resilience, and ripple effect. In general, SC risks can be classified into the areas of demand, supply, process, and structure (see Fig. 4.13). Risks of demand and supply uncertainty are related to random uncertainty and a business-as-usual situation. Such risks are also known as *recurrent* or *operational risks*. SC managers achieved significant improvements in managing global SCs and mitigating recurrent SC risks through improved planning and execution (Chopra and Sodhi 2014). From 2010 to 2014, SC disruptions occurred at a greater frequency and intensity, and thus had greater consequences. Such *disruptive risks* now represent a new challenge for SC managers (Simchi-Levi et al. 2015; Ivanov et al. 2017a, b). Let us concentrate on the disruption side.

First, globalization and outsourcing trends make SCs more complex and less observable and controllable. According to complexity theory, such systems become more sensitive to disruptions. Special focus in this area is directed towards disruptions in transportation channels. Second, the efficiency paradigms of lean

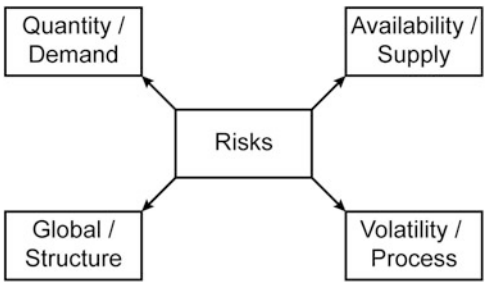

Fig. 4.13 Supply chain risks (Ivanov et al. 2014a)

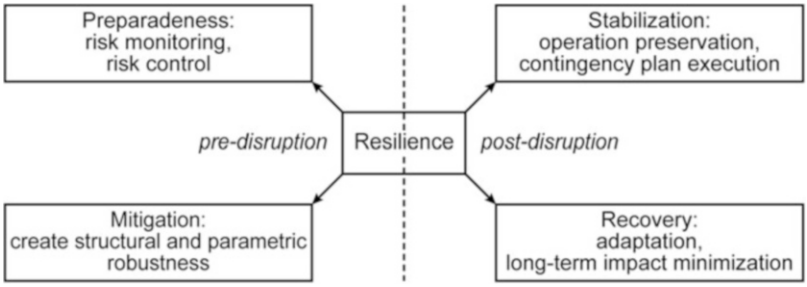

Fig. 4.14 Supply chain resilience (Ivanov et al. 2014a)

processes, single sourcing, etc. have failed in disruption situations. As a consequence, SCs have become more vulnerable, even to minor perturbations. Any disruption in a global SC, especially in its supply base, immediately affects the entire SC. Third, with increased specialization and geographical concentration of manufacturing, disruptions in one or several nodes affect almost all nodes and links in the SC. Fourth, IT became the crucial element of global SCs, since disruptions in IT may have significant impact on disruptions in material flows.

Resilience is the ability to maintain, execute, and recover (adapt) planned execution along with achievement of the planned (or adapted, but yet still acceptable) performance (Ivanov and Sokolov 2013). Building a resilient SC is based on mitigating risks, preparedness for disruptions, stabilization, and recovery (see Fig. 4.14).

Basic areas of resilience include system, process, and product resilience. To the basic elements of increasing SC resilience belong the following (Blackhurst et al. 2011; Pettit et al. 2013; Chopra and Sodhi 2014):

- Back-up suppliers
- Excessive inventory
- Excessive capacity
- Information coordination and data transparency
- Process flexibility
- Product flexibility.

Coordination and sourcing strategies in the SC are also typical in practice. Many companies also invest in structural redundancy (e.g., Toyota extends its SC subject to multiple-sourcing and building new facilities on the supply side). All these four elements of resilience can be seen as strategies for mitigating at the *pre-disruption* stage and reacting at the *post-disruption* stage in the resilience framework.

For practical implementation, it is important to understand that risk and resilience analysis means little unless they are brought into correspondence with their impact on cost efficiency. The trade-off "efficiency-flexibility-resilience" becomes more

and more important in SCOM and has been recently considered as *ripple-effect* in SCs (Ivanov et al. 2014a, b).

While the bullwhip effect describes high-probability-low-impact risks, ripple effect focuses on low-frequency-high-impact disruptions. Ripple effect in the SC results from disruption propagation of an initial disruption towards other SC stages in the supply, production, and distribution networks (Fig. 4.15).

Ripple effect is not an infrequent occurrence. In many cases, SC disruptions go beyond the disrupted stage; i.e., the original disruption causes disruption propagation in the SC, at times provoking still higher consequences. Ripple effect is a phenomenon of disruption propagations in the SC and their impact on output SC performance (e.g., sales, on-time delivery, and total profit). Ripple effect may have more serious consequences than short-term performance decreases. It can result in market share losses (e.g., Toyota lost its market leader position after the tsunami in 2011 and needed to redesign its SC coordination mechanism or lose company value. Hendricks and Singhal (2005) quantified the negative effects of SC disruption through empirical analysis and found 33–40% lower stock returns relative to their benchmarks over a 3 year time period that started 1 year before and ended 2 years after a disruption: large negative effects on profitability, a 107% drop in operating income, 7% lower sales growth and an 11% growth in costs, 2 years with a lower performance level after a disruption.

Ripple effect is also known as the "*domino effect*" or "*snowball effect*". The reasons for ripple effect are not difficult to identify. With increasing SC complexity and consequent pressure on increasing speed and efficiency, ever larger numbers of industries come to be distributed worldwide and concentrated in jowl industrial districts. In addition, globalized SCs depend heavily on permanent transportation

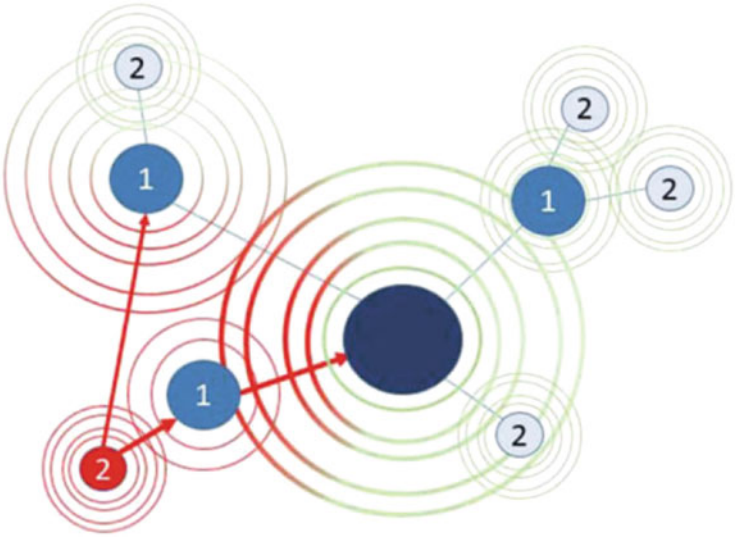

Fig. 4.15 Disruption propagation in the supply chain

Table 4.5 Ripple effect reasons and countermeasures

Reason	SCM impact	Ripple effect impact	Countermeasures
Leanness	Single Sourcing	In the non-disrupted scenario, it is irrational to avoid lean practices. At the same time, a capacity disruption may result in the ripple effect and performance decreases. Recommendation to use capacity buffers or a backup facility as additional capacity reserves.	Multiple/Dual sourcing/Backup suppliers
	Low inventory		Risk mitigation inventory
	Inflexible capacity		Postponement
Complexity	Globalization	Without a coordinated contingency policy, disruption recovery and performance impact estimation can be very long lasting and expensive. Coordinated control algorithms are needed to monitor SC behavior, identify disruptions, and adjust order allocation rules using a coordinated contingency policy.	Geographical sourcing diversification
	Decentralization		Global SC contingency plans
	Multi-stage SCs		Supplier segmentation according to disruption risks

infrastructure availability. Mitigation and recovery strategies for ripple effect are considered in the SC resilience framework (Fig. 4.14).

Table 4.5 summarizes the reasons and counter-measures for ripple effect (Ivanov and Rozhkov 2017; Dolgui et al. 2018; Ivanov 2018).

Literature provides evidence that disruption duration and propagation impact SC performance. Proactive strategies such as backup facilities and inventory have positive impacts concerning both performance and prevention of disruption propagation. Speed of recovery plays an important role in mitigating the performance impact of disruptions. An increase in SC resilience may imply cost increases in the SC.

4.5 Key Points

A SC strategy is one of the most important strategies in an enterprise. It should correspond to competitive and operations strategy. Such an alignment is called "strategic fit". SC strategies can be based on costs, agility, innovation, or quality. Frequently, hybrid strategies are very successful.

One of the crucial issues in SCM is SC coordination. Failed coordination in the SC can lead to the bullwhip effect. It can be prevented with the help of information coordination, sharing data about sales, demand forecasts, and inventory. VMI and CPFR are examples of coordination strategies. Sophisticated SC contracting can also help to ensure better SC coordination.

Finally, sustainability and resilience have become more and more important in SCM. The bottom-line "economy-ecology-society" has direct impact on the future

development of SCM. Resilient SCs are expected to continue their execution even if severe disruptions occur and parts of the SC are destroyed.

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