Cash to Cash Cycle as an Integral Performance Metric in Supply Chain Management: A Theoretical Review

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Supply Chain Management (SCM) involves the management of flows in a chain. These flows are material flow, information flow and money flow within a close network comprising suppliers, manufacturers and customers. The coordination and integration of these flows within a firm and among firms are critically important for an effectively operating supply chain. For this reason, new performance criteria should be introduced in order to evaluate the performance of the supply chain as a whole. One of these new criteria is Cash to Cash Cycle (CCC) which is calculated for any firm by subtracting the debt turnover period from the sum of inventory turnover and receivables turnover periods. Hence, one effective way of shortening the cash conversion cycle for an individual firm may be by contracting the days of receivables and inventory outstanding and extending the days of payables outstanding. However, some of the measures taken by a firm within a four-tier supply chain, consisting of suppliers, manufacturers, distributors and customers in a debt-receivable relation, have zero effects on the supply chain's total cash conversion cycle. The aim of this study is to develop a theoretical lens by examining the factors influencing CCC—an integral metric for the performance evaluation of supply chains.

Introduction

The concept of Supply Chain Management (SCM) is one of the emerging values in today's business world. SCM can be defined as the optimization of a product's route, flowing from the supplier to the manufacturer and then to the consumer and the minimization of the related costs. It is an integrated system of activities aiming at decreasing the inventory costs by providing the most appropriate flow of the product, minimizing the critical decision making processes by decreasing the uncertainties in the forwarding of the product and minimizing the planning expenditures by standardizing the ordering system. On having observed the direct effects of SCM strategies on a firms' competitive power, both academicians and practitioners have directed their attention to this area. The studies that are carried out in this field involve the evaluation of the outcomes of the applied strategies. In other words, they involve the methods and techniques that are used in the performance measurement of SCM.

SCM involves the management of flows in a chain. These flows are material flow, information flow and money flow within a close network comprising suppliers, manufacturers and customers. The coordination and integration of these flows within a

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firm and among firms is critically important for an effectively operating supply chain. Since the success of a firm in a supply chain depends on the total performance of the chain, managers are now enforced to have cooperation and mutual dependency, involving continuous and long time spanning information and risk-sharing. Within the context of this cooperation, new performance metrics should be mentioned in order to evaluate the performance of the supply chain as a whole. One of these new metrics is Cash to Cash Cycle (CCC), which is calculated for any firm by subtracting the debt turnover period from the sum of stock turnover and accounts receivable turnover periods. Hence, one effective way of shortening the cash conversion cycle for an individual firm may be by contracting the days of receivables and inventory outstanding and extending the days of payables outstanding. However, some of the measures taken by a firm within a four-tier supply chain, consisting of suppliers, manufacturers, distributors and customers in a debt-receivable relation have zero effects on the total cash conversion cycle of the supply chain. The aim of this study is to develop a theoretical lens by examining the factors influencing CCC—an integral metric for the performance evaluation of supply chains.

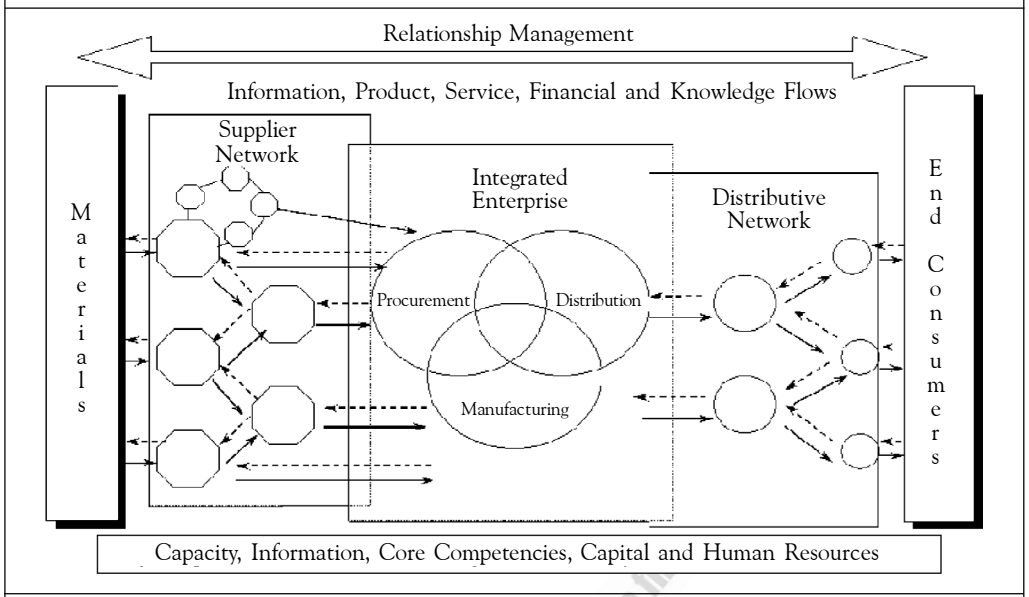
The paper proceeds to summarize the literature review on SCM with regard to the need for an integral metric; presents CCC for individual firms and compares the dynamic nature of CCC with the static nature of traditional performance measures; develops a theoretical lens for evaluating CCC in a supply chain and shows the calculation of CCC at each tier of the supply chain (suppliers, manufacturers, distributors and retailers), taking into account the mutual relations along the chain; and discusses important strategies to accelerate CCC in the supply chain.

Supply Chain Management

Supply chain has many definitions due to its ever-increasing popularity. In the *APICS Dictionary*, it is defined as "the integrated whole of functions linking the consumption processes among the firms which takes place in the channel lying between the raw material and the final consumer of the product and creating value for the customers" (Blackstone and Cox, 2008). Stevens (1989) defines supply chain as a system in which material and information flow among raw material suppliers, manufacturers, distributors and customers. According to another definition, it is a web which consists of suppliers, transporters, manufacturers, distributors, retailers and consumers (Lummus and Alber, 1997).

Supply Chain Council (2001) uses the following explanation: "Supply chain is a whole body of operations which compasses purchasing and manufacturing of final products and ranges from suppliers of the suppliers and customers of the customers. In a narrow sense, these operations consist of planning, procurement, manufacturing and delivery and in the broad sense, they consist of management of supply and demand, procurement of raw material and other materials, manufacturing and assembly, storage, inventory management, sales order management, distribution and delivery to the firms and customers in the channel." Figure 1 is a representation of a supply chain.

Figure 1: Supply Chain Management



Source: Bowersox et al. (2002)

All in all, supply chain, with all its aspects, is a whole range of activities such as procurement of raw material, manufacturing and assembly, storage and following up of inventories, sales order management, distribution and the management of information flow, being performed from the stage of the product as a raw material till its delivery to the customer. On the other hand, SCM may be expressed as the coordination and integration of all these operations in a continuous process (Lummus and Vokurka, 1999).

The success of a firm in a supply chain depends on the total success of the chain in general. For this reason, managers are forced to collaborate with other firms. This collaboration is often mentioned as a commercial partnership. Ellram and Hendrick (1995) interpret the concept of partnership as cooperation and mutual dependency involving continuous and long time spanning information and risk sharing. The degree of collaboration determines the type of the integration and hence the type of the chain. From this perspective, the integration of supply chains may be examined under four basic groups—physical, informational, control and structural integrations (Boorsma and Noord, 1992). In practice, organizations may undergo different integrations with various partners and processes at the same time. No matter what type or structure the integration is, its goal is to maximize the performance of the supply chain. This issue raises an important question: what is the performance criterion indicating the total success of the supply chain? There are numerous studies in literature which focus on the criteria to be used in the measurement of supply chain performance.

For an organization, performance management provides the establishment of a systematic relation between the resources and the processes. Performance management is

a crucial area in SCM. It is necessary to assess the current situation of supply performance and take it to desired levels. Performance measurement is an essential element of effective planning and control as well as decision making. It can provide the necessary feedback information to reveal progress, enhance motivation and communication and diagnose problems (Waggoner *et al.,* 1999).

When we think that almost all organizations are part of a supply chain and the individual performance of each firm affects the performance of the chain as a whole, the complexity of the performance measurement system is a natural outcome. The total success of a multi-level supply chain is equal to the success of its weakest parts. An operation which increases the performance of any member in the chain at on individual scale may also reduce the success of another member in the chain. For this reason, the success of the firms on an individual scale depends on the co-movement of the members of the chain through a common goal.

Performance measurement from the point of view of SCM should delineate the results of the applied strategies and also define possible opportunities. According to Beamon (1999), there is limited literature available on the design of performance measurement systems and selection of performance measures for SCM. However, in the last decade, many publications have addressed performance measurement in SCM.

Beamon (1998) categorizes the existing performance measures into two groups—qualitative and quantitative—involving customer satisfaction and customer responsiveness, flexibility, supplier performance, costs and those used in supply chain modelling. Beamon (1999) identifies three types of measures—resources, output and flexibility. Gunasekaran *et al.* (2001) developed a framework for measuring the performances from strategic, tactical and operational levels in supply chains respectively. This framework mainly dealt with supplier, delivery, customer service, inventory and logistic costs. Kleijnen and Smits (2004) dealt with multiple metrics in SCM via the balanced scorecard which measures customers, internal processes, innovations and finance. Chan and Qi (2003) claim that the existing performance measurement theory fails to provide necessary support in strategy development, decision making and performance improvement. An attempt is made by the authors to arrive at a set of innovative measures and methods that can contribute to the development of SCM. They propose a process-based systematic perspective that is employed to build an effective model to measure the holistic performance of complex supply chains. Ho (2007) proposed an integrated method—total related cost measurement—to evaluate the performance of a three-echelon Enterprise Resource Planning (ERP)-based supply chain system. For testing the validity, simulation is used to test the responsiveness of the total cost approach towards variations in the operating environment.

Dasgupta (2003) emphasized the need for a comprehensive, flexible and adoptable framework for evaluating the performance of a supply chain and its entities. The author finds that the framework is more effective under the condition of common scale of measurement and comparison with world standards. In this regard, he claimed that the

six-sigma metrics, which is a popular concept, can help an organization. Chan (2003), claiming that there is no systematic grouping of the different performance measures in the existing literature presents the formulization of both quantitative and qualitative performance measurements for easy representation and understanding.

A review of the literature shows that there is indeed a quest for an integral performance measurement system that can evaluate the performance of a supply chain as a whole. The criteria which consist of such a system are grouped under two fundamental headings—quantitative and qualitative criteria. The quantitative criteria which show the financial success of the supply chain concentrates on indicators such as profitability, Return on Assets (ROA), Return on Equity (ROE) and CCC. Financial indicators encompass both quantitative and qualitative measures. This is because without the profitability measurement of the supply chain, it is impossible to evaluate the total success of the supply chain by just looking at the qualitative performance measures (such as customer satisfaction and responsiveness) of the chain. Despite the fact that the traditionally structured financial indicators are mostly criticized, the final success of a supply chain, consisting of a number of profit-oriented firms, depends mostly on its financial success.

Another performance criteria which firms should take into consideration along with the profitability criteria is the cash flow criteria. A firm that operates with profit and does not plan the cash flow has no chance of survival in the long run. On the other hand, the cash flow of an individual firm also affects the cash flows of the other members of the chain. For this reason, a firm obtains cash inflows from the upstream levels in the chain and transmits cash outflows to the downstream levels. As a result, cash inflows of a level in the chain are equal to the cash outflows of another level in the chain. For this reason, the measures that are taken in order to speed up individual cash flows at any level have an effect on the total cash flow of the supply chain.

CCC for Individual Firms

Traditional measures of a firm's liquidity, such as current ratio, quick ratio, and net working capital turnover ratios, are based on static balance sheet items. They explain the extent to which the firm's currently maturing liabilities are covered by currently maturing assets (Jose *et al.*, 1996). According to Richards and Laughlin (1980), these measures fail to recognize that the basic liquidity protection against unanticipated discrepancies in the amount and timing of operating cash inflows and outflows is provided by a firm's cash reserve investments, in combination with its unused borrowing capacity, rather than by total current assets coverage of outstanding current liabilities.

CCC is a dynamic measure of liquidity management introduced by Gitman (1974) and later refined by Gitman and Sachdeva (1982). It measures the time between cash outflows for resources and cash inflows from product sales and tends to combine balance sheet data and income statement data to create a dynamic measure with time as a dimension.

The factors that affect the working capital of firms continuously change. The final product converts into cash or receivables. The operating cycle which begins with the collection of cash from the receivables, ends up with cash inflow to the firm. The sum of accounts receivables and inventory turnover can be seen as the operating conversion period, provided the inventory is purchased in cash. But, in order to decrease the need for working capital and balance, the cash outlays and cash receipts, most firms prefer purchasing inventories on credit. In this case, the cash conversion cycle period is calculated by subtracting the accounts payable days from the sum of the receivable turnover and inventory turnover days.

The following equations show the formulations of CCC of a firm:

$$CCC = ARD + ITD - APD \quad \text{...(1)}$$

$$ARD = 365/(CS/AR)$$

$$ITD = 365/(CGS/AI)$$

$$APD = 365/(CP/AP)$$

where,

ARD = Accounts Receivables Days

ITD = Inventory Turnover Days

APD = Accounts Payable Days

CCC = Cash Conversion Cycle

CP = Credit Purchases

AP = Average Accounts Payable

CS = Credit Sales

AR = Average Accounts Receivable

CGS = Cost of Goods Sold

AI = Average Inventory

CCC in a Supply Chain

Basically, SCM deals with the management of three types of flows—information, cash and material. Material flows from suppliers to the customers, cash flows from customers to suppliers and information flows mutually in both directions (Figure 2).

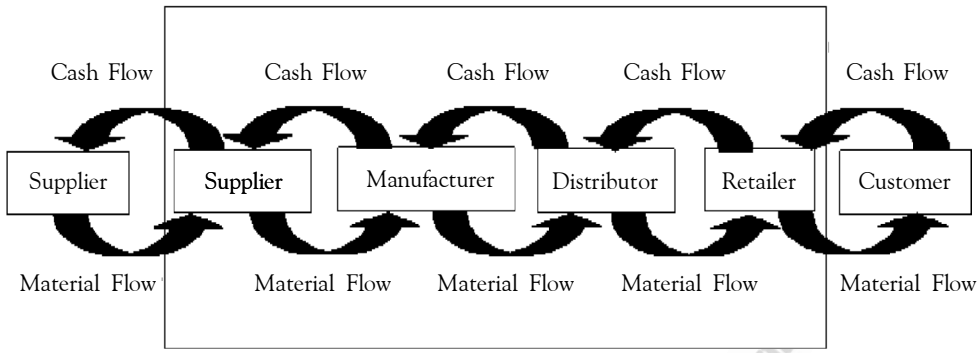
In a four-tier supply chain composed of suppliers, manufacturers, distributors and retailers, CCC of the total supply chain equals to the sum of CCCs of each tier. Each tier's CCC is the average CCCs of the firms at that particular tier, such that:

$$CCC_{SC} = CCC_S + CCC_M + CCC_D + CCC_R \quad \text{...(2)}$$

where,

CCC_{SC} = Cash Conversion Cycle of the Supply Chain

Figure 2: Flows in a Supply Chain



CCC_S = Cash Conversion Cycle of the Suppliers

CCC_M = Cash Conversion Cycle of the Manufacturers

CCC_D = Cash Conversion Cycle of the Distributors

CCC_R = Cash Conversion Cycle of the Retailers

The modelings for each tier's cash conversion cycle will be analyzed separately.

Suppliers' Cash Conversion Cycle

This tier which takes place in the first part of the chain and provides basic raw material inputs may be made up of firms which supply this raw material, as well as those that store them. The major cash inflows in this tier come from the cash collections from the sale of the products. The related cash outflows arise from the payments made for the purchased raw materials from the suppliers or from the payment of the expenses which are necessary for the manufacturing or extraction of natural resources. The CCC at the suppliers' tier is a function of the cash collection period of the sales to the manufacturing tier, inventory turnover period and the payment period of the purchases of goods and services from the suppliers. At the suppliers' level, it may be expressed as:

$$CCC_S = ARD_S + ITD_S - APD_S \quad ...(3)$$

$$ARD_S = 365/(CS_S/AR_S)$$

$$ITD_S = 365/(CGS_S/AI_S)$$

$$APD_S = 365/(CP_S/AP_S)$$

where,

ARD_S = Average collection period of the sales on credit by the suppliers

ITD_S = Average inventory turnover period at the suppliers' level

APD_S = Average days payable outstanding by the suppliers

CCC_S = Average cash conversion cycle of the suppliers

CP_S = Purchases on credit by the suppliers

AP_S = Average trade payables of the suppliers

CS_S = Sales on credit by the suppliers

AR_S = Average accounts receivables of the suppliers

CGS_S = Cost of goods sold by the suppliers

AI_S = Average inventory held by the suppliers

In this equation, ARD_S is calculated by dividing the total number of days in a year by the receivables turnover period, ITD_S is the ratio of the inventory turnover period (the ratio of cost of goods sold to the average inventory) to the total number of days in a year, and APD_S is calculated by dividing the total number of days in a year to trade payables turnover (the ratio of purchases on credit to average trade payables). There are three factors that accelerate the cash inflows at the suppliers' level—increasing receivables turnover, inventory turnover (shortening receivables and inventory turnover periods) and decreasing trade payables turnover (extending payables turnover period).

Manufacturers' Cash Conversion Cycle

Manufacturers form the second echelon in a four-tier supply chain. At this level, the raw material inputs provided from the suppliers are processed into final products and transmitted to the next level in the supply chain—the distributors. The main cash receipts at the manufacturers' level are composed of the cash collections from sales to the distributers. The cash outlays are composed of payments to the suppliers for purchases of raw material and other expenses. The CCC at the manufacturers' level is a function of the cash collection period, inventory turnover period and trade payables turnover period. At the manufacturers' level, it may be expressed as:

$$CCC_M = ARD_M + ITD_M - APD_M \quad \text{...(4)}$$

$$ARD_M = 365/(CSM/ARM)$$

$$ITD_M = 365/(CGS_M/AI_M)$$

$$APD_M = 365/(CP_M/AP_M)$$

where,

ARD_M = Average collection period of the sales on credit by the manufacturers

ITD_M = Average inventory turnover period at the manufacturers' level

APD_M = Average days payable outstanding by the manufacturers

CCC_M = Average cash conversion cycle of the manufacturers

CP_M = Purchases on credit by the manufacturers

AP_M = Average trade payables of the manufacturers

CS_M = Sales on credit by the manufacturers

AR_M = Average accounts receivables of the manufacturers

CGS_M = Cost of goods sold by the manufacturers

AI_M = Average inventory held by the manufacturers

The services and goods purchased by the manufacturers on credit are equal to the amount of services and goods sold by the suppliers. As a result, the average days payable outstanding by the manufacturers is equal to the average collection period of the sales on credit by the suppliers, as:

$$APD_M = ARD_S$$

In such a case, extending the payment period of payables by the manufacturers slows down the receivables turnover period of the suppliers. For this reason, there will be zero effect on the CCC of the total supply chain.

Distributors' Cash Conversion Cycle

Distributors form the third echelon in a four-tier supply chain. At this level, the distribution of the final products is made to the retailers. The main cash receipts at the distributers' level are composed of the cash collections from sales to the retailers. The cash outlays are composed of payments to the manufacturers for purchases of products and other expenses. The CCC at the distributors' level is a function of the cash collection period, inventory turnover period and trade payables turnover period. At the distributors' level, it may be expressed as:

$$CCC_D = ARD_D + ITD_D - APD_D \quad ...(5)$$

$$ARD_D = 365/(CS_D/AR_D)$$

$$ITD_D = 365/(CGS_D/AI_D)$$

$$APD_D = 365/(CP_D/AP_D)$$

where,

ARD_D = Average collection period of the sales on credit by the distributors

ITD_D = Average inventory turnover period at the distributors' level

APD_D = Average days payable outstanding by the distributors

CCC_D = Average cash conversion cycle of the distributors

CP_D = Purchases on credit by the distributors

AP_D = Average trade payables of the distributors

CS_D = Sales on credit by the distributors

AR_D = Average accounts receivables of the distributors

CGS_D = Cost of goods sold by the distributors

AI_D = Average inventory held by the distributors

The services and goods which are purchased by the distributors on credit are equal to the amount of services and goods sold by the manufacturers. As a result, the average days payable outstanding by the distributors is equal to the average collection period of the sales on credit by the manufacturers, as:

$$APD_D = ARD_M$$

In this case, extending the payment period of payables by the distributors slows down the receivables turnover period of the manufacturers. For this reason, there will be zero effect on the CCC of the total supply chain.

Retailers' Cash Conversion Cycle

The retailers' echelon in the supply chain consists of firms conveying the final products to the customers. The only positive cash inflow in the supply chain is realized at this level. The cash flows at the other echelons are composed of exchange of funds. The main cash receipts at the retailers level are composed of the cash collections from sales to the customers. The cash outlays are composed of payments to the distributors for purchases of goods and services and other expenses. The CCC at the retailers' level is a function of the cash collection period, inventory turnover period, and trade payables turnover period. At the retailers' level, it may be expressed as:

$$CCC_R = ARD_R + ITD_R - APD_R \quad \text{...(6)}$$

$$ARD_R = 365/(CS_R/AR_R)$$

$$ITD_R = 365/(CGS_R/AI_R)$$

$$APD_R = 365/(CP_R/AP_R)$$

where,

ARD_R = Average collection period of the sales on credit by the retailers

ITD_R = Average inventory turnover period at the retailers' level

APD_R = Average days payable outstanding by the retailers

CCC_R = Average cash conversion cycle of the retailers

CP_R = Purchases on credit by the retailers

AP_R = Average trade payables of the retailers

CS_R = Sales on credit by the retailers

AR_R = Average accounts receivables of the retailers

CGS_R = Cost of goods sold by the retailers

AI_R = Average inventory held by the retailers

The services and goods which are purchased by the retailers on credit are equal to the amount of services and goods sold by the manufacturers. As a result, the average days payable outstanding by the retailers is equal to the average collection period of the sales on credit by the distributors, as:

$$APD_R = ARD_D$$

Supply Chain's Cash Conversion Cycle

In Equation (2), any factor affecting the CCC of one of the echelons affects the CCC of the other echelons in an opposite direction. We need to expand the equation to clear this relation, as:

$$CCC_{SC} = (ARD_S + ITD_S - APD_S) + (ARD_M + ITD_M - APD_M) + (ARD_D + ITD_D - APD_D) + (ARD_R + ITD_R - APD_R) \quad ...(7)$$

$$APD_M = ARD_S$$

$$APD_D = ARD_M$$

$$APD_R = ARD_D$$

Having considered the above inferences, the supply chain's CCC may be expressed as:

$$CCC_{SC} = ITD_S + ITD_M + ITD_D + ITD_R + ARD_R - APD_S \quad ...(8)$$

As a result, we find that the factors which affect the supply chain's CCC are inventory turnover periods of all the echelons, the receivables turnover periods of the retailers, and the payable turnover period of the suppliers. The days receivables outstanding and the days payable outstanding at the manufacturers' and distributors' levels have zero effect on the supply chain's CCC. On the other hand, the extension of the payable turnover period of the suppliers—the first echelon in the supply chain—has a contracting effect on the supply chains's CCC. The extension of the receivables turnover periods of the retailers—the level where the final products are sold to the customers—has an increasing effect on the supply chain's CCC.

Accelerating the Supply Chain's Cash Flow Cycle

On an individual basis, three factors impact the supply chain's CCC—outstanding days receivables, days of inventory, and the days payable. Therefore, the three measures that need to be taken by a firm are summarized below.

Shortening the Receivables Turnover Period

The quickening of the cash collection from receivables is one of the factors which contributes to the shortening of the CCC. For example, the utilization of banking or post box system may quicken the cash collection cycle. These methods are vital only at the retailers' level, and therefore, should be applied to the final customers. The measures taken at all other levels will neutralize each other. Therefore, only at the retailers' level, there is a possibility to affect the supply chain's CCC positively by quickening the receivables collection.

Extending the Payables Turnover Period

Firms prefer slowing down the payments as much as possible in order to shorten the CCC. For example, utilization of electronic payment may contribute to the extension of the payment period. Another method is to make partial payments to the sellers or to use off-shore banks. This measure is again useful at the retailers' level and has a neutral effect on cash flows of all other levels of the supply chain.

Shortening the Inventory Turnover Period

Inventory turnover period is the only factor that impacts the CCC at all levels in the supply chain. The shortening of the days inventory outstanding at any level of the supply chain contributes positively to the total CCC. This is because contracting the inventory turnover period decreases the funds tied to the inventories. There are two factors which affect inventory turnover rate—cost of goods sold, and average inventory ($ITD = 365/(CGS/AI)$). The shortening of the inventory turnover period depends on decreasing the inventories, the cost of the goods sold remaining stable.

Inventories should be held at minimum levels while taking into account profitability, sales maximization, and customer satisfaction concerns at all echelons in the supply chain. To this end, the Just-in-Time (JIT) production philosophy should be applied to decrease the non-value-adding processes like control, storage and transportation. On the other hand, JIT entails the usage of a pulling system which provides the information flow, beginning from the retailers' level to the levels of distribution, manufacturing and supplying. In a pulling system, products are pulled out or demanded by the proceeding levels from the preceding levels. The amount pulled is exactly the amount demanded. Since the amount of material needed and the time when it is needed are known only by the final level, the last level pulls out the products from the preceding levels. As a result, each level holds a minimum level of inventories to respond to the demands of the proceeding levels. This contributes to the minimization of inventory fluctuations across the levels in the supply chain.

Conclusion

The most important topic in supply chain performance measurement is the effect of the decisions taken by any member in the supply chain to improve its performance indicators, on the total success of the supply chain. Due to the fact that the concept of supply chain has a broad meaning, performance evaluation of the supply chain becomes a complex issue. Previous studies in this field mainly focus on specific parts rather than encompassing the whole structure of the supply chain. This study contributes to the literature as an integral approach to explain the dynamic nature of SCM. The paper analyzed and discussed the critical factors which contract the supply chain's CCC. Therefore, the factors that have a positive impact on a supply chain's CCC are grouped under three headings—shortening the receivables turnover period at the suppliers' level extending the payables turnover period at the retailers' level, and shortening the inventory turnover period at all the levels in the supply chain. ⌘

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