

Solutions **Chapter 8: Performance Measurement in Supply Chains**

Review question 8.1:

Changing the perspective from the single entity to the entire supply chain adds several layers of complexity. This complexity stems mainly from two factors. The first factor is the importance of operating performance in supply chains. One strong stream of performance measurement in supply chains is consequently concerned with operational or even technical aspects. Operational supply chain measures deal with procurement (supplier satisfaction, reject rate (%), etc.), with production (output, defect rates, etc.), or logistics (order picking accuracy, on-time shipments, delivery times, etc.).

Performance measurement in for-profit organizations, however, ultimately refers to financial success. Thus, operating performance has to be translated into financial performance. The link between operating excellence and financial success, though, is often more than fuzzy.

The second factor adding complexity is the multitude of involved parties. Naturally, a supply chain involves more than one entity, typically at least three (supplier, manufacturer, customer). When adding this factor to the scene several questions arise, such as whether we should evaluate the performance of each individual player in the supply chain or whether we should evaluate the performance of the supply chain as a whole.

Review question 8.2:

Performance measures can take three different perspectives:

1. The individual firm-perspective: any entity in a supply chain can measure its own performance (operating and financial, micro view). Examples are a company's own inventory turnover or its profit margin.
2. The bilateral perspective: any entity can measure the bilateral relationship and trust between itself and a business partner up- or downstream the supply chain. Examples are the average response time of a supplier or the creditworthiness and payment behavior of a customer.
3. The supply chain-perspective: performance measurement can encompass the entire supply chain (macro view). Such measures try to depict the success (or failure) of the supply chain as a whole. Examples are total cycle time or total landed cost.

Review question 8.3:

The terms performance measures, indicators, performance metrics, or scores are often used synonymously in practice. However, there is a conceptual difference. The terms metrics and scores are usually synonymous with measure. With a measure, we obtain direct information about an object. An indicator, in contrast, usually provides only indirect information about the object. As such, an indicator does not measure a precise activity or result – it rather *indicates* the performance. Indicators are linked by a hypothesized cause-and-effect relationship with the element to be measured.

An example is a tachometer that measures the speed of a car. We can *measure* kilometers per hour with it. At the same time we can use kilometers per hour as an *indicator* of environmental performance, for instance. High speed is an indicator of low environmental compatibility.

Review question 8.4:

Please refer to table 1.1 in the chapter.

Review question 8.5:

Business goals in supply chains are various. Typically, goals in a supply-chain context circle around the three dimensions of cost, quality and time. In our view, there are more goals to consider that provide a more refined framework:

- increase efficiency/ reduce costs
- increase quality
- increase speed / reduce time
- increase agility and adaptability
- increase service focus
- increase collaboration
- increase basis of trust
- increase information exchange

Unfortunately, it is often not possible to optimize all performance goals simultaneously. Multiple trade-offs must be balanced when optimizing some of the goals, for instance, increasing quality might interfere with efficiency and thus cost reduction.

Review question 8.6:

Total delivered cost (TDC) represents the amount of money it takes to procure the material, produce the goods and deliver them to customers. TDC is the complete cost of sourcing, manufacturing, and delivering products to their final destination. In particular, it includes cost of goods, transportation cost, inventory carrying cost, and material handling cost.

Review question 8.7:

Cost to serve (CTS) focuses on the cost of servicing a particular customer. Thus, it computes the cost of all activities for preparing and executing the distribution of a product. In particular, it includes cost of order processing, cost of picking and packing, cost of delivery, cost of invoicing. This is done on a customer or product level, which allows for a distinct customer or product profitability analysis.

Review question 8.8:

Net working capital can be used as an indicator of how efficiently a company manages its operating assets. Net working capital is usually defined as the difference between the current assets and the current liabilities of a firm ($NWC = \text{Current assets} - \text{current liabilities}$). Managers try to minimize NWC to save on capital cost. The main drivers of NWC are inventories, accounts receivable and accounts payable.

In a macro perspective, one can measure how efficient the supply chain as a whole manages its net working capital. All measures introduced under the single entity perspective can be applied on a supply chain level, too. For instance, supply chain net working capital (NWC) would be the sum of the NWC of all supply chain partners. From a holistic supply chain management perspective, the objective is to reduce the supply chain's aggregated NWC.

Review question 8.9:

- Customer satisfaction

It is often measured using (online) questionnaires that cover different features of a product and the perceived relevance of these features. Individual survey items are then consolidated into a satisfaction index, which may take a score from 0 to 10 (highest satisfaction). Such scores are usually highly entity-specific and not comparable across firms. In an extra effort, it makes sense, though, to push through a consistent definition and methodology across all trading partners in a supply chain.

- Number of product returns per unit sold (reject rate)

This measure is calculated by relating the quantity of returned output units due to defects, insufficient quality or other problems to the total quantity of sold units. The measure can be expressed as a percentage ratio and is an excellent indicator of (technical) product reliability. Note, however, that customers may return products also for other than technical reasons. It is therefore important to properly categorize and record the causes for product returns.

- Number of defects per unit procured

This is a central measure in accounting for procurement and relates the number of defect or dysfunctional items procured from a supplier to the total number of items procured from the supplier (in a given period). The measure is often determined separately for different items or components. It is a measure of the quality and reliability of a supplier, rather than evaluating an organization's own quality processes. However, poor performance in this ratio will also have a negative effect on an organization's own output quality.

For further examples please refer to the book.

Review question 8.10:

- Replacement time

This measure takes a single entity's purchasing perspective. Replacement time measures how long it takes from placing an order at a supplier to receiving the good at the intended location. On the one hand, it allows for evaluating a supplier's performance (speed and flexibility). However, on the other hand, it may also evaluate the purchasing company's internal purchasing processes and procurement strategy.

- Order fulfillment cycle time (response time)

OFCT, also called response time, represents the time it takes from a customer placing an order to the receipt of the product or service by the customer. Thus, it covers the time of sourcing material, manufacturing a product and distributing it to the customer. OFCT can be decomposed into the single time measures sourcing cycle time, make cycle time, and delivery cycle time. It demonstrates the speed at which a company can satisfy demand.

- Throughput time

This measures how long it takes to pass through a manufacturing process, i.e. to finalize a product from the first work operation until the last step in production. The lower the throughput time, the more efficient an organization, because the same output (products) can be produced with less input (time). Manufacturing throughput time comprises productive as well as unproductive times. It may include processing time (transforming materials to finished goods), inspection time (inspecting raw materials, work-in-process, and finished goods), move time (moving items between workstations as well as into and out of the manufacturing area), and queue time (waiting for processing, inspection and moving).

For further examples please refer to the book.

Review question 8.11:

This question requires to make a selection that can be drawn from the book. Here are some examples:

- Order fill rate

This is a ratio that focusses primarily on the distribution part of logistics. OFR measures the ability to ship from stock within the agreed time window (e.g. same-day, overnight or 48 hours). OFR is calculated as the percentage of Total volume shipped within the service level window divided by Total volume ordered for shipment within the service level window. Under the perspective of customer service, a high OFR indicates the rate at which a company promises to satisfy demand.

- Average service response time

This can be measured in hours. Long response times to requests (or not responding to request at all!) show

that a business doesn't take its customers and trading partners serious.

- Courtesy ratio

A special wish of a customer or a complaint may be dealt with on an ex gratia basis, that is, as a concession of the firm without a legal obligation to do so. The courtesy ratio measures the volume of settlements on a goodwill basis as a percentage of sales in a given period.

For further examples please refer to the book.

Review question 8.12:

Basically, any cost of procurement, logistics, manufacturing, distribution, and after-sales can be considered from a macro perspective spanning the entire supply chain. When aggregating single costs over the entire supply chain, however, one has to watch out for intra-supply chain profits and capitalized costs. Period costs that do not become part of cost of goods sold can easily be summed up for the entire supply chain. This refers to research, service cost, warranty cost, or general administration, for instance. Inventoriable cost, in contrast, such as freight in, and all manufacturing costs are capitalized as inventory and become cost of goods sold once they are sold downstream in the supply chain. Such costs have to be consolidated, that is, any intra-supply chain profits have to be eliminated when calculating the entire cost over the whole supply chain.

Review question 8.13:

The satisfaction of the end-customer is vital for every partner in a network since the satisfaction of end-customers drives the sales for all supply chain partners. In a collaborative supply chain setting, customer satisfaction must overlay the entire supply chain to ensure that all trading partners contribute to the common goal. However, supply chain partner should share the same definition of measuring customer satisfaction, to ensure acceptance.

Review question 8.14:

Supply chain time to market (SCTTM) measures how long it takes the supply chain from identifying a consumer trend until providing a product to an end-customer. As such it deals with the supply chain's ability to react to new or changing market demand. SCTTM indicates the agility of the supply chain as a whole in responding to marketplace changes in order to gain or maintain a competitive advantage. SCTTM is an important factor for fast-moving industries (such as the fashion industry) or for industries that are exposed to strong forces of change (e.g. through digitalization).

Review question 8.15:

- Number of joint projects

This is a rather simple indicator of the frequency (and intensity) of a collaboration. Two trading partners may agree on a certain number of projects for cooperation within a certain time period. Such projects may include the development of a pre-product by the supplier or a simple purchase agreement of raw materials, for instance. Monitoring the number of projects they actually carried out provides an insight into how close they really collaborate. Increases or decreases can indicate how successful the past collaboration was.

- Duration of partnership

Rather than counting the number of projects, this measure records the time a supplier-customer relationship exists. A long partnership is considered as an indicator of an intense relationship.

For further examples please refer to the book.

Review question 8.16:

In “resident engineering” suppliers delegate selected engineers for a defined time (usually 2-3 years) to work at the manufacturer. During their time at the manufacturer, the delegated employees of the supplier are involved in product development. By collaborating with and integrating the supplier into the development phase, the manufacturer allows the supplier to exert influence already at an early stage of the design and production of a new market offer.

Review question 8.17:

In practice, trust is difficult to quantify. Measuring trust between supply chain partners is usually done by collecting experiences and impressions of operating managers in surveys. Such surveys should be done on a regular basis to monitor trends and variances. Assessing the “soft factor” trustworthiness of a business partner is can often only be estimated. In fact, many supply chain managers go with their gut feeling in practice. However, there are ways to evaluate trustworthiness to some extent and make it less subjective. A model to assess trust is presented by Weber and Wallenburg (2010). Please refer to the book for details.

Review question 8.18:

An example of supply chain business practices that necessitates a high amount of trust is vendor-managed inventory (VMI). In VMI, the supplier takes responsibility for the inventory. Operationally, in VMI, the supplier has access to the manufacturer’s or retailer’s inventory and sales data, which is usually done electronically by automatic data exchange.

VMI requires great trust because of the potential for dishonest behavior by the supplier. A supplier may abuse the autonomy by pushing unneeded inventories onto downstream parties. With a trustworthy supplier, however, the system can generate benefits through better inventory management and saving transaction costs.

Review question 8.19:

Practitioners, as well as researchers, agree that focusing on a single performance measure is not enough – it is often the interplay of various measures and indicators that provides a thorough insight into the performance of an organization. It is the so-called performance measurement systems that group individual measures and visualize logical or mathematical links between them. The systems provide guidance on what measures to use and identify the drivers of performance.

Review question 8.20:

Avoiding excess capacity is a driver that refers to the lower path of the DuPont performance pyramid in figure 5 in the chapter. Avoiding excess capacity refers to asset utilization. Excess capacities mean a large number of assets that are not being used. The reduction of assets avoids underutilization and leads to a more efficient use of the remaining assets. Fewer assets (current and non-current) increases total asset turnover (TAT). A higher TAT leads to a higher return on assets (ROA).

Review question 8.21:

The Supply Chain Operations Reference (SCOR®) model, is a hierarchical process model that describes supply chain-related processes at four different conceptual levels (process types, process categories, process elements, and activities). The model is more than a pure description of processes in a supply chain. It describes the way processes interact, how they perform, how they are configured, and the requirements (skills) on staff operating the process. It, therefore, comprises business processes, metrics, best practices, and technology into

a unified structure to support communication among supply chain partners and to improve the effectiveness of supply chain management and related supply chain improvement activities.

The performance section of SCOR consists of two types of elements: performance attributes and metrics. Performance attributes are: reliability, responsiveness, agility, costs, and asset management efficiency. For each attribute, the SCOR model provides a selection of recommended performance measures, including detailed descriptions.

Review question 8.22:

The Balanced Scorecard (BSC) in its original form is more focused on the individual company. Although it also includes a customer perspective and a process perspective, these are not specifically aligned to a supply chain context. While it is possible to interpret and adapt the original perspectives in the sense of a supply chain, most authors have nevertheless designed their own variants. Consequently, the BSC has been subject to various modifications, including adding a suppliers' perspective or a network perspective.

Review question 8.23:

Brewer and Speh (2000) maintained the four-perspective structure of the original BSC but modified the internal process and the learning and growth perspective (see also figure 7 in the chapter). They transform the internal process perspective into a perspective that measures "interfirm and intrafirm functional integration, sharing and cooperation" (Brewer/Speh 2000, p. 78). They call this perspective supply chain management goals and propose that it employs the objectives of waste reduction, order fulfillment cycle time, flexible response, and unit-cost reduction.

The original learning and growth perspective becomes the supply chain management improvement perspective in Brewer and Speh's model. Like in the original balanced scorecard, the perspective deals with the ability to innovate, to learn, to continuously improve, and to adapt to changes. However, the authors apply these attributes specifically to product and process design, and to the ability to leverage human knowledge within the network by improved collaboration. Furthermore, the perspective covers improved information flows that all supply chain partners should have access to. Finally, Brewer and Speh propose to evaluate the competition, which the original balanced scorecard does not consider explicitly. The other two perspectives (financial and customer) remain largely the same as in the original balanced scorecard.

Review question 8.24:

The supply chain scorecard by Werner (2017) comprises five perspectives. Three of them are basically identical to the original BSC and are just slightly adapted to a supply chain context. Werner's supply chain scorecard combines the financial, customer and internal process perspective with two new perspectives: a supplier perspective and an integration perspective. The author drops the learning and growth perspective since it is mainly oriented towards a single entity (see also figure 8 in the chapter).

The integration perspective evaluates the performance of the interfaces. This perspective deals with the relationships between business partners, which is, in the view of the author, the groundwork of the supply chain. Objectives and measures comprise the intensity and quality of the collaboration, as well as the technical aspects of information flows.

Review question 8.25:

Some common weaknesses of performance measurement in supply chains are the following:

- Performance measures are designed for single entities and not for the entire supply chain.
- Often, there is a lack of information and data to compute the desired performance measures.
- Often, there is a high cost of compiling performance measures. Consequently, the cost-benefit criterion may be violated.

- Performance measurement is usually carried out as a static analysis measuring the performance at a point in time only.
- Definitions of performance measures vary in practice.
- In benchmarking against other supply chains it is difficult to find real peers.
- Performance measures might conflict with each other.
- Performance measures are potentially subject to manipulation.
- Firms often operate their performance measurement system in isolation and do not connect it with their strategy.

Exercise 8.1:

Taking a holistic supply chain view is important in various aspects. Managers first and foremost tend to concentrate on the financial performance of their own organization. However, this can be a very short-sighted view. Being a member of a supply chain involving several trading partners, the focus on the single entity might miss out on financial opportunities. Such a micro view may let go cost savings for the entire supply chain.

The same argument applies to operating performance. Each single trading partner will benefit if the network's output is of high quality if the network is fast and agile and if it is service focused. Eventually, all these attributes will contribute to financial success. Consequently, instead of concentrating solely on their own operating performance, supply chain members should also have a view on the overall supply chain's performance from a macro perspective (Kache/Seuring 2014).

Striving for economic success is a natural goal of any business enterprise. We can logically deduce that an entity within a network should not only pursue its own operating performance and financial welfare but should also have an interest in a most efficient supply chain as a whole. Provided that a fair sharing of profits is in place, a company will benefit, if the entire network can provide a good or service of high quality to a customer in a fast and most cost-efficient way. Furthermore, the single entity will benefit, if the network remains agile and adaptable to change, and when it is service focused and facilitates collaboration among the partners.

Exercise 8.2:

The technology and software industry can be highly volatile. BAT Systems and its suppliers need to be agile players in the market and be able to adapt to the upcoming market changes. For dealing with an expected but still uncertain higher demand, BAT-Systems and its suppliers need to measure their upside flexibility and adaptability. Two well-suited measures for this are

Upside flexibility: This measure deals with the ability of a business to react to an unforeseen upside in demand for its products or services. It is usually measured as the time it takes (in days) to accommodate an unexpected increase in demand by 20% without a significant increase in unit cost (van Aken 2011). The measure may encompass several processes in a business including sourcing, production, and distribution. Thus, upside flexibility can be decomposed into several sub measures, evaluating the performance of the subprocesses in question. Upside production flexibility, for instance, measures the time it takes the entity to increase production output by 20%. We can apply similar measures for sourcing or distribution capacity.

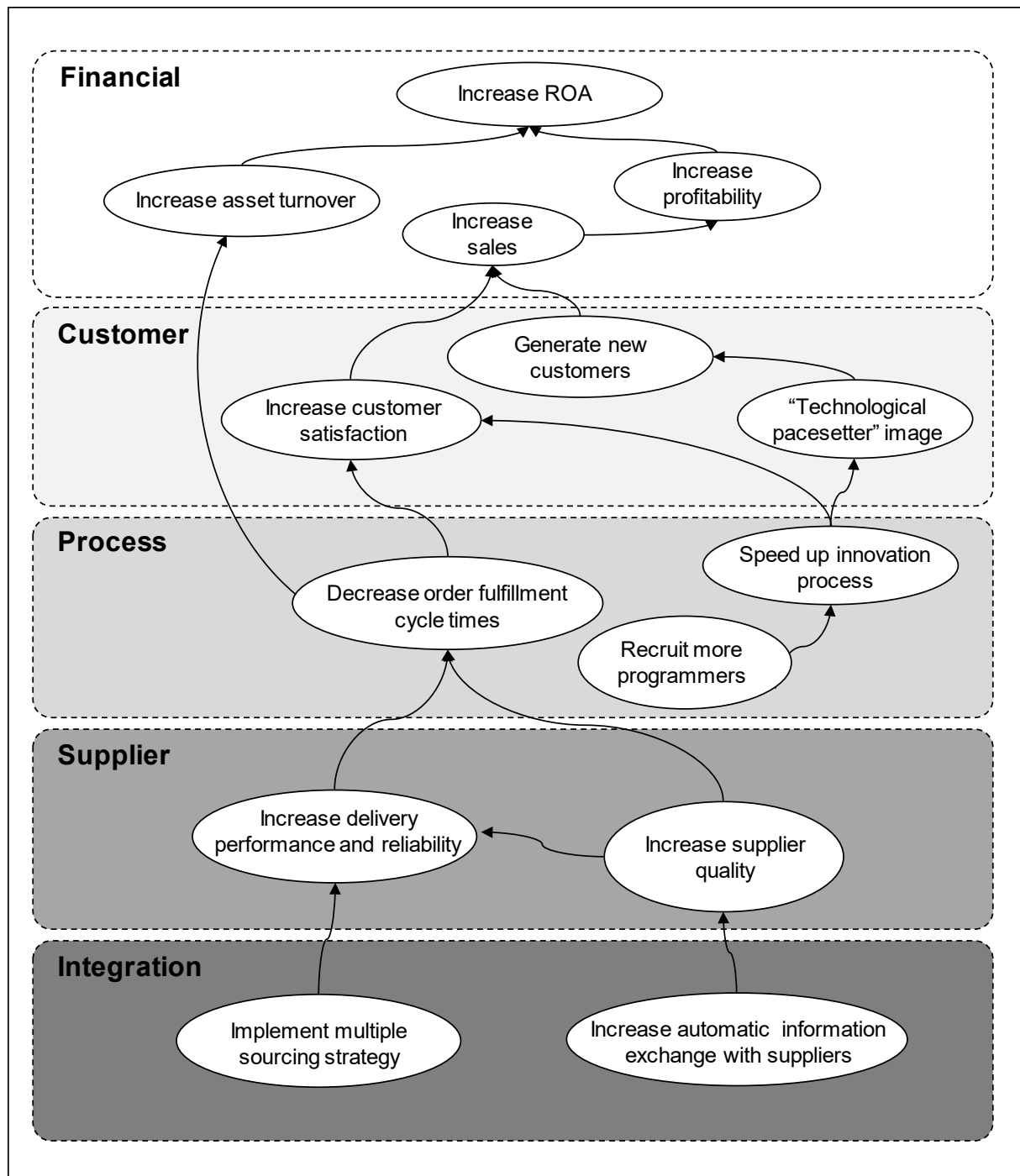
Upside adaptability: A similar measure to upside flexibility is upside adaptability. In contrast to the measure of flexibility introduced above, adaptability deals with changes that can be forecasted and planned. Upside adaptability is calculated as the number of additional items, or instances of services that a firm can produce, deliver and maintain within a given time period. Similar to the flexibility

measure, adaptability can be decomposed into the subprocesses of sourcing, producing, delivering and servicing. Likewise, upside adaptability is determined by the first limit you hit (van Aken 2011).

Exercise 8.3:

Ventus' problems are twofold: (1) they have trouble finding skilled software engineers, and (2) one of their suppliers shows weak performance. The fact that Ventus' order fulfillment cycle time is adversely affected reveals their vulnerability and dependence on this supplier.

A strategy map should address these problems, while at the same time maintaining the strategic focus of Ventus: innovation (technological pacesetter) and customer focus. Ultimately, of course, the strategy has to result in financial success. A potential strategy map could look as follows (for discussion, other solutions possible):



Ventus could introduce a multiple sourcing strategy, thus making it less vulnerable to underperforming suppliers. Besides, information exchange should be improved in order to have a leading indicator for any problems with suppliers. In addition, recruiting more programmers would speed up innovation processes (to be measured by time to market, for instance). Fixing its problems with suppliers will decrease order fulfillment cycle times, which, in turn, will increase customer satisfaction. Shorter innovation processes will help to maintain Ventus' reputation as technology leader. This will attract new customers, and, together with increased customer satisfaction, sales will increase. Higher sales will lead to higher profit.

Shorter order fulfillment cycle times will avoid idle capacities (e.g. machine utilization), which will increase asset turnover. Higher profit and higher asset turnover will ultimately increase ROA.