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Abstract. Many companies (especially SMEs) still feel poorly prepared and notice a deficiency of financial know-how when facing situations such as limitations in working capital. To reduce the amount of capital employed, close linkage of financial measures to the daily operations within the companies is required. Yet, supply chain performance measures are often not directly linked to overall financial targets (e.g. cost of capital vs. service level). This paper proposes taking financial parameters into consideration when making supply chain management decisions. It outlines supply chain finance (SCF) solutions available to bigger corporates, analyses current financial metrics for supply chain management and proposes concepts for a greater linkage between finance and supply chain performance measures. Finally, this paper will also reveal gaps where current concepts and metrics have limitations and future research is needed.

Keywords: supply chain management (SCM), financial measures, metrics

1   Introduction

1.1   Motivation

Within the last decades Supply Chain Management (SCM) gained enormous attention. It is no secret that it gives many companies great competitive advantage or even decides over success or failure of a product. That is why countless research efforts could be noted within this sector and it is an inherent part in the education of logistics managers. Even though progress in terms of optimizing and synchronizing material and information flows in SCM has been made, financial flows are insufficiently elaborated in practice by supply chain managers and their impact is not clarified. Since the targets are not aligned, finance managers limit supply chain operations in a sometimes unfavorable way and supply chain managers primarily focus on operational targets neglecting their financial impacts. Many companies (especially SMEs) still feel poorly prepared and notice a deficiency of financial know-how when facing situations such as limitations in working capital after the upturn following the latest financial crisis. After the production capacities and assets were reduced, the need for investments in new production assets and financing raw materials to serve the increased

demand led to difficulties. Another example are the increasingly turbulent fluctuations in the currency and raw material markets that make it more difficult for global companies to forecast the financial flows. Deeper knowledge integration of financial concepts in the decision-making process of supply chain managers is expected to be a major competitive advantage allowing to create more robust and better performing supply chains.

1.2 Problem statement

A current study in Germany shows that many medium-sized companies rely on traditional solutions when financial resources are needed. The vast majority (84 %) asks for loans from a bank and only 31 % of the medium-sized companies work on reducing their working capital [1].

This paper shall serve as a starting point for making supply chain finance (SCF) concepts more accessible for practitioners especially in SMEs. This will specifically be done by a closer linkage of financial know-how to the supply chain management measures. Until now, financing concepts are mainly implemented by the finance department of a company. The target values of finance managers are (beside others) to reduce the cost of capital within the supply chain. However, supply chain managers are primarily rated for performance measures like delivery reliability, fill rates or their own costs. A closer linkage between these different target values is needed to improve overall performance. This paper will outline a recommendation and reveal gaps where current concepts have deficiencies and future research is needed.

1.3 Methodology

This research is based on a literature research as well as on interviews with representatives from Swiss banks and industry. The methodology follows the following three steps. First, an overview about current application of SCF concepts is presented. Second, approaches for linking financial to supply chain performance measures are analyzed. In a third step, the potential gap between existing metrics and desired requirements are deduced and a new approach is outlined.

2 Application of financial measures within SCM

In this chapter, a short overview regarding the usage of financial methods within the SCM discipline will be given. For this reason, a common understanding of the term SCF will be provided in the first subchapter. Then, the cash-to-cash cycle as an important measure for the net working capital will be explained. At the end, an overview over existing SCF solutions in the market will be developed.

2.1   Definition of supply chain finance (SCF)

Unfortunately, there is no distinct definition of SCF in the literature. By the banks, it was often used as a term for buyer-centric solutions and reduced on specific tools (reverse factoring[1] in specific). Lamoureux and Evans define SCF as a sub-set of trade finance (meaning both the supplier and the buyer side). This means a combination of technology solutions and financial services that closely connect global value chain anchors, suppliers, financial institutions and, frequently, technology service providers [2]. This definition is wider, but still not wide enough since SCF doesn't e.g. necessarily need financial providers or technology service providers. Moreover, in this paper SCF will be defined in a more general way as a concept encompassing any financing solution that supports the buyer or seller side of the supply chain to a considerable extent (accordingly to [3], [4]). This includes for example all concepts a supply chain manager applies that influence the financial measures of the buyer, seller or his own company.

In the next subchapter, the application of the cash-to-cash cycle as an important metric as well as its strengths and weaknesses will be explained.

2.2   Net working capital and the cash-to-cash cycle

On average, the working capital accounts for 25 % of the turnover for companies listed in the Swiss Performance Index (SPI) [5]. Consequently, reducing the working capital has been on the agenda of many companies for a long time. Working capital is defined as the current assets of a firm minus its current liabilities [6]. Wagner and Locker specify the assets as accounts receivable plus inventory [5]. One key focus of SCM in the last years consequently is to reduce inventories (e.g. by just-in-time deliveries). The impact of decisions on accounts payable or receivable is not a key interest for many supply chain managers even though the accounts payable are directly influenced by e.g. vendor Managed Inventory (VMI) concepts where the supplier maintains the customer's inventory.

Looking for measures for the working capital, the cash-to-cash cycle has been often used as an indicator / measure for the net working capital that is needed by a company [7]. It bridges inbound material activities with suppliers, manufacturing operations and outbound sales activities with customers [8]. The cash-to-cash cycle can be calculated by Days Sales Outstanding (DSO) plus Days Inventory Outstanding (DIO) minus Days Payables Outstanding (DPO). Measures to improve the cash-to-cash cycle are therefore to reduce DSO and DIO and extend DPO.

This concept has been very successful for specific companies. One of the most prominent examples is the Dell Computer Corporation. In 2001, Dell had four days of inventory supply, 32 days of sales in accounts receivable, and 66 days in accounts payable adding up to a negative cash-to-cash cycle of 30 days [7]. For comparison:

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[1]   With reverse factoring (RF), early payment is provided by a bank or factoring company to a supplier against a rate based on the buyer's creditworthiness by selling confirmed invoices from the supplier to the factor. After the payment term the buyer pays the invoiced amount to the bank or factoring company [14].

European companies had a positive cash-to-cash cycle of 58,6 days in the same year [9].

But using the cash-to-cash cycle as the only metric has some drawbacks. The risks are e.g. rising costs and a higher probability of disruptions along the supply chain. This is due to the fact that while the stronger supply chain partner (which generally has the better credit rating) is able to e.g. reduce its DSO and therefore the needed working capital, the less powerful supply chain partners face worse conditions and their working capital employed is going up. When this moves on along the supply chain, it can lead to rising costs and serious problems at some point for smaller players. The effects of using the cash-to-cash cycle as a main metric for SCM measures are analysed by e.g. Losbichler and Rothböck [9] or Seifert and Seifert [10].

Due to these reasons, other measures to improve the financial situation of a company need to be analysed. In the next subchapter a brief outline over the range of available SCF solutions is given. It must be noticed that these solutions are mainly offered to bigger corporates since a critical turnover and market position is often essential to benefit from an implementation and recover the implementation and administration costs.

2.3   Range of commercial SCF solutions

The benefits for larger companies implementing SCF concepts with their suppliers or buyers include: 1) Reduced risks (by stabilizing their supply chain partners), 2) reduced costs along the supply chain (by e.g. lowering the working capital) and 3) enhanced capabilities of their supply chain (by e.g. providing cash to their supply chain partners that they can invest in new assets). That is why most major manufacturing and retail companies, for example, have a high degree of familiarity with SCF programs and are either considering or already using such a solution [4]. Therefore, different vendors offer various solutions to exploit these potentials (see e.g. [11], [3]). Among others, Yunqi especially mentions the advantages of online supply chain finance systems [12].

Banks traditionally marketed the term SCF and are offering a wide range of solutions. Beside others, these encompass factoring solutions (by selling the accounts receivable to a factor at a discount [13]) resp. reverse factoring, inventory finance, commodity finance or receivables finance.

Non-bank solution providers also exist and offer highly automated electronic platforms. These platforms involve several banks (or investors) that can provide the cash needed for various solutions. The relationship to the financial institutions is often not as strong, but a company might benefit from a greater competition between the funding providers.

Beside these platform solutions, concepts that do not involve a bank at all complement the portfolio. One example is dynamic discounting where a company enables its suppliers to choose when to receive the payment on outstanding invoices. The earlier the payment is received, the greater the discount the supplier has to accept [4]. In case the buyer has better access to capital, this might be a beneficial solution for all parties involved.

This chapter covered the definition of SCF, the introduction of the cash-to-cash cycle as a common metric to measure the net working capital and a short overview regarding the range of SCF solutions that larger businesses can choose of. The next chapter will now deal with solutions applicable to SME and especially implementable in the performance metrics of supply chain managers.

3 Linking finance and supply chain performance measures

An implementation of before mentioned solutions often requires powerful market players who want to tighten their supply chain by supporting their buyers or suppliers. Even for them, onboarding suppliers can be difficult (see e.g. [14]). Within the supply chain, only a limited amount of information is shared due to several reasons (e.g. lack of trust, transparency). But especially SMEs with more restricted resources might have difficulties to participate when no larger player is interested in such a program. In these cases, the broad range of solutions that banks or platform providers offer is remarkably narrowed down.

Still, it can be beneficial if the SCF solutions are directly implemented in the SCM operations. Selected examples will be shown below. After that, a path is outlined to improve the application.

3.1 Financial measures in inventory management

Existing approaches for a greater linkage between finance and supply chain performance measures exist e.g. in the area of inventory management. In 2004, Buzacott and Zhang stated that the financial situation impacts optimal inventory decisions when using asset-based financing (a lender loans money to the customer based on his assets) [15]. This is because the amount of money a company can borrow for financing inventories depends on the value of the inventory itself (only a specific percentage of the inventory-value depending on various factors will be provided by e.g. the bank). The variables are the following. A bank must decide the interest to charge and the loan limit whereas the retailer needs to decide the amount of capital to borrow within the limit and the amount of inventory to order. Buzacott and Zhang model the available cash dynamically in each period. A deterministic model is developed to understand how asset-based financing influences inventory decisions and the ability to grow for a company. Besides, a stochastic model analyzes the motivation of asset-based financing and impact of demand uncertainty. The demand uncertainty is important because it is one reason why the lender might not be able to pay back the loan (when the demand is smaller than expected). They state that their model is especially useful for start-ups facing financial restrictions. This argumentation follows the proposition of this paper that especially smaller companies might benefit from innovative SCF solutions.

With asset-based financing, Buzacott and Zhang focus on short-term debts. Protopappa on the other hand considers long-term interrelations [16]. She states that payment delays impact profit margins and motivates a joint consideration of financial

and operational objectives since financial flows are often treated separately from the physical product flow nowadays. Therefore, a model is presented to understand the trade-off between operational and financial parameters in order to answer questions like how working capital targets affect ordering policy and the trade-off between financial and operational measurements. She analyses the interrelation between inventory level, service level, return on working capital investment, cash flows and working capital requirements. In short, operational and financial performance measures. The analysis is done by a mathematical model within various environments (single / multi-product, various product characteristics, multi-echelon supply chain with joint working capital restrictions, etc.). She concludes that offering more tight payment delays on the customers may have counterproductive outcomes on the performance of the SC due to increased costs on the customers.

These examples proof the positive performance when inventory decisions depend on both operational and financial measures. Still, the supply chain manager must be perfectly equipped with the needed financial know-how and information. Besides, financial measures must be included in his personal objectives. Since this is often not the case, other ways are elaborated to directly implement these measures into the supply chain metrics. This will be outlined in the next subchapter.

3.2 Implementing financial measures within supply chain performance metrics

In this subchapter, a way is outlined for implementing financial measures within the supply chain management department. For this being successful, metrics that are already common in this discipline have to be used. A widely accepted model within the supply chain management discipline is the Supply Chain Operations Reference (SCOR) model created by the Supply Chain Council (SCC) [17]. It provides an extensive framework and is organized around five primary management processes plan, source, make, deliver, and return and details them so that the processes of most supply chains can be described by standardized elements. Within every management process there are three levels of detail. A fourth level is left empty for organization-specific processes. For the purpose of this paper, the SCOR model is used to show where the financial parameters are needed to be taken into account in a greater way in order to improve the overall situation.

Performance is one component of the SCOR model besides processes, best practices and people. Performance contains the attributes reliability, responsiveness, agility, costs and asset management efficiency. Attributes cannot be measured and are used to set a strategic direction (e.g. for specific products or markets). Attributes are groupings of metrics. Metrics can be measured. This paper proposes using a new attribute that describes the financial situation 1) in the market, 2) within the supply chain and specifically 3) for the company. As shown in the previous chapters, these parameters have turned out to directly influence overall performance when included in the decision making process.

For example, in the current setting it would nearly always be beneficial to increase the accounts payable (payables outstanding) and reduce accounts receivable in order

to increase the return on working capital (hierarchical structure in the SCOR-model: asset management – return on working capital – accounts payable). As shown before, this can negatively impact the situation of the suppliers which might therefore lead to higher risks of failure of a supplier. A new strategy might be to strengthen the overall supply chain and therefore reduce risks. This could have its reasons in the market situation (e.g. many smaller suppliers in a low-wage country). The strategy would make use the new "financial supply chain" attribute which encompasses e.g. a risk factor at the first level. At a second level, this risk factor is detailed in e.g. a combination of the days sales outstanding (DSO) and other factors. Balancing the DSO with the other factors would now lead to an optimal situation (whereas otherwise it would be beneficial to just increase the DSO). At the end, this could lead to a more robust supply chain. Another example is the start-up scenario Buzacott and Zhang [15] mentioned before where access to capital is limited. Following the strategy of taking "financial supply chain" attribute more into account would also lead to better inventory decisions in that case.

These are just a few examples. In the next step, the attribute would have to be elaborated in a greater detail considering various levels and analyzing the impacts and interactions. After that different case studies might have to be conducted.

4 Conclusions

The research problem has been brought to academia by several companies (in particular SMEs) who stated that they do not feel well prepared regarding financial measures within the supply chain management operations. SCF represents a powerful tool to improve supply chain performance (e.g. by releasing working capital). The paper therefore illustrates this need and creates a common understanding of SCF. It also shows current solutions in the market. In the third chapter, concepts for integrating financial concepts into the daily operations are introduced and an approach to link them to the SCOR model is outlined.

Nevertheless, SCF concepts are not easy to implement. This might be due to the fact that it is an interdisciplinary topic with several departments involved and it might have complex impacts on other measures or supply chain partners that are not always easy to foresee. Also, different objectives among the supply chain players, limited capabilities or lack of trust and transparency in the supply chain might lead to some implementation difficulties. Nevertheless, it is important to develop profound concepts that can be implemented in the daily operations. Structuring the requirements for a successful implementation of these concepts might be an important future research topic.

Also, until now an outline of the background and the need for financial measures is provided. An approach to include financial measures into the SCOR model is also given. In future research efforts, a structured catalogue of supply chain finance concepts might be developed. After that, the suggested approach has to be further detailed and case studies have to be conducted to prove positive overall performance. At the end, decision makers would be enabled to find suited metrics for their specific supply

chains by selecting them from the overview according to their strategies and the indication from the SCOR model.

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