B2B Supply Chain Risk Measurement Systems: A SCOR Perspective

Abstract

Purpose- Globalization, trade barriers, unprecedented health crises, and geo-political crises have forced organisations to revisit their performance measurement systems to better prepare their supply chain against the risk and improve performance in times of crisis. The study's main objective is to review the SCOR-based performance measurement systems (PMS) and propose a dynamic SCOR-based PMS for supply chain risk management (SCRM).

Design/methodology/approach-Due to the need for multi-stakeholder perspectives on SCOR-based PMS for the SCRM, we aimed to develop a theory rather than to elaborate upon or test the theory. Hence, we adopted an inductive theory-building approach to build research propositions. We gathered 12 semi-structured interviews with knowledgeable managers from B2B international companies.

Findings- The findings of the study highlight the challenges faced by the organisations during the implementation of the SCOR-based performance indicators and the positive impacts they have on decision-making and on the continuous improvement strategy of organisations to tackle supply chain risks and improve performance. The findings suggest that the effects of these indicators are more felt during risk management and risk monitoring stages.

Research limitations/implications- Like any other study, our study has some rules, and thus we caution the readers that they must interpret the findings of our research considering these limitations. The study is based on semi-structured qualitative interviews. The interviews were conducted with 12 knowledgeable managers from France; thus, the insights drawn from the study cannot be generalised to other settings. Further, our samples represent something other than small and medium enterprises. In the future, the samples from small and medium firms can offer a nuanced understanding of the performance indicators for supply chain risk management.

Originality/value- This is one of the few studies which has attempted to revisit the SCOR-based PMS in the B2B supply chain for risk management. The study's findings help expand the SCOR-based PMS literature and offer numerous insights to the management and consultants facing challenges in SCOR implementation.

Keywords: *B2B Supply Chain, SCOR, Performance Measurement Systems, Supply Chain Risk Management, Qualitative Research*

1. Introduction

Rapid globalisation and the complexity of the supply chain networks have increased the risk of failures (Milovanovic et al. 2017). Risk management has made significant progress and is now considered the vital differentiating point between the most successful and average-performing organisations (Ivanov et al. 2021). Risk management can be understood as a part of the overall company's strategy to reduce uncertainties (Hallikas et al. 2004). Hence, risk management can significantly influence business performance, depending on how the organisation has implemented it (Oliveira et al. 2019). Hendrick and Singhal (2003) argue that poor risk management significantly negatively impacts business performance. The rise in supply chain risks has forced organisations to develop a robust risk mitigation strategy and develop a performance measurement system (PMS) to measure and control supply chain risk (Chopra and Sodhi, 2004; Antai and Olson, 2013; Heckmann et al. 2015; Shrivastava, 2023). During the last decades, the increase in the development of "*PMS*" has been described as "*continuous and incremental*" (Hald and Mouritsen, 2018). The PMS is the measurement related to the position of a company in terms of performance, turnover, costs or ratios, and indicators that confirm or refute the work and the company's practices (Coleman, 2016). Implementing the PMS is essential as the organisation's competitiveness depends on how the PMS is aligned with the organisation's overall supply chain management strategy (Gunasekaran and Kobu, 2007; Dubey et al. 2017).

Over the last few years, the development of supply chain performance key indicators has been one of the main research areas that have always excited the supply chain management community (Ramanathan et al. 2011). In the past, supply chain performance has been evaluated using different metrics depending on the context in which it operates (Wagner and Bode, 2008; Chae et al. 2009). Many supply chain scholars have discussed the SCOR model concept in this multiplicity of performance indicators (Rohsan and Jenson, 2014). In addition to providing a common language between companies, it also offered a tool to benchmark them (Lima-Junior and Carpinetti, 2019; Chehbi-Gamoura et al. 2020). The SCOR model is appreciated for its universality and the detailed framework it offers (Sundarakani et al. 2018). However, despite the extensive literature on the subject, it is essential to note that there needs to be a more nuanced understanding of supply chain performance measurement systems in the context of risk within B2B supply chains. Our study aims to develop a comprehensive PMS for B2B supply chain risk management. The guiding research questions of the survey are:

RQ1: What are the key performance indicators (KPIs) for supply chain risk management?

RQ2: How do the supply chain risk management KPIs influence organisational performance?

To answer our research questions, we relied upon the inductive theory-building approach (Gioia et al. 2013; Corbin and Strauss, 2014). We conducted 12 semi-structured interviews with knowledgeable managers linked to SCOR-based performance measurement systems, supply chain risk management, key performance indicators (KPIs), and B2B supply chain management. Based on Gioia et al. (2013) recommendations, we performed our data analysis on qualitative data. The findings of the study offer two-fold contributions. Firstly, we provide theoretical insights into B2B supply chain risk management initiatives. Unlike B2C supply chains, B2B supply chains are far less complex. It is important to recognize the significant differences between B2B and B2C supply chain processes (Stott et al. 2016; Garner and Mady, 2023). B2B supply chains offer businesses more direct negotiations and greater bargaining power due to fewer customers (Lambert, 2009; Hansen, 2009; Bag et al. 2021a). B2C supply chains, on the other hand, involve a more extensive network of producers, wholesalers, and retailers (Anderson et al. 2022) and focus on building brand loyalty and repeat customers due to the larger customer base (Zhang and Du, 2020). To succeed in competitive eCommerce and B2B marketplace businesses, it is crucial to have a user-friendly eCommerce platform and a connected supply chain (Gani et al. 2022). This requires integration between B2B eCommerce and supply chain management to capture leads, build relationships, and increase sales. Furthermore, while B2C companies sell directly to consumers, B2B companies sell to other companies, with differing levels of bargaining and risk (Enrique Bigne et al. 2008; Bag et al. 2022; Hu et al. 2022). This study aims to clarify risk assessment and indicators used to measure risks specific to the B2B supply chain and propose a PMS for B2B supply chain risk. The existing PMS does not differentiate between B2B and B2C, highlighting the need for targeted solutions. The next section of this paper provides the research's conceptual and theoretical background. After that, we present the research design section, which summarises the steps involved in the study, including the philosophical choice, appropriate research strategies, the description of the sampling design, and interviews. Subsequently, we present our data analysis and discuss our findings in which we also suggest the study's limitations and offer future research directions. Finally, the paper concludes with a summary.

2. Theoretical Background

2.1 Supply Chain Risk Management

Turbulent and changing business environments are the source of supply chain risks (Christopher and Peck, 2004). The emergence of new technologies results in cyber threats and offers significant opportunities that new technologies and big data offer (Dubey et al. 2021; Gani et al. 2022). The

increasing exposure to risks further forces the companies to invest in resilient capabilities that allows the organisation to minimise the risk (Teece et al. 2016). Following the emergence of numerous dangers in the early 2000s, Ritchie and Brindley (2007) demonstrated an increase in interest in supply chain risk management (SCRM). There is a growing interest among scholars and practitioners to manage uncertainty using metrics and indicators of performance following the supply chain improvements strategy and their research of performance (Gunasekaran et al. 2004). Tang (2006, p. 453) defined SCRM, as "*the management of supply chain risk through coordination and collaboration among the supply chain partners so as to ensure profitability and trigger*". The main objective of SCRM is to mitigate the risk to reduce the effects of disruption on the supply chain profitability and performance. Svensson (2000) defines supply chain disruptions as the result of an unexpected event in an uncertain context directly impacting the operational and financial performance along the supply chain. These disruptions disturb the usual flow of materials, information, and the coordination between these flows (Craighead et al. 2007). In this way, SCRM supports decision-making by considering the potential benefits and losses of a decision for the company (Tang, 2006). By assessing current risks linked to today's society, risk management highlights the presence of business issues due to technologies' emergence adding to other market risks (Aven, 2016).

2.1.1 Identification and Assessment of Supply Chain Risk

There are many definitions of risk. They all deal with uncertainties, events, and their consequences for businesses (Aven, 2016). Risk includes several dimensions, such as the probability of occurrence, the losses that can be caused by risk, and the speed and frequency of occurrence of this same risk (Manuj and Mentzer, 2008). Three dimensions of risk are agreed upon by researchers (Ritchie and Brindley, 2007):

- *The likelihood of occurrence (the probability for a risk to occur)*
- *The consequence of the occurring events (the impacts that can be financial, material, or reputational)*
- *The causal pathway of the event (the causes and origins of the event).*

The possible consequences of this event are at the root of the concept of vulnerability of companies towards risks (Heckmann et al. 2015). Organisations' profits cannot be predicted or stabilised in an uncertain environment (Beckert, 1996). Increasing uncertainty and vulnerability have prompted many companies to hedge their risks (Lee, 2002; Wagner and Bode, 2006). Hedging helps organisations to mitigate risks through pooling and sharing the resources in the supply chain (Lee, 2002). To reduce the risk, it is essential to identify and assess the risk (Tummala and Schoenherr, 2011; Manotas-Duque et al. 2016). Elaborating on several scenarios is the first step in determining

the possible causes and consequences of threats on the supply chain when placing bets. (Hallikas et al, 2004). Knowing and identifying the risks results in appropriate management (Shabani-Naeeni and Ghasemy Yaghin, 2021). The fact that supply chains are interconnected means that everyone is responsible for reducing risks (Sreedevi and Saranga, 2017). Each supply chain depends on the other regarding raw material supply, transportation of communication (Kumar et al. 2010). The dependency on these networks results in fragility, where a minor disruption impacts the whole supply chain (Handfield et al. 2020; Liu and Park, 2021). If we take the example of demand risk, poor demand forecasts or severe demand fluctuation can disrupt the supply chain by generating a bullwhip effect from the raw material supplier to the wholesaler (Lee, 2002; Tang, 2006). To mitigate all types of risks, Um and Han (2021) suggest implementing the SCOR model. The SCOR model gives indications of the current performance of the company, which helps organisations gaining in stability and work on their weaknesses considered risk carriers (Ellram et al. 2004; Totaru et al. 2014; Sundarakani et al. 2018; Moazzam et al. 2018).

2.1.2 Classification of Supply Chain Risk

Classification of supply chain risk is essential for managers while preparing for supply chain risk management (Rangel et al. 2015). Despite several works on supply chain risk management, there is a lack of consensus on supply chain risk identification and management approaches (Sodhi et al. 2012). The classification schemes various scholars adopt help shape the broader picture of supply chain risk management. Table 1 provides some classification schemes offered by multiple scholars in supply chain management. For instance, Manuj and Mentzer (2008) classify global supply chain risks into four categories, while Christopher and Peck (2004) classify the supply chain risks based on external and internal sources. In addition to these classifications, Cavinato (2004) discusses the innovation risk.

Table 1: Summary of Classification of Supply Chain Risk

Source	*Risk*
Manuj and Mentzer (2008)	Supply risk
	Demand risk
	Operational risk
	Security risk
Christopher and Peck (2004)	External to the network
	Climate change
	Geo-political crisis
	Economic crisis
	Political instability
	External to the firm but internal to the supply chain network
	Supply risk
	Demand risk
	Internal to the firm
	Process
	Control
Cavinato (2004)	Physical risk
	Financial risk
	Informational risk
	Relational risk
	Innovational risk

(Source: Authors own compilation)

In the last few years, human beings have experienced far more risk. Hence in addition to the above sources, other sources need to be acknowledged. In Table 2, we have classified various supply chain risks and their drivers based on an extensive review of the literature (see, Chopra and Sodhi, 2004; Sodhi et al. 2012; Ho et al. 2015; Katsaliaki et al. 2022).

Table 2. The Classification of Supply Chain Risk and their Drivers

	Risk	*Drivers of Risks*
External Risks	Demand risks	Inaccuracy of forecasts
		Lack of visibility along the supply chain
	Supply risks	Supplier dependency (a single supply source)
		Delays issues
		Delivery/transportation mode issues

Internal Risks	Disruption risks	Natural disasters
		Wars
		Geopolitical conflicts issues
		Pandemic
	Legal risks	Tariffs changes
		Currency rate changes
		New import/export regulations
		GDPR updates
	Operational risks	Machine breakdowns
		Quality issues
		Delivery issues
	Inventory and Capacity risks	High-capacity costs
		Capacity flexibility issues
		Inventory obsolescence
		Demand and supply uncertainty
		Holding costs
	IT and Cyber-Security risks	IT breakdowns
		Data theft

(Source: Authors own compilation)

All these risks directly impact the economy and the markets in which businesses evolve. Trkman and McCormack (2009) argue that the rise of endogenous and exogenous uncertainties often leads to vulnerabilities. Because of turbulences, these uncertainties translate into the internal and external risks a company may face. A strong supply chain strategy is a critical determinant in anticipation of turbulences and uncertainties and the reduction of risk exposure (Lee, 2002; Sodhi et al. 2012).

2.2 The SCOR Framework

The Supply Chain Operation Reference model (SCOR) was introduced by the Supply Chain Council in 1996. The SCOR aimed to create standard matrices and terms to describe logistics and operations activities to enhance the interaction effects among supply chain partners (Schoenherr and Swink, 2012). SCOR offers a framework for processes and performance measurements in the supply chain (Sellito et al. 2015). The SCOR model is a valuable tool for analysing the supply chain configuration. It examines the interaction between the different stages and processes occurring along the supply chain, from the supplier's suppliers to the customers' customers (Ntabe et al. 2015). The SCOR model defines the supply chain operations and design, which allow companies to improve their strategy, and further enable the companies to anticipate future events (Ivanov, 2022).

SCOR is considered a tool to benchmark the organisation and to compare it to its competitors in the industry. It further helps organisations to make improvements by focusing on six processes – *plan, source, make, deliver, return, enable – to measure* supply chain performance (Lambert and Enz, 2011).

- *Plan* represents the elaboration of a plan for the supply chain operations considering the existent resources and capabilities of the company.
- *Source* refers to the order and the reception of the procured raw materials and components.
- *Make* takes into consideration all the manufacturing stages and the transformation from inputs to outputs, including recycling and upcycling processes.
- *Deliver* involves the packing and distribution of the order.
- *Return* focuses on reverse flow logistics and return of goods.
- *Enable* involves the overall supply chain management as performance and risk management.

The SCOR model adds value to the supply chain, regardless of product complexity, processes, and network (Sellitto et al., 2015). By adapting the model to different supply chain designs, a company can implement performance measurements for specific projects (Lima-Junior and Carpinetti, 2019). This illustrates the need for continuous improvements of the SCOR model as the business environment changes. Supply chain risk management involves defining the chain, creating a map, identifying risk tolerance, and defining an organisation's tolerance for risk.

2.3 SCOR Attributes and Performance Metrics

SCOR performance metrics enable the evaluation and the understanding of the supply chain strengths, weaknesses, competitive advantage, or paths to improvement (Praharsi et al. 2022). These performance standards are classified into five metrics: *responsiveness, reliability, agility, cost, and asset management efficiency* (APICS, 2017) (see Figure 1). The key terms used in Figure 1 are defined in Table 3.

Figure 1: SCOR performance metrics (Source: Authors own work)

Table 3: Definitions

Metric	Definition
Responsiveness	It describes the rapidity of action or reaction to do a task or to respond to a demand or an order
Reliability	Reliability at the customer interface is defined as "the ability to perform tasks as required"
Agility	It refers to the capacity to counter an external influence or disturbance.
Cost	It refers to the cost along the supply chain. They relate to the different stages and processes, including material, labour, and transportation costs.
Asset management efficiency	It refers to the excellent use of the assets and the chosen strategy related to the manufacturing or outsourcing strategy

- .Source: APICS (2017, p. vii).

If some companies tend to focus on one, the complementarity of the metrics categories appraises their correlation in the research of performance improvements. Each attribute regroups metrics and strengths a company performs and manages to reach its objectives related to its strategy. However, only performance standards will provide quantitative data and measure the supply chain performance. Thus, their ease of reading facilitates their analysis. One of the objectives of using the SCOR performance metrics is the performance benchmark that compares an organisation to its competitors or an industry (Peng Wong and Yew Wong, 2008). Performance standards are used to identify the tendency of the supply chain based on internal and external performances (Liang, 2015). These performances become an element of comparison among companies in the same industry. Opportunities and possible improvements can be suggested to the company (Lima-Junior and Carpinetti, 2016). Benchmarking is a factor having a positive influence on supply chain improvements (Bititci et al. 2013). Indeed, the comparison among other companies in the industry results in a better knowledge of the strengths and weaknesses of the organisation and underlines its competitive advantage. Hence, the SCOR model metrics are valuable if they are analysed and evaluated according to the management control objectives.

3. Research Methods

We aimed to propose a theory for SCOR-based PMS in B2B supply chains with multi-stakeholder perspectives. Recent studies need a holistic approach to supply chain performance measurement systems for risk management (see, Fan and Stevenson, 2018; Moazzam et al. 2018). Franciosi et al. (2021) defined stakeholders as individuals or organisations with a share, claim, or right to a system. Therefore, the study considered diverse stakeholders to understand the metrics helpful in evaluating the performance of SME manufacturing B2B firms. This study explores different contexts and stakeholder perspectives to identify indicators for measuring supply chain performance for risk. The inductive theory-building approach is the most desirable in such cases (Corbin & Strauss, 2014; Bansal et al., 2018; Duensing et al., 2023). Bansal et al. (2018) argue that the inductive approach is constructive in addressing complex phenomena and generating new insights. This approach is now well. established in the B2B supply chain management journals (Lindgreen et al. 2021; Wang et al. 2021). Our method follows the research-onion framework (Saunders et al. 2009). The framework outlines philosophical stances, theory development approaches, methodological choices, research strategies, data collection, and analysis.

3.1 Research Approach

This study is based on an inductive approach. The inductive approach aims to build new knowledge from an empirical situation. Our research intents to respond to the questions "*what*" and "*how*". This reasoning led to the adoption of the qualitative approach. Unlike the quantitative approach, the qualitative approach fits the exploratory study. Indeed, this approach aims to put words on opportunities, or issues met following the implementation of SCOR metrics. Different strategies can be set up by selecting qualitative research, action research, case study research, ethnography, grounded theory, and narrative inquiry. Among these other possible methods, we adopted the qualitative grounded theory approach (Gioia et al. 2013; Bansal et al. 2018). This selection has been made based on getting the respondents' experiences and building a theory around the collected data.

3.2 Data Collection

To understand how SCOR-based PMS function in B2B supply chain risk, we interviewed executives from multinational companies based in France and other stakeholders in small and medium-scale manufacturing enterprises (SMEs). Supply chain executives in the B2B industry have more insight into the challenges of implementing SCOR-based PMS than traditional supply chain performance metrics. SMEs have less experience with SCOR-based PMS, so we relied on qualitative interviews with knowledgeable supply chain executives. Our sample size was not predetermined but developed over the course of the investigation, resulting in 12 respondents from SMEs. In the next, we provide details of our interview protocol.

3.2.1 Justification of the Selected Data Collection Strategy and Technique: Semi-Structured Interview

Data collection has been conducted following a mono-method qualitative study. We evaluated that the most appropriate method for this study was the semi-structured qualitative interviews. Interviews help in gaining an understanding of the respondents' perceptions. Appraising qualitative data collection methods (Bansal and Corley, 2011) allowed us to consider different possibilities according to our pre-set objectives. We opted for the semi-structured interview among the different types– structured, semi-structured, and unstructured. Even if each style has its advantages, semi-structured interviews allow the development of additional thoughts and opinions. Semi-structured interviews give the research more freedom, enabling us to reformulate or explain a question to the

respondents. Although the presence of the interview guide frames the interview and the main topic discussed, this interview type allows the discussion of other issues linked to the considered ones. Semi-structured interviews entail the debate and the trust relationships between the respondents and the researcher. It also enhances information transparency and data reliability (Bansal and Corley, 2012; Gioia et al. 2013; Bansal et al. 2018). We preferred to conduct the single interview over the group interview to maintain the trust between the interviewer and interviewee. Further, in a way, we assured the confidentiality of the data.

3.2.2   Interview Guide Structure

The interview guide first introduces the topic and its objectives. The interviews were conducted in four parts.   The first part concerns the performance indicators. We asked the questions to participants regarding which performance indicators are commonly followed in their organisation. The second part deals with the implementation of SCOR indicators and their challenges. The last two factors are related to the effects of SCOR indicators on supply chain risk (identification, management, and mitigation) and conclude on the SCOR metrics during a high-risk exposure situation (**See Appendix 1**). To ensure the quality of our findings, a specific sample was needed including inclusion and exclusion criteria. This sample is discussed in the following section.

3.2.3   Sample Criteria

To undertake this research, the selected sample corresponds to the following inclusion criteria. The respondents must be managers or employees working for the supply chain department or departments working in correlation with the supply chain. The companies the participants are working for must have implemented SCOR performance indicators. This specific sample fits with our interest in having the respondents' opinions due to their professional visions and their experience in the supply chain area. We excluded workers working not directly with these indicators. Indeed, the main research question being directly related to the question of SCOR metrics, we could not include employees not embedded in this process.

3.3 Ethics Considerations

Ethics is a critical topic during the data protection process. The first step has been to get an ethical form from the University. During the interview process, the participants were informed that their responses would remain anonymous and would only be used for academic research. This research ensures neither harm nor exposure to the respondents during and after the interviews. No physical or psychological consequences occurred during this research.

4. Data Analysis and Findings

In total, 12 respondents participated in the interviews (**see Appendix 2**). All of them are working in France, B2B manufacturing sector. 33% (4 out of 12) of the participants were men, while 67% (8 out of 12) were women. Regarding company size, 10 of the respondents work for big companies, while only 2 works for SMEs. 33% (4 out of 12) of the participants are employed in national companies, while 8 12 are used in international companies.

4.1 SCOR Indicators of Performance's Costs and Savings Assessments

4.1.1 The Difficulty to Assess Expenses and Revenues

The participants mainly were not sure about the costs and savings realised through the implementation of performance indicators. They are not sure what is embedded in their implementation. Moreover, the participants had no clear idea regarding the investment made by their organization in the implementation of the SCOR-based performance indicators. Most of the respondents could not give a precise answer and only answered by providing estimations.

4.1.2 Costs of Implementation of SCOR Metrics

The amount of costs for implementation corresponds to 10% of the budget. This 10% budget is allocated to the continuous improvements of these indicators, including their latest versions and complementary tools. For some participants, these costs are necessary and essential for the company. However, participants consider SCOR indicators of performance as time-consuming. The time spent on the implementation and adoption of the metrics is found to be consistent across the industry.

4.1.3 Savings Realized through SCOR Indicators of Performance

The participants identified two types of savings: *customer loyalty* and *costs*. Customer loyalty is considered a saving since it is cheaper to keep a customer than to gain a new one. Even though it is challenging to evaluate, customer satisfaction and customer loyalty are essential performance indicators. Savings are also made in terms of costs. Indicators of performance positively impact the savings of different departments of the company as well as in the supply chain. Finally, saving time is considered one of the most essential savings. Considered an asset by respondents, time savings

are one of the main motivations for companies contemplating implementing SCOR-based performance measurement systems.

4.2 Challenges of Implementation

4.2.1. Human resource

The resistance towards change from employees can be a hindrance to the implementation of indicators of performance. Countering the implementation of indicators due to the fear of being replaced and becoming obsolete is common. Employees also fear the obsolescence of their skills and knowledge and their incapacity to renew it. According to several respondents, human represents a challenge in terms of resource needed to implement indicators. Indeed, their implementation cannot be made without humans' knowledge and capacities. This challenge can also appear as a limit to their performance in a way that the limits of human knowledge in terms of implementation analysis define the boundaries of the indicators. Even if indicators are an extension of human capacities, they are limited by human cognition.

4.2.2 The Selection of Indicators to Implement

Selecting the right indicator that matches the desired objectives is essential but remains a difficult path. The application of factors and variables directly influences the indicators and their analysis. Participants defend that betting on the wrong hands of performance gives incorrect information about the strategy to follow and can, unfortunately, lead to poor decision-making. Making an accurate decision concerning the indicator to implement is difficult if the company wants to avoid being caught up in a spiral of unappropriated choices and strategies.

4.2.3. Analysis of the SCOR Indicators of Performance

Participants agreed on the importance of human technique and knowledge. Human resource is the most asset required for the analysis of indicators of performance. Some tasks as data crushing, involve human knowledge and capacities and cannot systematically be done by IT tools. Furthermore, the interdependency among the different indicators adds difficulties to analyse them independently.

4.3   The Effects of SCOR Indicators of Performance on Supply Chain Risks

4.3.1   The Controversy Towards the Use of Indicators of Performance to Forecast and Predict

Participants' opinion towards using indicators as a prediction tool differs from one to another. On the one hand, SCOR indicators of performance must be used to predict. They give the alert and bring indications about the company's current state. On the other hand, participants think that indicators do not help during the forecast stage. According to them, the alarm is launched while the current exposure to risks. According to the results, SCOR indicators are not helpful during the identification stage of risks. Participants blame the fact that indicators are based on historical data. Establishing the future on past data can only provide information if the risk has ever occurred in the past. Indicators of performance cannot predict risks that have not already happened in the past.

4.3.2   The Impact of SCOR Indicators of Performance on Decision-Making

SCOR indicators of performance are used as a tool for decision-making. SCOR indicators of performance benchmark the company and evaluate its current performance and strategy. Companies taking part in a continuous improvement strategy use metrics to assess the new measures and undertaken actions. They concretise the objectives set up and quantify the evolution of a strategy and the effects of a decision made. Participants claim the importance of these metrics to visualise the current situation and the objective that wants to be reached, giving indications on the decision made and the strategies adopted along the path.

4.3.3   SCOR Indicators of Performance for the Long-Term Risk Management Strategy

Employing performance indicators as a decision-making tool also results in anticipation and investments. Through the implementation of SCOR metrics, participants observed a reinforcement and reassessment of their risk strategy. Redefining priorities and reassessing the risk grid can improve long-term vision and responsiveness in high-risk exposure situations. Thus, metrics encourage the process of implementation or enhancement of the risk management strategy in the long term.

4.4   Limits of the SCOR Indicators of Performance on Risk Management in Supply Chain

4.4.1 The Counter-Performance of SCOR Indicators of Performance in the Risk Management of External Risks

Indicators of performance are implemented to help in the management of internal risks as operational risks. Nevertheless, they could be more productive for avoiding or limiting external risks. Participants mainly use SCOR indicators of performance for supply and disruption risks. However, hands have limited capacities in the identification of external threats. These difficulties are primarily due to the hindrance to concretely analysing the business context. Indeed, respondents estimate that external risks cannot be measured or assessed by only basing predictions on historical data. Participants also expressed the lack of SCOR indicators of performance dedicated to measuring the company's impacts on sustainability. Considering the world's current issues with the limitation of energy consumption, developing this performance indicator is vital for companies.

4.4.2 The Dependency of SCOR Indicators of Performance

Participants judge indicators as being highly dependent upon IT and database tools. ERP and data are primordial along the entire path of performance indicators, from their implementation to the analysis and final use. Human represents a resource necessary to analyse these indicators comprehensively and efficiently. In other words, indicators are not autonomous. Further, participants noted the existence of interdependency among indicators of performance. An arrow can easily influence another one which complicates their analysis. Their dependency increases the complexity of their research and enhances the risk of misunderstanding.

4.4.3 SCOR Indicators of Performance Seen as Costly and Hard to Implement for Small Companies

Participants also discussed the cost of implementing these indicators. Most of the participants worked for large international companies. Their previous experiences illustrate small and medium companies' difficulties in implementing SCOR indicators. The human, technical, and financial resources and capacities hinder their ease of implementation. The obstacles to their implementation often discourage small organisations, which suffer most of the impacts of risks and crises on their business.

5. Discussions

The study's findings highlight that the cost of implementation, resistance to change and the skills needed to adapt to new technology are the major roadblocks to the successful implementation of the SCOR-based PMS. SCOR metrics appear challenging to undertake in terms of commission due to the human skills and capacities required for it. The results illustrate that the choice of the most adapted indicators of performance and their analysis are the main difficulties met. While the effectiveness of these metrics as forecasting tools remains a topic for debate, participants agree on their efficiency for decision-making. Using SCOR performance indicators to create or enhance long-term risk management strategies has proven beneficial. The SCOR performance indicators positively impact the identification and assessment stages of supply chain risk management. Nonetheless, the metrics have their limitations. Internal and external factors are not synergised enough to make the system work effectively. As a result, SCOR-based PMSs fail to adapt to external environmental changes like any other PMS.

5.1 Implications for Scholars

The findings of the study contribute in a two-fold manner to scholarship in SCRM and PMS. The SCOR process is often classified into multiple levels depending on its application. The success of the SCOR relies on four pillars: *performance*, *processes*, *practices*, and *people*. Based on the findings, the study contributes to the understanding of how performance metrics along the major processes help prepare the organisation for risk. Hence, we can argue that the hierarchical representation of risks by the SCOR model is critical, as well as the view of risk management as transactional instead of strategical. The study's findings further suggest the development of a performance measurement system (PMS) for benchmarking and the effect of external forces in shaping performance metrics. The study's findings support Dubey et al. (2017) findings that how institutional factors and the organisational culture shape the PMS. We thus agree that these external factors, in the form of institutional pressures such as competitor pressures, regulatory changes, or a set of rules and policies, account for the performance indicators of supply chain risk management. Institutional forces suggest that the institutional environment provides social expectations and norms regarding organisational structures, operations, behaviours, and practices (DiMaggio and Powell, 1983; Liu et al. 2010; Dubey et al. 2017; Hendrics and Matthyssens, 2022). Adhering to these expectations is essential for a firm to maintain legitimacy and access resources (Liu et al. 2010; Kauppi, 2013; Bag et al. 2021b). Therefore, when deciding whether to adopt an innovation, a firm will consider institutional expectations and norms, assess the potential costs and benefits, and position itself accordingly to mitigate uncertainties (Liu et al. 2010). Institutional pressures, including normative,

mimetic, and coercive pressures from constituents in the field, affect a firm's interpretation of the environment and innovation adoption intentions (Dubey et al. 2019). Accordingly, we propose our first research proposition of our theory (see Figure 2).

Proposition 1: *The Institutional pressures shape the performance indicators of the PMS based on the SCOR framework.*

Although interviewees agreed that the cost is one of the reasons why most organisations do not find much confidence in the implementation of SCOR 12.0 (the latest version), this problem is due to the lack of visibility in the supply chain. Effective supply chain management requires timely, accurate, and relevant information (Wang and Wei, 2007). Barratt and Oke (2007) argue that in supply chain management literature, visibility is often misunderstood. Visibility is a higher-order capability often created through the bundling of resources (i.e., technology and information sharing). The visibility in the supply chain does not only include supply and demand. It also refers to the extent to which each employee is aware of the SCOR and how SCOR-based PMS helps managers make effective and efficient decisions. Information visibility refers to the degree of on-hand information related to demand and supply (Brandon-Jones et al. 2014). It can be achieved through different means, including technology-based media, social contacts, and procedural venues (Kauffman and Pointer, 2022). The interviewees have also shared that most of the time, due to a lack of adequate information or reliable data, the benefits realised through the implementation of SCOR-based PMS are not reflected in the profitability statement. The difficulties in implementing SCOR-based PMS are reinforced by the lack of historical data. Indeed, the accuracy of the performance indicators will depend on the accuracy and amount of past data of the company. An organisation with limited historical data will have a limited capacity to implement performance indicators. If set up, missing data would mistake their analysis and the indicators resulting from it. Small and Medium Enterprises (SMEs) sometimes have limited data collection and a limited capacity for data analysis which complicate the use of the SCOR model and the indicators of the model. Hence, we argue that proper information sharing may reduce internal resistance to the implementation of the SCOR-based PMS. Therefore, monitoring supply chain partners' opportunism is easy with high visibility (Chen et al. 2017). Sharing information reduces information asymmetry and monitoring costs, thus lowering the incentives for transactors to behave opportunistically (Luu et al. 2018). Real-time demand data and inventory visibility are critical for effective supply chain forecasting, planning, scheduling, and execution. Increased visibility is a cornerstone of improved supply chain performance. Hence, we propose the second research proposition of our theory.

Proposition 2: *Accurate information sharing reduces behavioural uncertainties and reduces the internal resistance to the implementation of the SCOR-based PMS.*

Interviewees agree that the role of leaders is critical at this point. The managers' role is critical in shaping the organisational structure and creating policies based on their perceptions and beliefs. In a dynamic environment, the team leaders are influenced by various factors, including the competitor's choice of IT products, the inputs offered by reputable consultants, or their internal report based on the cost-benefit analysis against other organisations and products. The top manager in such cases, needs to appreciate the current situation and assume significant responsibility for both changes in terms of technology and organisation. According to institutional theory, institutional pressure encourages organisation steps by creating a sense of legitimacy around these actions (DiMaggio and Powell, 1983; Liu et al. 2010). However, this theory is incomplete as it assumes that the organisation endorses this institutional legitimacy and can undertake the actions required to conform to institutional requirements (Greenwood and Hinings, 1996). Organisational variance exists around both these assumptions. We draw from the role of intra-organisational dynamics in fostering organisational change to identify two factors that are especially critical in effecting organisational change in response to institutional pressures: a commitment to reform and a capacity for change (Scott, 2008; Colwell and Joshi, 2013; Dubey et al. 2017). This study defines top management commitment as the willingness to reform and the ability to adapt to change. High top management commitment increases the likelihood of adopting SCOR-based PMS for supply chain risk management because it aligns with the organisation's vision and capabilities. In contrast, low top management commitment leads to resistance to institutional pressure to adopt SCOR-based PMS for supply chain risk management. Hence, we argue that the top management involvement plays a significant role in motivating the team members to adapt to the new SCOR-based PMS and help in the successful implementation of the PMS for the organisation's overall benefit. Accordingly, we posit the third research proposition:

Proposition 3: The top management involvement mediates the effects of the institutional pressures and the SCOR-based PMS implementation.
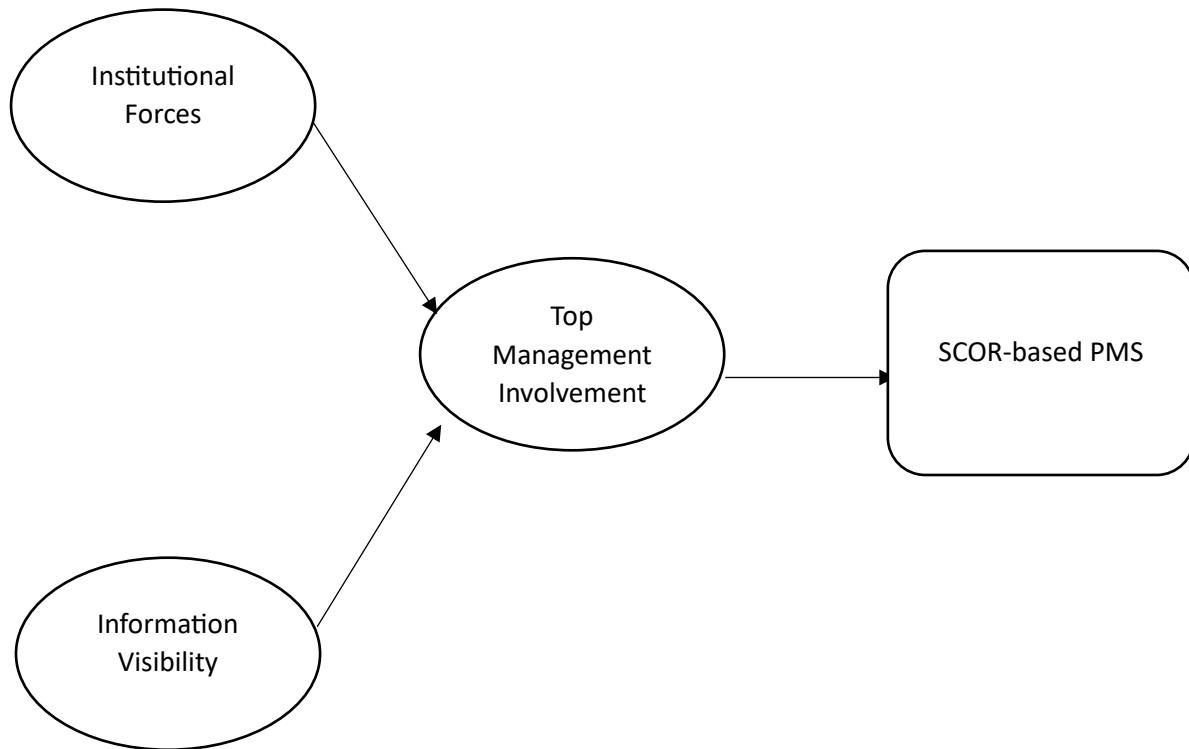
Figure 2: Theoretical Model (Source: Authors own work)

5.2 Practical Implications

The findings of our study provide significant direction to management and consultants. The SCOR model measures supply chain performance in five areas: reliability, responsiveness, agility, cost, and asset management. These metrics align supply chain goals with customer service and cost objectives. The model includes a hierarchy for root-cause analysis and continuous improvement through best practices. Previous studies have highlighted the importance of SCOR-based PMS to mitigate the risk in the supply chain and improve performance (Rotaru et al. 2014; Mozaam et al. 2018), to date the stakeholder's perspectives have been widely neglected in the B2B supply chain literature (Tang et al. 2004; Schubert et al. 2011) given how the risk resulting from globalisation, geo-political crises, and pandemic, influence the organisation's decision to invest in the SCOR-based PMS for the SCRM. Therefore, the SCOR model is ideal for supply chain risk management. It streamlines the process by allowing organisations to define and map their supply chain using the SCOR-based PMS framework. This approach is repeatable and simplifies the evaluation of elements common to multiple supply chains. The model also integrates risk management metrics and best practices with the five supply chain processes, allowing organisations to identify risk sources and develop mitigation actions. Based on our interviews, the most impactful measures organisations can adopt to implement the SCOR-based PMS successfully is to improve visibility in the supply chain and effectively communicate the information to minimise the resistance towards

change. The opposition to the change is one of the areas of significant concern. In most cases, the employees are unaware of the potential benefits of the organisational change (Lassnig et al. 2022). In turn, they develop a sense of fear and perceive the change as a threat. Hence, the role of top managers is often considered vital in building employee confidence and regaining trust, which is one of the most critical attributes for improving employee cooperation for successful implementation of the SCOR-based PMS for positive outcomes. Management plays a crucial role in implementing SCOR-based PMS through concrete meat-structuring actions. The performance of the SCOR-based PMS will not be as successful if managers lower their involvement in meta-structuring activities. Moreover, our findings reveal that external forces strongly influence the performance of the SCOR-based PMS. Ideally, the participation of the consultant is till the implementation. However, the consultant's involvement is even more critical after the performance of the SCOR-based PMS. Further, we suggest that the organisation encourage employees to attend conferences organised by APICS or reputable conferences to exchange information with their counterparts.

5.3 Limitations of the Study and Future Research Directions

The study has limitations, and we firmly believe that our limitations might help scholars pursue research to address some of the unanswered questions. Results must be interpreted knowing that the sample of respondents is small (12 participants). Even if the model remains representative, we cannot generalise it to the entire population. Our study is based on a sample of participants working for big and international companies. Small and medium enterprises are not represented among the participants. In the future, we could gain interesting theoretical insights if the study was conducted on SMEs and their experience with SCOR-based PMS. Indeed, the types of risks managed can differ according to the company size. SCOR performance indicators will not be the same according to the company size because perceived risks will differ. Risk perception varies from country to country as well. The study takes part in the risks present within the French territory because it occurs in France. Threats evolve and cannot remain the same according to the territories. As a result of the classification of risks, we could predefine them. In addition to their occurrence fluctuations according to the world's regions, the continuous evolution of the environment and the appearance of new risks can cause chain reactions. Hence, in the future, the study should involve organisations from multiple countries to gain deeper insights.

6. Conclusions

The increase in risks and the awareness of their impacts on businesses led to the developing of different strategies to counter them. At the same time, SCOR indicators of performance launched several versions before launching version 12.0, on which we based our research. A significant impact highlighted by the study is the long-term perspective of risk management strategy, even if some reservations are expressed regarding SCOR metrics' skills as forecasting. Moreover, SCOR performance indicators positively impact decision-making and are considered guides. The study points out the occurrence of these impacts during the identification and assessment stages of supply chain risk management, with more limited consequences during the management and monitoring stages. Nevertheless, limits hinder the exploitation of the full potential of these positive impacts. The complexity of the implementation of SCOR indicators of performance and the difficulties of external risk identification represents the negative aspects of these indicators.

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Appendix 1: Interview Sample

Our research question is "What are the impacts of the implementation of the SCOR indicators of performance or metrics on the management of risks linked to the supply chain". Our main objective is to establish a relationship (positive or negative) between the implementation of SCOR metrics and the management of supply chain risks.

Thank you for participating in my study. This study deals with the SCOR model and indicators of performance and their effects on risk mitigation, identification, and management within the supply chain area. Please, notice that these data will remain confidential and anonymous. During this interview, we will focus on the SCOR indicators of performance, also called metrics. Before going further into the topic of research, I would like to ask for some information about you.

Personal data

1. Are you: ☐ a male ☐ a female ☐ Other

2. What is the company size you are working for?
☐ Micro-sized company (< 10 employees)
☐ Small-sized company (10-49 employees)
☐ Medium-sized company (50-249 employees)
☐ Large-sized company (> 250 employees)

3. Is your company:
☐ Local
☐ National
☐ Multinational

4. Where is company located?

5. What is your position in your company?

6. What is your mission in the company you are working for?

Questions

Indicators of performance
1. Which indicators or standards of performance are implemented in your company?

2. Since how long have you been using indicators of performance?

Implementation of indicators of performance

1. What are:
   a) The costs of implementation of these standards?
   b) The cost savings?

2. What are the main challenges of implementation of these standards?

3. How do you consider the analysis of these metrics?

Effects of SCOR metrics on risks

1. What are the main benefits of these performance indicators on the supply chain?

2. Do you consider them as a "facilitator" for understanding the performance?

3. Did, and in which ways, the implementation of indicators of performance help you in:
   a) the identification of supply chain risk?
   b) the management of supply chain risk?
   c) the supply chain risk avoidance?

4. For which major risk do you use these metrics?

Situation

Within a high exposure of risks:

1. Would you consider the indicators of performance as a support or as an obstacle to the management of risk?

2. How would indicators of performance help you to recover from the potential impacts and consequences of this risk?

3. What are the limits of the indicators of performance in general?

4. What are the limits of indicators of performance towards risk management?

Conclusion

Thank you for participating in this interview. Would you like to add something?

Appendix 2: Summary of Representative Quotes from Interviews categorised by themes.

The interviews were conducted in French. These quotes have been translated from French to English.

SCOR Indicators' Costs and Savings Assessment	
The Difficulty to assess expenses and revenues	"I am not able to discuss as I am just in charge of their use" (Participant 2) "I guess we've been saving millions of euros since their implementation […], but I can only guess it based on the fact that [name of the company] relies a lot on it" (Participant 4)
Costs of indicators implementation	"We evaluate the costs at around 10% of our budget" (Participant 1) "Their [indicators of performance] implementation didn't involve high costs as we have already implemented tools such as ERP [Enterprise Resource Planning] and database. […] And we mainly use these tools for indicators of performance" (Participant 8) "Implementation of indicators is very time-consuming which is, according to me, is the main cost to consider" (Participant 10)
Savings realized thanks to indicators	"Savings come from different types: the time with 10% of savings, the conformity and law compliance in terms of technology and for this part, the savings are really big, around 20% and the maintenance, 15% of savings" (Participant 1) "Our main savings are the earnings in business thanks to the customer loyalty which are satisfied of our performance, but it remains hard to evaluate" (Participant 3)
Challenges of Implementation	
Human is the main challenge to consider	"Human is an important challenge to consider along the implementation of the indicators of performance even more if the team is sensitive to change" (Participant 3) The main considerations a company must have before implementing indicators are the costs and the knowledge necessary to their implementation" (Participant 5)
The choice of indicators of performance	"The main challenge is the choice of the indicators to implement" (Participant 9) "Making sure the indicators will measure what we want them to measure and that they include the desired factors and variables" (Participant 12)
Analysis of the Indicators of performance	"The analysis is part of the continuous improvement implied by the indicators, but it is difficult because of the interdependence among the indicators" (Participant 6) "Human technique must be involved to do data crushing necessary for their analysis" (Participant 8) "A lot of knowledge can be necessary to be able to analyse them" (Participant 10)
The Effects of Indicators of Performance on Supply Chain Risks	
The controversy towards the use of indicators of	"Forecasting is the *raison d'être* of indicators of performance. […] Their main objective is to give the alert and assess the risks at their roots" (Participant 6)

performance to forecast and predict	"Indicators allow the identification of risks thanks to the trend" (Participant 4) "Indicators of performance give the possibility to detect procurement or production issues for example" (Participant 11) "Only a small number of indicators are predictive. Most of the time, the alert is given too late because the indicators are based on the past data instead of looking at the future" (Participant 8)
The use of indicators of performance for decision making	"I consider indicators as a help in the decision making, the continuous improvements and in improving the current strategy of the company" (Participant 12) "Indicators open the possibilities linked to strategy's evolution and adjustments according to the context and the analysed impacts" (Participant 1)
Indicators of performance for the long-term risk management strategy	"As I said, indicators help in the decision making and these decisions can also result in long-term investments made for having risk strategy based on anticipation" (Participant 6) "Indicators helped us in the reassessment of risk grid with the attribution of criteria and in the enhancement of crisis management plan. This plan helped us improving our management of the latest procurement crisis that happened in our business sector. We redefined impacts and priorities we must focus on during a high exposure to risk" (Participant 3)
Limits of the Indicators of Performance on Risk Management in Supply Chain
Indicators of performance does not help in the risk management of external risks	"Indicators are used mainly for financial, technical and to predict the future maintenance of machines to avoid machine breakdowns" (Participant 6) "I use indicators of performance […] also to manage supply and disruption risks but their identification thanks to indicators are limited" (Participant 3) "Indicators of performance evaluating or identifying potential environmental or energetical risks is vital if we consider the next upcoming crisis linked to energy" (Participant 2)
Dependency of indicators of performance	"Indicators depends on different tools as ERP and data. […] They also have a high dependency on human as the main resource needed for their analysis" (Participant 7) "Indicators have a low level of autonomy and a high level of dependence and even interdependency among them" (Participant 1)
Indicators of performance can be very costly and hard to implement for the small companies	"Indicators can be hard to implement within small companies because they don't have the budget, the cost to allocate to their implementation […] and they also miss human resources and time" (Participant 10)