

PRINCIPLES OF THE SUPPLY CHAIN PERFORMANCE MEASUREMENT

BEATA ŚLUSARCZYK¹, SEBASTIAN KOT²

Abstract: Measurement of performance in every business management is a crucial activity allowing for effectiveness increase. The lack of suitable performance measurement is especially noticed in complex systems as supply chains. Responsible persons cannot manage effectively without suitable set of measures those are base for comparison to previous data or effects of other supply chain functioning. The analysis shows that it is very hard to find balanced set of supply chain performance measures those shows achieving main supply chain goals as well as current operations. Therefore the authors presents chosen methods of supply chain performance based on costs perspective, well known balanced scorecard methodology as well as measures focused on responsiveness and efficiency.

Key words: supply chain, performance measurement

1. Introduction

The measurement of business performance is deeply grounded in the backward-looking accounting disciplines of recording profit [13]. As a means to enhance future profits, management now measures and reports on a wide range of business performance from customer perception to strategy consistency and adherence. At the operational level of customer service, the supply chain is the kernel of the business. Indeed, the potential from supply chain thinking and practice is founded in realigning operations through the chain to reduce total cost and maximize service and return on assets. So measurement is a core discipline and capability to provide a framework for defining realignment and reporting progress as to its attainment. The supply chain is a complex system with many interfaces and dynamic interactions. It is a significant challenge to define the measures at each point in the chain that are appropriate and consistent with the overall desired results. In addition, the desired outcomes in terms of profit, service, stock, assets and costs cannot be managed directly; while there is a general expectation that sales growth will drive profits, the connections to stock, service and cost are less direct.

Performance management in the supply chain is about setting goals within and between functions that will lead to the desired results with balance and without conflict [6, 16]. Ideally, these goals are then embedded in the fabric of the management measurement and reporting of the functions of the firm and its customers, suppliers and service providers. Each function is responsible for delivering its part of the chain to the performance

¹ university professor, Czestochowa University of Technology
jagoda@zim.pcz.czest.pl

² university professor, Czestochowa University of Technology
sebacat@zim.pcz.czest.pl
42-200 Czestochowa, ul. Armii Krajowej 19b, Poland,

objectives; and when things do not work as planned, the requirement is for failures to be identified and recovery actions mounted.

2. Supply Chain Performance Measurement Methods Review

There is the still increasing demand on the methods and tools that can measure the performance of the supply chains in the present globalization market environment. Each company that is part of supply chain needs the instruments that can consider the performance and outputs resulting from the cooperation with its suppliers and customers. Just thorough understanding of the contemporary state in the whole supply chain allows improving its performance systematically.

D. M. Lambert and T. L. Pohlen bring up more detailed reasons for creating of the complex tools for the whole supply chain measuring [10]:

- The essential perspective of supply chain.
- The need of specification of relation between the company and supply chain performance.
- The requirement on activity and information unification about the performance to implement the strategy that enables to reach the supply chain goals.
- The requirement on differentiation from others competitive supply chains.
- The purpose to encourage the cooperation across the companies functions and companies in the chain.

Many authors tried to provide costs based analysis as a principal. Relations showing the connections between profit and costs of a company are of particular significance. General justifications of a systemic concept require the adoption of cost, index, or effect formula.

Formulae of supply chain performance analysis based on cost, capital, and profit considerations investigate the above categories in a structural aspect of the system, since the above mentioned categories may be directly related to the whole supply chain as well as to its elements. The evaluation of supply chain can be made by taking into account different cost calculation models. Taking into consideration the requirements of contemporary economy, an effective cost calculation should be characterized by openness. It should also extend its operating range and be oriented towards the information and reporting needs of a company and departments coordinating the activity of the whole supply chain.

The rise of new cost management concepts, which would fulfill the requirements of contemporary economy and might be applied to supply chain analysis, was directly enforced by [18]:

- the focus on maximum value for an end customer,
- perceiving costs as a price paid by an end customer,
- realizing that companies compete on the level of processes, and competitive advantage belongs to the company which performs its activities and economic processes better and more efficiently,
- the desire to introduce new, renowned product categories to the market and to service profitable customers,
- the need for identification of partners and supply chain participants that are “cheapest on the long run”.

As far as the financial perspective is concerned, the following formulae may be adopted to evaluate supply chain management effectiveness:

- **Supply chain cost account** is an approach engaging cost assessment of all activities taking place in a supply chain [9, 16]. The estimated costs of particular processes may be utilized for the supply chain effectiveness evaluation. It is of great significance as far as composition and structure of effectiveness assessment and allocation of benefits within a supply chain are concerned. Reduction of costs, together with possibilities of improving the value of goods or services perceived by a customer, is one of the opportunities for achieving success through supply chain management.
- **The concept of activity based costing** is the outcome of changes within the composition of corporate costs, consisting in the increasing domination of indirect and overall costs over direct costs [3]. One could observe a growth in costs which are not directly triggered off by the production process and volume. In the up-to-now cost account a problem has appeared, connected with the increasing share of administration costs and production preparation costs. It is not met with relevant acknowledgement and justification.

Activity based costing gives new opportunities for comprehensive evaluation. It increases costs transparency in indirect spheres of corporate activities, gathers more precise information on sources and cost-making factors, ensures effective use of resources, detects and defines prospective savings, identifies and improves the effectiveness and optimization of activities, eliminates possible errors in cost calculation conducted with the application of traditional methods, reduces the number of strategic decision mistakes, and improves cost management effectiveness or budget planning.

Lapide [11] complain on traditional performance measurement writing: Traditionally, companies have tracked performance based largely on financial accounting principles. Financial accounting measures are certainly important in assessing whether or not operational changes are improving the financial health of an enterprise, but insufficient to measure supply chain performance for the following reasons:

- The measures tend to be historically oriented and not focused on providing a forward-looking perspective.
- The measures do not relate to important strategic, non-financial performance, like customer service/loyalty and product quality.
- The measures do not directly tie to operational effectiveness and efficiency.

Lapide also warn that a major problem encountered with most performance measurement systems is that they are functionally focused. Within these systems, each functional area measures its performance in its own terms, with individuals evaluated based on their ability to meet objectives consistent with their department's performance measures. Individuals working under these measurement systems tend to drive operations toward improving their own area's performance, frequently at the expense of the performance of other functional areas. When each functional area sets its performance measures in isolation from those of others, it often leads to functional silos and conflicting organizational goals.

Balanced scorecard described by Kaplan and Norton [8] are the answer for accounting measures complaining. A balanced scorecard provides a picture of a business by combining

financial measures with assessments for customer satisfaction, key internal processes and organizational learning and growth. It requires specific goals for customers in terms of time, quality, performance, service and cost as well as relationship, brand and product leadership. The internal perspective provides focus on the core competencies, processes, decisions, and actions that have the greatest impact on attaining customer satisfaction. The learning and growth perspective measures continual improvements to people, systems and processes. Sitting above this framework are the financial measures, which are essential for showing whether executives have correctly identified and constructed their measures in the three preceding areas.

Fundamentally a balanced scorecard should have a balance between output measures (financial and customer) and input measures (performance drivers, such as value proposition, internal processes, learning and growth). Every measure selected for a scorecard should be part of a link of cause-and-effect relationships, ending in financial objectives that represent a strategic theme for the business. Kaplan and Norton outline four key processes that the balanced scorecard relies on to connect short-term activities to long-term objectives [9]:

1. Translating the vision
2. Communicating and linking
3. Business planning
4. Feedback and learning

Balanced scorecard puts strategy and vision, not control, at the centre. The measures are designed to pull people toward the overall vision. This methodology is consistent with the approach of supply chain management by helping managers overcome traditional functional barriers and ultimately leads to improved decision making and problem solving.

Another proposals allowing for the supply chain performance analysis is approach introduced by Hausman [5] that describe supply chain performance - using two characteristics - responsiveness and efficiency. All intuitively know what these two characteristics imply, but there is a problem with detailed definition so that they can be measured objectively. Hausman used four measurement categories:

1. Customer Service
2. Internal Efficiency
3. Demand Flexibility
4. Product Development

2.1. Customer Service. Customer service measures the ability of the supply chain to meet the expectations of its customers. Depending on the type of market being served, the customers in that market will have different expectations for customer service. Customers in some markets both expect and will pay for high levels of product availability and quick delivery of small purchase quantities. Customers in other markets will accept longer waits for products and will purchase in large quantities. Whatever the market being served, the supply chain must meet the customer service expectations of the people in that market.

There are two sets of customer service metrics depending on whether the company or supply chain is in a make to stock (MTS) or make to order (MTO) situation [17]. Popular metrics for a make to stock situation are:

- Complete Order Fill Rate and Order Line Item Fill Rate

- On-Time Delivery Rate
- Value of Total Backorders and Number of Backorders • Frequency and Duration of Backorders
- Line Item Return Rate
- Popular metrics for a make to order situation are:
 - Quoted Customer Response Time and On-Time Completion Rate
 - On-Time Delivery Rate
 - Value of Late Orders and Number of Late Orders
 - Frequency and Duration of Late Orders
 - Number of Warranty Returns and Repairs

Make to Stock situation is one where common commodity products are supplied to a large market or customer base. These are products such as office supplies, cleaning supplies, building supplies, and so on. Customers expect to get these products right away any time they need them. Supply chains for these products must meet this demand by stocking them in inventory so they are always available.

2.2. Internal Efficiency. Internal efficiency refers to the ability of a company or a supply chain to operate in such a way as to generate an appropriate level of profitability. As with customer service, market conditions vary and what is an appropriate level of profit varies from one market to another. In a risky developing market the profit margins need to be higher in order to justify the investment of time and money. In a mature market where there is little uncertainty or risk, profit margins can be somewhat lower. These markets offer the opportunity to do large volumes of business and to make up in gross profit what is given up in gross margin.

Some popular measures of internal efficiency are [1, 2, 14]:

- Inventory value
- Inventory turns
- Return on sales
- Cash-to-cash cycle time

Inventory Value should be measured both at a point in time and also as an average over time. The major asset involved in a supply chain is the inventory contained throughout the length of the chain. Supply chains and the companies that make them up are always looking for ways to reduce inventory while still delivering high levels of customer service. This means trying to match inventory availability (supply) with sales (demand) and not have excess inventory left over. The only time a company would want to let inventory exceed sales is in a growth market where the value of the inventory will increase. However, markets change and as a rule it is best to avoid excess inventory.

Inventory Turns is a way to measure the profitability of inventory by tracking the speed with which it is sold or turned over during the course of a year. This measure is often referred to as T&E or "turn and earn." It is calculated by the equation:

$$T = C_A / V_A \quad (1)$$

where

T – Turns,

C_A - Annual Cost of Sales,
 V_A - Annual Average Inventory Value.

Generally, the higher the turn rate the better, although some lower turning inventory needs to be available in order to meet customer service and demand flexibility.

Return on Sales is a broad measure of how well an operation is being run. It measures how well fixed and variables costs are managed and also the gross profit generated on sales:

$$R = E / S \quad (2)$$

where

R – Return on Sales,
 E - Earnings before Interest & Tax,
 S - Sales.

Again, as a rule, the higher the return on sales the better. There are times though when a company may deliberately reduce this number in order to gain or defend market share or to incur expenses that are necessary to achieve some other business objective.

Cash-to-Cash Cycle Time is the time it takes from when a company pays its suppliers for materials to when it gets paid by its customers. This time can be estimated with the following formula:

$$T_C = D_S + D_O - P_A \quad (3)$$

where

T_C – Cash-to-Cash Cycle Time,
 D_S - Inventory Days of Supply,
 D_O - Days Sales Outstanding,
 P_A - Average Payment Period on Purchases.

The shorter this cycle time the better. A company can often make more improvements in their accounts payable and receivable areas than they can in their inventory levels. Accounts receivable may be large due to late payments caused by billing errors or selling to customers who are bad credit risks. These are things a company can manage as well as inventory.

2.3. Demand Flexibility. This category measures the ability to respond to uncertainty in levels of product demand. It shows how much of an increase over current levels of demand can be handled by a company or a supply chain. It also includes the ability to respond to uncertainty in the range of products that may be demanded. This ability is often needed in mature markets. Some measures of flexibility are [2, 4]:

- Activity Cycle Time
- Upside Flexibility
- Outside Flexibility

Activity Cycle Time measures the amount of time it takes to perform a supply chain activity such as order fulfillment, product design, product assembly, or any other activity that supports the supply chain. This cycle time can be measured within an individual company or across an entire supply chain. Order fulfillment within a single company may

be fast but that company may only be filling an order from another company in the supply chain. What is important is the cycle time for order fulfillment to the ultimate end use customer that the entire supply chain is there to serve.

Upside Flexibility is the ability of a company or supply chain to respond quickly to additional order volume for the products they carry.

Outside Flexibility is the ability to quickly provide the customer with additional products outside the bundle of products normally provided. As markets mature and technologies blend, products that were once considered outside of the range of a company's offerings can become a logical extension of its offerings.

2.4. Product Development. This encompasses a company and a supply chain's ability to continue to evolve along with the markets it serves. It measures the ability to develop and deliver new products in a timely manner. This ability is necessary when serving developing markets.

Product development measures a company or a supply chain's ability to design, build, and deliver new products to serve their markets as those markets evolve over time. Technical innovations, social change, and economic developments cause a market to change over time. Measurements in this performance category are often overlooked, but companies do so at their own peril. A supply chain must keep pace with the market it serves or it will be replaced. The ability to keep pace with an evolving market can be measured by metrics such as:

- Percentage of total products sold that were introduced in the last year
- Percentage of total sales from products introduced in the last year
- Cycle time to develop and deliver a new product

Conclusion

Presented supply performance measures are chosen tools of effectiveness analysis of such a complex systems as supply chain. Of course authors realized that this paper is not drain on consideration in this matter. The measures choice depend on many circumstances and presented aspects can be insufficient in some cases where the detailed analysis of particular area is important. However the considerations are important in strategic management of whole supply chain.

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