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## Article

# New challenges in the area of supply chain risk management: Unpredictable events and their effects

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# **New Challenges in the Area of Supply Chain Risk Management: Unpredictable Events and Their Effects**

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## **Summary**

- Research questions:** How important are SCRM and joint approaches for companies, and do they have established reasonable KPIs in their organisations, if recent events had such a tremendous effect to their SCs?
- Methods:** The basis of the study was a survey specifically designed to collect data from German supplier companies operating in the special machine building segment, which was distributed to company professionals employed for specific roles within their supply chains.
- Results:** The results of this study show that supply chain risk management is generally a management tool that attracts a lot of attention in companies. In addition, it was found that the identified collaborative aspects are taken into account with varying degrees of intensity, so that general applicability cannot be guaranteed. Furthermore, different correlations to the associated sub-activities were found whereby the focus clearly lies on greater flexibility, efficiency and improved dynamics. Eventually, it was found that key performance indicators are almost exclusively based on financial-based measurement systems and that a shockingly large number of companies have not even established them.
- Structure of the article:** Introduction; Literature Review; Research questions & methods; Empirical results; Conclusions; About the Author; Bibliography

## Introduction

Globalisation has brought many benefits to businesses over the past few decades, as it accounts for an important share of gross domestic product (GDP) by providing them international growth opportunities (Surugiu & Surugiu, 2015). However, Joseph E. Stiglitz (2017) highlights that increased risk is generated by the dependency on international linkages in regard to natural resources, imperfect competition raised by the differences of company's sizes and country-specific law regulations, and the failure of companies to pay enough attention to the long run (e.g., rising labour costs in Asia after shifting entire production facilities to these countries). Supplementary challenges like political instability, poor logistic performance, capacity or quality problems, and natural hazards are just a few examples of factors that determine the ability of companies to work within an international environment (Monostori, 2018).

Hence, international supply chains (SC) are increasingly tensioned by many influences and supply chain risk management (SCRM) is therefore an important managerial tool to increase flexibility and improve resilience against these influences (Manuj & Mentzer, 2008).

## Recent Events and Impacts

During the year 2020, the COVID-19 pandemic had a tremendous effect on global trade. Nana & Starnes (2020) revealed in an article of the International Finance Corporation that the pandemic put significant downward pressure to global trade and that the effects exceeded the impact of the finance crisis in 2008-2009. Thus, it was expected that the volume of merchandise trade slump by -15% for North America, -12% for Europe, -8% for South and Central America and -5% for Asia.

However, the first deep impact of the pandemic hits the world's economy only for a short time. The fall of the global GDP in 2020 was expected to reach 4.3% whilst the forecast for 2021 predicts a rise of 4.1% with a significant advantage for developing countries (United Nations, 2020). The International Bank for Reconstruction and Development supports this statement by forecasting the global trade growth by 5.6% in 2021 which is the strongest post-recession speed in 80 years (The World Bank, 2021). From the author's perspective, these enormous effects highlight the importance of resilient and highly flexible SCs and lead to the

assumption that functioning and lived SCRM helps to reduce these effects by appropriately evaluating market signals.

Another event that has challenged the ability of companies to cope with unexpected phenomena was the "Ever Given" accident where the containership blocked the Suez Canal, one of the world's most important trade arteries, through which twelve percent of the daily global trade value are delivered. Thus, the stranded vessel held back an estimated \$9.6bn of daily trade along the waterway, blocked 369 ships in the tailback on the canal, and cost global trade between \$6bn to \$10bn a week and could even result in a reduction of annual global trade (Russon, 2021).

Further tension hampered the flow of goods as the port of Los Angeles restrained 111 container ships from unloading. A rapid increase in demand for goods and commodities as a result of the partial recovery of the global economy and the lack of truck driver capacity are cited as the root causes of this event. The effects reached a scale that even the US president commented on the incidents and the port imposed a fine of \$100 per container that remained in the docks for more than 9 days. Ultimately, the backlog not only affected consumers through much longer lead time of goods, but also thorough an increase in prices (Macias, 2021) & (Meeks, Isidore, & Yurkevich, 2021). Also, rising volumes of ordered goods from abroad intensified this situation especially during the Covid pandemic as many citizens spend less for services such as traveling or movie nights (Meeks, Isidore, & Yurkevich, 2021).

However, a rising global trade volume may also have negative effects to this situation. For example, the export value of the US and Germany has grown from \$187.60bn. (US) and \$175.24bn. (Germany) in 1970 to \$2.38tn. (US) and \$1.81tn. (Germany) in 2020 (Ortiz-Ospina & Beltekian, n.d.). This rapid change would not have been possible without innovative information and communication technologies. These technologies including machine-to-machine communication, web services, human machine interfaces, middleware, e-commerce platforms and many other systems which are potential attack points for cyber-crime as well (Oláh, Zéman, Balogh, & Popp, 2018).

The Harvard Business Review (2021) published an article which highlights the dramatic rise of cyber criminality focusing on critical infrastructure, private companies, and municipalities and grabbing headlines on a daily basis. The exponential increase of Ransomware

attacks (malware to access and block computers and encrypting data on them) which rose by 150 percent in 2020 led to an increase of 300 percent of paid amounts by victims. With the huge amounts of money extorted by professional cybercriminals (up to millions of dollars), it becomes perspicuous that cyber security and the related SC integrity should get high attention within business—especially because Ransomware is just one of many threats companies face up in this digital era, and because the opponents have understood company's financial picture and how they can exploit the company maximum effect (Sharton, 2021).

Regular adjustments of SCs are also triggered by political and social aspects that are putting more and more pressure on international SCs. An adequate and well-known example that combines these two aspects is Brexit, which separates Great Britain's (GB) trade activities from the European Union (EU) based on the social preference of citizens to exit this alliance. This decision had a tremendous negative effect on GBs export value towards EU countries (-16,73% in 2016 and -15,55% in 2017-2018) as well as non-EU countries (-12,94% in 2016 and -13,34% in 2017-2018). Moreover, import declined a little with a recognizable bias towards non-EU countries (Douch, Edwards, & Soegaard, 2018). Additionally, Brexit changed underlying contractual aspects by turning the EU-GB border from a free trade zone into a hard border for goods and services. Stringent immigration policies created critical labour market shortages, like for example truck drivers, leading to a fuel crisis in GB in 2021. It also hits the healthcare sector by missing professionals or even the food supply industry by missing salespeople. Another consequence of the changes initialised by Brexit was that beyond the labour market shortages other basic supplies like electricity were affected. The energy sector has been hit by rising bills estimated at \$677.8m. a year from exiting the EU "internal energy market", which ultimately increased the cost of living for GB citizens (Dhingra, Machin, & Overmann, 2017) & (Ziady, 2021).

Finally, environmental phenomena on a global scale cannot be ignored when thinking about international SCs. Rising traffic on water, land, and air carry more and more goods around the globe and, in contrast, natural resources are scarcer than ever before. For example, from 1950 till 2018, the global export value increased from \$61.81bn. to \$19,468.14bn. which is 315 (rounded) times the prior value and the earth overshoot day was brought forward accordingly. Whilst the first

earth overshoot day was recorded on December 30, 1970, the 2018 line was already crossed on July 26. Indeed, global events like the Corona crisis stalled this dramatic progress for a short time (August 22, 2020) but the trend seems to be maintained (statista.com, 2021) & (overshootday.org, 2021).

As a result, global monopolies on natural resources intensify global competition, tensioning SCs, and lead to local dependencies, allowing individual countries with a strategic foresight to create dramatic effects and twists in global markets, such as China with magnesium (Siebel, 2020).

The key aspect for most companies for addressing the issues above is sustainability, although sustainability is not meant just to focus on natural resources and the physical composition of goods. Newport, Chesnes & Linder (2003) pointed out that economic and social aspects are supplementary elements of sustainability, as are environmental principles.

According to World Vision (2021) child labour and trafficking were among the top five social crises in 2021, with more than 8m. children forced into begging and child labour because their parents cannot even afford their food. The Ecological Threat Report measures and highlights supplementary threats based on rapid population growth, water risk, food risk, temperature anomalies and natural disasters, and considers other recent events such as wars that need to be minded when setting up or adjusting SCs (Institute for Economics & Peace, 2021). Accordingly, companies should incorporate the above-described aspects into their SC activities and apply SCRM principles to their day-by-day business to mitigate these threats.

However, all of the threats described above are just a sample of events that can potentially affect SCs. When keeping this in mind it becomes clear that SCRM should be given high attention in order to reduce the associated risks and performance-impairing effects on organisations to a minimum.

## Literature Review

Supply chain management (SCM) has come a long way until it has reached its importance as it is today. During the 1960s and 1970s, companies tried to obtain new customers and capture their loyalty by developing new detailed market strategies. Higher flexibility and

responsiveness were a subsequent requirement within the 1980s throughout increased customer demand for novel products. This market development forced companies to enhance their products, services, and processes, or to invent other products to meet customers demand accordingly. Within the 1990s, the awareness about the impact of materials and services supplied and their major effect to meet customers demand increased. Additionally, the focus shifted from a product quality perspective towards a broader view on products and services so that the nowadays commonly known aspects of right time, cost, condition, place, and quantity gained managers' attention (Monczka, Handfield, Giunipero, & Patterson, 2009).

SCM becomes even more important within the 21st century and is now a kind of umbrella which covers nearly every aspect of company's value chain. This includes the fields of marketing, logistics, sourcing, and operations and considers the managing of product, services, funds, and information from raw material to salable goods and even the subsequent stage of aftersales service and reverse logistic (Ketchen & Giunipero, 2004) & (Stadtler, 2005).

Due to the comprehensive extent of linkages within modern businesses and the associated responsibility of SCM, another supplementary tool attains more and more attention. Risk Management (RM) serves as a managerial tool for identifying, evaluating, preparing (counteractions), implementing (planned actions), and monitor potential risks within a certain business intention (Olson & Wu, 2017). However, although identified risks can be monitored and managed as conscientiously as possible, eventually a particular

level of residual risk remains. This means even with an established conceptual framework of risk avoidance steps (risk avoidance, reduction, spreading, and transferring), a certain level of risk either cannot be eliminated—which leads to risk acceptance—or will not be identified (Fenelly & Perry, 2017).

Both previously described managerial approaches (SCM & RM) could be considered either as independent interests of companies—which obviously would be erroneous—or as intersecting approaches with a certain level of overlapping interests. The intersection of these interests is called supply chain risk management (SCRM), a comprehensive and highly important tool within organisations that is used to increase resilience by identifying, analysing, evaluating, treating, and monitoring sources of risk within the SC (de Oliveira, Silva Marins, Rocha, & Salomon, 2017). Thereby, the main focus of companies and researchers lays on traditional risks like logistical performance, altering demands, technical problems, shutdowns of supplier factories or forecast and demand uncertainty and try to cope with them by establishing or maintaining business relationships (Ouabouch & Paché, 2014) & (Sodhi, Son, & Tang, 2012).

RM is normed by the ISO 3001 which describes risk assessment tools and techniques. This standardised procedure of risk identification, evaluation, selection and implementation of counteractions, and monitoring was advanced by de Oliveira, Silva Marins, Rocha & Salmon (2017) towards a framework of SCRM steps harmonised with the standard.

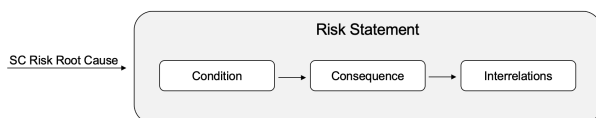
Figure 1: Systematic SCRM Process (de Oliveira, Silva Marins, Rocha & Salmon 2017)



### Risk identification

Risk identification requires a detailed determination of potential SC risks evoked by an intended purpose. Therefore, risk areas must be explicitly identified, and related consequences must be understood to increase the probability that potential risks are covered as best as possible. The clear identification of risks is also a basic precondition to derive risk-mitigating strategies and to ensure their appropriateness. Even so it is highly important (when identifying certain risk of an event) to understand and recognise interrelations, varieties, and linkages to other SC activities (Tummala & Schoenherr, 2011). In other words, root causes of SC risks need to be identified and entirely understood so that a risk statement can be made.

Figure 2: Risk Statement Including Interrelations



### Risk analysis and evaluation

The analysis of risks (measurement of risks) and their evaluation aim to quantify risks to an organisation by numerical evidence. These subsequent processes consist in three steps. The first step is to execute a stipulation of all consequences of potential risks in consideration of their specific impact to the organisation. Therefore, consequences are defined as the manner of how the risk affects the resources of an organisation. Manifestations of these manners could be a delay of projects, cost overrun, process underperformance, or reduced service levels. Thus, tools like an event tree or a Failure Mode and Effects Analysis facilitating the identification of SC risks and corresponding consequences within the risk measurement. Once these tools are applied, the weighting of identified threats can take place. A common characteristic to rate SC risks is to distinguish between trivial (1), small (2), medium (3), and large (4) risks what represents the risk consequence index. Whilst trivial risks occur more frequently but their

severity is quite low, the occurrence of large risks is quite low and their severity is significant (Tummala & Schoenherr, 2011).

Risk assessment, as a complementary action, focus on the assessment of SC risk uncertainties. The likelihood of a risk factor is therefore the variable which needs to be considered based on objective information (factual, data based and not affected by bias). If, however, objective information is not available, subjective information, beliefs, or judgment can be used to assess the likelihood of a certain risk (Tummala & Schoenherr, 2011). A common differentiation of this risk probability index is: rare (1), seldom (2), occasionally (3), and often (4).

Eventually, the combination of the above-described techniques (risk measurement and risk assessment) allows to assess the extent of how enormous the impact of a certain risk will be when it becomes reality. Therefore, the exposure of the impact is calculated as follows (Kuster, et al., 2011):

$$\text{Risk Factor} = \text{Risk Consequence Index} * \text{Risk Probability Index}$$

Consequently, every risk is having an individual risk factor which refers to a special risk treatment approach. A common risk categorisation is 'low (1-5), medium (6-10), or high (11 and higher)' which then contains different action levels to ensure the appropriate treatment of the identified threat. For example, it could be required to develop at least two scenarios to bypass a certain higher ranked risk which in addition needs to be pursuit continuously, whilst a small risk is determined only once and a defined action takes place when the problem emerges (cf. table 3) (Kuster, et al., 2011). Adaptions of the described evaluations steps, however, have to be made according to the underlying business needs (denominations, rankings, indexes, etc.).

Table 1: Risk Factor Calculation (Kuster, et al., 2011)

Probability	Consequence			
	1	2	3	4
1	1	2	3	4
2	2	4	6	8
3	3	6	9	12
4	4	8	12	16

### Risk treatment

As no risk equals another risk, the correct and individual treatment of risks is an essential part within the SCRM approach. Therefore, it is necessary that organisations not only focus on how risks can be identified and classified but also on how risks can be modified and other possible options can be used.

Risk response planning (previously indicated as *proposal of strategies*) is an important strategic guideline to be pursued by organisations to explore how risks could be strategically reduced or distributed. In contrast to risk analysis and evaluation, the focus is not on validating the extend of impact when a risk emerges, it is on modifying risks towards the best possible case (cf. figure 3) (The British Standard, 2009).

Risk avoidance strategies contain approaches taken to eliminate a certain risk towards a minimum impact. The decisions made within this step can alter from withdrawing SC activities to reduce risk-comprising situations, until the change of suppliers, or not even starting a certain SC intention that gives risk to the organisation (The British Standard, 2009) & (Hajmohammad & Vachon, 2016).

In contrast to risk avoidance, risk reduction focuses on mitigating potential losses though balancing rudiments (The Investopedia Team, 2021). In other words, if risk avoidance is not sufficient for dealing with a potential risk, reduction strategies must be considered. For example, companies operating in the chemical and synthetic industry will not be able to avoid the creation of gases through special conditions within chemical processes. Therefore, safety measures like exhaust gas filters or gas recognizing alert systems are implemented to mitigate the potential risk of those processes which are fundamental to produce specific chemicals.

Outsourcing is a common example for transferring risk to a supplier. Mostly, business processes

that are not a core competency of an organisation are outsourced to another company which, in the best case, has its core competencies in this area. However, firms must be aware that outsourcing is not only a risk mitigating approach, but also a risky endeavour due to the fact that sensitive information about a product usually needs to be shared with another company. Furthermore, risk transfer can also take place through the agreement of flexible contracts with clauses that benefit the own company regarding possible changes in the environment and other associated risks (Manuj & Mentzer, 2008). Hence, the tenet of risk transferring strategies is to reduce the impact of risks which affecting the own organisation by shifting the responsibility of possible threats to other business associates.

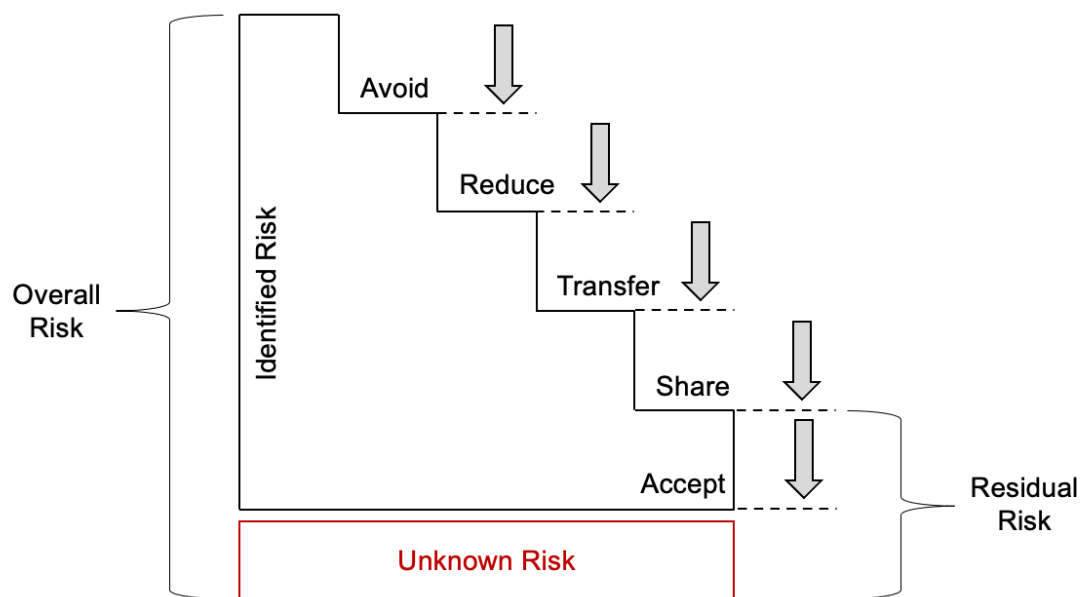
The consecutive step within the risk response planning strategy is risk sharing which is mostly divided into two basic approaches. Risk-sharing agreements and risk-sharing partnerships with suppliers are common techniques to distribute risk to a business partner (Gonçalves, Santos, Silva, & Sousa, 2018) & (Figueiredo, Gutenberg, & Sbragia, 2008). However, it is very unlikely that a risk sharing approach will shift all the risk to another business partner, worse, that partner will have a specific advantage in mind when transferring risk towards their own organisation. Related expectations can be an improved position within the partnership, an advantageous position in the SC, the receipt of sensitive information or other underlying strategic insights. Therefore, risk sharing requires a tactical alignment of companies to successfully share risk with their business associates, but they must be aware that this can result in a reduced bargaining chip.

Finally, the residual risk manifested by a SC activity is made up of two components. Risk acceptance implies that a remaining risk potential, as the name expresses, is still acceptable and manageable even if the

forecasted threat occurs. Good knowledge of the risk based on past events or a very small and non-critical impact could lead to such a classification. However, even accepted risks need to be fully understood and treated as intended (referring to the risk identification and analysis) so that the organisation is aware about their impact and able to execute defined countermeasures quickly (Kauer, Fabbri, Remy, & Heering, 2002). The second component

of the residual risk is the unknown risk. SCs are very much influenced by these kinds of risks due to their unpredictability and uncertainty, as they occur unexpectedly and require a solution be found very quick, as their impact is also unknown. Therefore, conscientiously executed SCRM should minimise the proportion of unknown risk and mitigate its impact.

Figure 3: Risk Response Planning



### Risk monitoring and criteria review

The ongoing process of managing risk is called risk monitoring (The British Standard, 2009). It must be understood that SCRM is not a single event which is executed once, it is rather an ongoing process which monitors risks continuously to re-evaluate, modify, and revise already identified or newly examined risks. Therefore, each step of the SCRM framework adds new knowledge to the construct and helps to understand the complexity of related risks of an SC activity.

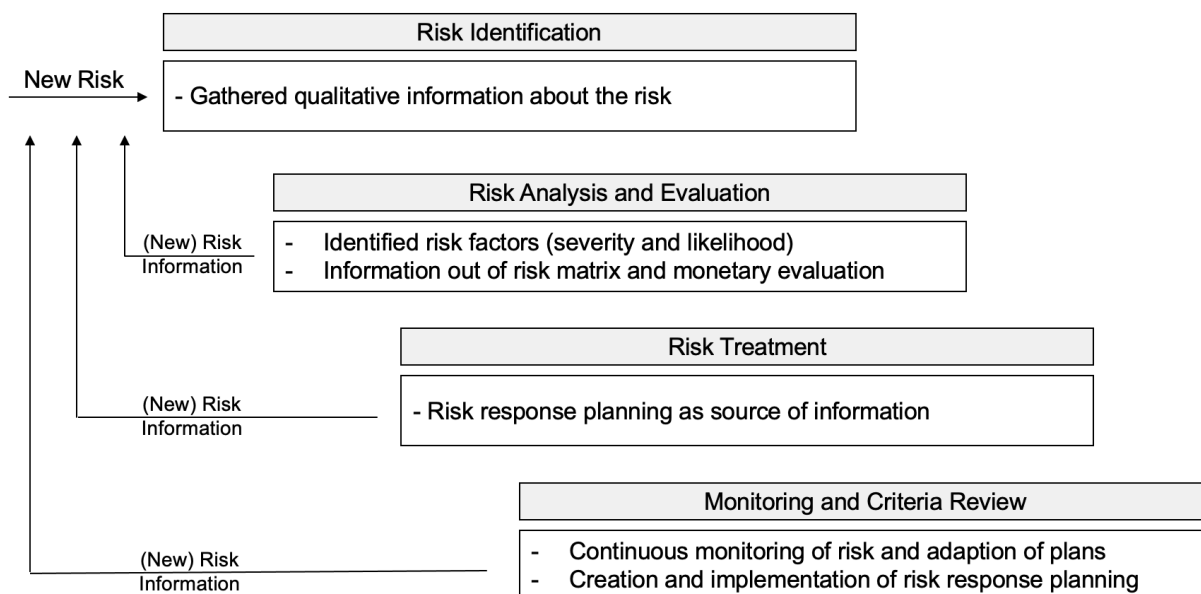
Thus, the selection of suitable risk treatment options involves balancing the costs and efforts of envisaged risk treatment activities against the benefits derived, considering legal and regulatory aspects, and

other related standards like social responsibility or environmental protection (cf. figure 4).

Even if risk optimisation is not directly considered within the risk management approach by de Oliveira, Silva Marins, Rocha & Salmon (2017), all consecutive steps of SCRM aim at optimizing risk influences and/ or their treatment. This leads to the statement that risk optimisation must also be a vital part of risk monitoring and the criteria review so that newly defined and revised risk strategies can be appropriately evaluated.



Figure 4: Risk Monitoring Approach



### Supply Chain Risk Management Extension

International SCs are even more challenging to SCRM compared to domestic SCs, due to various linkages between firms worldwide. Manuj & Mentzer (2008) are distinguishing between internal and external risks emerging in eight different levels of supply, operational, demand, security, macro, policy, competitive, and resource risks.

Hence, from the perspective of the author, an international environment increases the potential of risk for focal firms and challenges them by requiring much higher attention to manage high levels of environmental and operating uncertainty.

However, SCRM usually focus on financial and operational criteria towards SCs but surprisingly little on advanced collaboration between SC partners to overcome SC internal barriers and to create leading SCs to bring competitive advantage. At the same time SC specialists are indicating that a state-of-the-art SCM will be a decisive success factor for companies in the future, which does not only refer to operational and financial key figures (Maderner, 2018).

Now the question arises what constitutes a state-of-the-art SC(R)M? With this background knowledge further literature review aims to reveal various parameters that could affect SCRM, while focusing on closer collaboration and potential integration of SC partners as a factor for reduced risk and ultimately competitive advantage.

Collaborative culture (CC) is a key word for international organisations to increase interorganisational system appropriation and improved SC collaboration including joint learning. SC partners with a CC are supposed to increase the possibility of establishing interorganisational systems, promoting communication, and exploring new knowledge together. In addition, the likelihood of creating common goals, promoting the exchange of information, and improving open interactions are further effects of CC. Therefore, CC should be an objective for every organisation within today's rapidly changing environment which is aiming for further success by focusing on competitive advantage though enhanced collaboration. Mostly, interorganisational (IT) systems between SC partners are recognised as essential parts of the collaboration to ensure an appropriate exchange of information between them, but more extensive steps are mostly not addressed. Thus, collectivism, long term orientation, power symmetry, and uncertainty avoidance are the main components of CC that firms should strive for (Zhang & Cao, 2018).

Manuj & Metzner (2008) pointed out the moderating role of organisational learning (OL) but no further evidence was given for the beneficial effect in terms of risk mitigation and increased SC resilience. However, subsequent studies supported these effects by demonstrating a positive contribution of OL to supply chain ambidexterity and that transformational leadership tremendously influences this ability (Ojha, Acharya, & Cooper, 2018). Also, Akhtar, Arif, Rubi & Naveed

(2011) confirmed direct positive effects of OL to SC performance based on knowledge sharing and linked to the leadership style promoted in an organisation. Other studies also set knowledge sharing as a basic prerequisite for profound OL but also refer to collective learning from errors as an important element (Putz, Schilling, Kluge, & Stangenberg, 2012) & (Iebra Aizpurúa, Zegarra Saldaña, & Zegarra Saldaña, 2011).

Beyond that, OL is directly affected by the level of innovation of a certain SC, based on the degree of information shared within the up- and downstream (Puška, Maksimović, & Stojanović, 2018). Arnold, Benford, Hampton & Sutton (2010) state that increased information sharing within transnational alliances is a result of enterprise risk management and that reduced risk is an associated effect. Hence, information sharing holds an essential share within thriving multi-national SCs which cannot be ignored. This action field was distinguished by Kembro, Nälung, & Olhager (2017) into six general sub-activities of power structure, cultural and legal aspects, business processes, as well as utilisation of technology and information.

According to Pandey, Singh, Gunasekaran & Kaushik (2019) another risk of modern SCs must be considered. Cyber security is an accompanying and rising issue in the age of global SCs as information becomes more important and technical infrastructures of organisations become the target of professional hackers. Thereby, special attention of cyber-attacks was given to critical infrastructure, inserting of fraudulent information into collaborative production and access to sensitive data. Thus, coding and encrypting of data, regular backups of data, protection of information from unauthorised access and increasing the knowledge, strict password and account management and increasing awareness of employees are indicated as main drivers of SC security. Therefore, including SC partners into the own cyber security operations could be a major step towards a more resilient and collaborative SC.

Another changing aspect within SCs which is also closely linked to information sharing is cashflow management. Third party payment becomes a more frequently used payment method in the downstream which increases customers' demand, decreases consumers' price sensitiveness, and benefits the focal firm accordingly (Xiaojun, Wenyu, Ting, & Endian, 2020). On the other side, firms are struggling with upstream payments like long payment periods, delayed payments, and partial or non-payment as well, which

could result to unnecessary over-pricing against these risks. Hence, overpriced services, goods, and liquidity bottlenecks harm the operational effectiveness of companies and reveal a major potential for company closings. To cope with these risks, security of payment acts, advanced payment agreements or the integration of block chains are suitable solutions. In addition, block chains have the potential eliminate other underlying root causes of payment risks like project delay, complications from contractual conditions, or completion of tasks exceeds allocated budget by enhancing trust, efficiency, and transparency (Nanayakkara, Perera, Senaratne, Weerasuriya, & Bandara, 2021).

In contrast to main objectives of companies like efficiency or cost reduction, another aspect of SCM is increasingly coming into focus, one that cannot be realised without investments: Sustainability is a rising factor which affects companies in a multi-dimensional way, especially when it comes to international operations. Therefore, sustainability is not only a matter of environmental friendliness, as is widely assumed, but rather consists of responsibility towards social, ecological, and ethical aspects (Hofmann, Busse, Bode, & Henke, 2014).

Due to stakeholders' pressure, modern SCM is forced to change behaviour within organisations and foster technological innovations. Therefore, investing into research and development (R&D) provides a wide range of opportunities for positive long-term contributions in terms of financial returns and a positive impact to natural environment, economy, and society. As mentioned above, block chains can support a wide range of modern challenges within SCs. Due to its nature (*"decentralized online database that permits a master ledger of data and transactions to be accessed securely by multiple stakeholders"*) block chain technology has the potential to transform SCs and change the way how we produce, market, acquire and consume goods. Block chains serve as a database to record any event within a SC and sharing them through peer-to-peer community. This also enhances communication with SC partners, covering information and knowledge gaps, fosters transparency, and contributes to more equal power distribution. Additionally, block chain technology serves as an aid for identifying misconduct of any tier within the SC due to increasing responsibility by peer-to-peer interactions with digital signatures (Gurzawska, 2020).

Thus, block chains have the potential to improve compliance in regard to sustainable and responsible SCs.

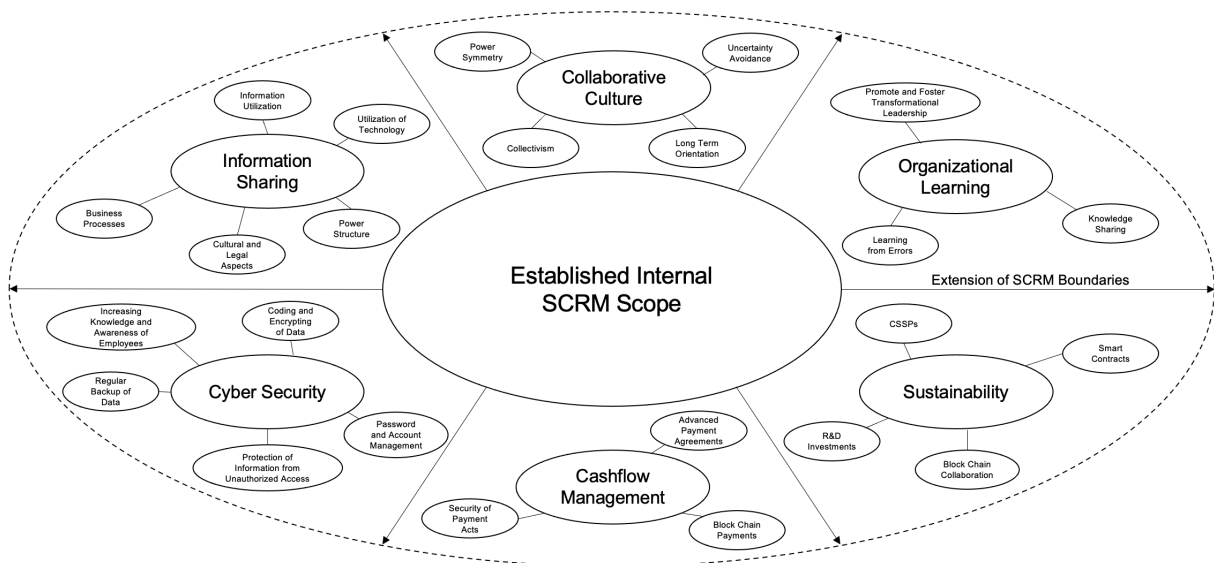
Another application within block chains is smart contracts which is an electronical transaction protocol to verify negotiations and transactions in terms of underlying legal contracts. Therefore, smart contracts add the concept of self-enforcement by maintain local copies of a ledger of an intended transaction. Hence, when executing a transfer, the related funds and rights can be enforced directly when the deal takes place and other corresponding minor points like tax payments, freight paper or quality checks are directly realised (Prause, 2019).

However, technology alone cannot bring salvation when it comes to modern slavery, climate change, natural exploitation, or political abuses. These aspects of sustainability can only be solved, if various stakeholders are engaged into SCM activities and contribute diligent and voluntarily to it.

In fact, a multi-stakeholder approach, known as cross-sector social partnerships (CSSPs), is rated as the most effective way to achieve higher self-responsibility and sustainability with SCs. Building up such kind of relationships may be more challenging than establishing “normal” business relations, but finally, they make a tremendous contribution to multi-stakeholder organisations by monitoring and tracing cross-national activities what perhaps would be not possible for a single organisation.

Based on the above-described content, the following framework of advanced collaboration within SCs is elaborated on. It contains the main aspects of collaborative partnerships which are supposed to lead to competitive advantage when actively using them and to build up trust-based cooperation’s focusing on mutual success.

Figure 5: The Second Layer of SCRM



### Supply Chain Performance Indicators

Increasing SC complexity raised the need to track and assess the performance of a system which switched from a linear construct into a complex grid of countless interactions. Therefore, SC performance can be described as the ability to serve customers’ needs with provided goods or services in terms of time, quantity, and quality by the lowest number of applied resources. Consequently, organisations need to be aware that the proper selection of indicators is essential to evaluate SC performance appropriate. The related measurement of indicators should be executed in consideration of a particular context where the analysed dimensions

resulting from the purpose of the activity. The underlying performance evaluation criteria can be distinguished into three dimensions (Leonczuk, 2016):

1. Efficacy – is the relation between the achieved result and the intended objective
2. Efficiency – is the relationship of involved efforts and resources of an operation and the specific utility value of it as result of the action
3. Effectiveness – is the indicator in which degree a desire is successfully realised

Supply chain performance measurement (SCPM) is the corner stone for quantifying the efficiency and

effectiveness of operations to provide feedback for the basis of strategic decisions (Agami, Saleh, & Rasmy, 2012).

Amongst different theory there are various definitions of how measures should be designed. Beside the well-known SMART principle (specific, measurable, achievable, reasonable, time-bounded) advanced definitions like the SMARTER goal setting characterisation came up. However, the interpretation of the additional characteristics is not interpreted homogeneous amongst researchers, the range reaches from *explainable*, *evaluable*, until *ecological* or *ethical* and from *relative*, *reviewed*, until *resourced* or *recorded* (Kaganski, Majak, & Karjust, 2018) & (Haughey, 2011) & (Herridge, 2021).

Another approach is the so-called PACT principle (purposeful, actionable, continuous, trackable) which in contrast to the SMART(ER) principle focuses on the output (actions which contribute to achieving a goal) instead of the outcome (what a business wants to achieve) (Le Cunff, n.d.).

Over the last decades numerous researchers and experts have discussed and suggested lots of desirable characteristics of SCPM but they all agreed that effective SCPM should characterised by the following properties (Agami, Saleh, & Rasmy, 2012):

1. Inclusiveness – Coverage of all aspects of SC processes
2. Universality – Possibility of comparison amongst different conditions
3. Measurable – Outputs or outcomes must be quantitative and measurable
4. Consistency – Measurers must be compatible with SC goals

The basic distinction of SCPM types can be made between financial and non-finical performance measurement systems. Within those, two specific financial performance measurement systems (FPMS) attain prior attention within today's operations, even though, they ignore important non-financial aspects. Likewise, researchers grouping recent non-financial performance measurement systems (NFPMS) into nine groups according to their criteria of measurement (Agami, Saleh, & Rasmy, 2012).

## Research Question & Methods

Many researchers have investigated the advantage of collaboration and integration of different stakeholders into the own business operations. Nearly every research revealed that these two aspects hold a vital share to company's success and eventually foster their competitive edge.

Thus, many articles can be found which revealing the effects of SC integration and collaboration confirming positive effects to SC performance and their contribution to successful companies. In contrast, the number of articles investigating the effects of SC collaboration and integration regarding effective SCRM is, in comparison, quite low. The article of Imran, & Khalid (2016) provided a first framework of collaborative activities which are supposed to raise a firm's performance when actively involving SC partners into SCRM. Their framework also covers rudiments of the second layer of SCRM like information sharing, joint knowledge creation, or collaborative communication.

Hence, the articles out of the literature review either confirm collaboration and integration of different stakeholders as necessary cornerstone for success, or establish that SCRM is the most important backup for firms to prepare for unexpected events, or even that joint SCRM activities increase resilience of SCs. Therefore, a whole batch of researchers confirmed different positive outcomes of joint approaches not only in SC activities but also in relation of SCRM approaches. Through empirical evidence and other investigative approaches taken, it becomes clear that enhanced cooperation between firms is given a highly important role in the endeavour to keep competitive advantage. As a result, the question comes to mind if companies really consider these recommendations within their daily operations. This thought led to the following research question:

*How important are SCRM and joint approaches for companies, and do they have established reasonable KPIs in their organisations, if recent events had such a tremendous effect to their SCs?*

Based on the current market situation, it seems to be obvious that some companies failed to actively perform risk mitigation through SCRM, so that uncertainty remained, and a lack of operational adaption

led to certain bottlenecks which had even an effect on daily commodities. Similar effects can be recognized in the special machine building segment where lead times for complex basic functional modules such as central processing units have increased to six months or simple items like metal sheets require eight weeks to deliver regardless the origin of the raw materials used. This situation could be considered as indicators that SCRM is a managerial tool which does not get the attention required in this multinational and vulnerable environment to protect companies from incisive events. According to Dierig (2021), 37 percent of German-based companies operating in mechanical engineering facing serious, and 47 percent noticeable delivery bottlenecks in their SC. Assuming that not every one of these companies ignore the importance of SCRM, the following hypothesis is stated.

H1 – A maximum of thirty percent of the supplier companies operating in special machine construction in Germany have established an SCRM culture for effective and reliable risk treatment.

Effectively managing SC processes is the basic requirement of SCM. Due to the changed focus of SCM from a factory to a network monitoring level, the system to be controlled becomes increasingly boundaryless and the definition of KPIs more complex (Goknur & Turan, 2010). Hence, controlling the right system with the correct indicators is a must for every organisation to ensure their market position based on operational success by reducing hampering effects though continuously improved processes.

Thus, modern economies are supposed to consider intangible (information-based) assets as primary drivers of company's performance creation and value driver. Therefore, non-financial measures should represent the ultimate determinants of financial results in consideration of cause-effect scenarios that exist between chosen drivers of strategic success and should be described by directors on indicators considered as most effective. Due to the rapid change of SCs, network performance will overtake the importance of financial aspects for companies as competition consists between competing business concepts in the same industry and that success is rather created by the perfect execution of a unique strategy than necessarily by a specific strategy (Bini, Dainelli, Giunta, & Simoni, 2019). Referring to the

research by Zarzycka & Krasodomska (2022) most companies have embedded non-financial KPIs in their annual disclosure report, but only 41 percent include reasonable explanations of how and why they are used by their management. This indicator is used for hypothesis H2 to investigate if this figure is also relevant for suppliers of the special machine building segment in Germany.

H2 – Less than forty percent of the supplier companies for special machine manufacturers operating in Germany are deriving their KPIs from NFPMS.

A functioning SCRM is supposed to serve as an umbrella to protect all operations and intended projects as best as possible from unexpected threats. Therefore, SCRM boundaries shall not be restricted by internal processes, but they should rather include external interfaces with partners and other kind of stakeholders that harbour the potential of additional risk. This way of thinking could also have had a mitigating effect on the surreal extended lead times for components in the special machine building segment by appropriately preparing countermeasures and actively involving key company partners operating in and outside the EU. Therefore, an active and lived joint operation between SC partners based on the second layer of SCRM is supposed to increase the resilience of their SCs, build up trust, reduce uncertainty, and eventually maintain their competitive advantage or set the direction towards it. As the dramatic impact of recent occurrences to companies' SCs led to unexpectedly long delivery times and even partly unavailable goods, the following third hypothesis is examined in this paper:

H3 – *At least fifty percent of German special machine construction suppliers do not involve SC associates in their SC decisions considering the six areas of the second layer of SCRM.*

Further, a deeper insight into the six areas of the second layer of SCRM shall help to understand the current market situation even better. As these identified collaborative aspects should theoretically contribute positively to the performance of SCs in many ways and therefore prevent the current market situation, active collaboration in these fields of action seems to be absent in enterprise's SCRM approaches. Therefore, it is further

examined whether the six fields of action have a positive influence on the execution of the identified sub-activities or not.

*H4 – The identified sub-activities of the second layer of SCRM are collaborative aspects considered by the companies' SCRM approach*

### Empirical Design

Primary data collection is employed to test and analyse the above-mentioned hypotheses by the quantitative model of a self-administrative survey, which is provided on a web-based platform to make it easily accessible for every questionee and to avoid invalid answers. Each contact person was personally approached and informed about the subject so that the requirements and the purpose of this research was known in advance. External data collected from supplier companies operating in Germany for the special machine construction segment formed the basis of the data acquisition, regardless of their field of operation. The survey itself consists of 16 closed-ended questions, associated with specific direct hypotheses, and includes all possible answers to simplify interpretation and tabulation of the data collected. The types of questions varying between *yes-no* (nominal) and scaled (ordinal) answer possibilities (Natrop, 2015). The only exception from this form is question seven which contains different management approaches for KPIs and the possibility of an individual answer which, however, can then be allocated to the classification (FPMS or NFPMS) required to examine the related hypothesis. Other questions of the survey are used for general information collection and feedback only. Further, this form also serves to provide the respondent with a golden thread through the survey by only offering answers that are relevant to the research purpose.

### Sample Description

The companies surveyed for this study were chosen on the basis of their importance for the focal firms. Supplier companies for the special machine building segment with a business unit located in Germany are part of this sample. The selection took place by the determination of lead buyers about suppliers which have strategic importance for a special machine builder in the south of Germany. Therefore, suppliers were rated by the annual volume of purchased goods as

well as the specific importance of products that cannot be substituted for a variety of reasons. Thereby it was insignificant which industrial segment the companies belong to (e.g., electrical or optical industry). Moreover, the sample does not belong to a specific regional area of Germany and was not segmented by company sizes. Further, it was not known whether the companies managing their SCs or whether SCRM strategies are carried out. In total, the sample size consists of 25 supplier companies which are distributed across different industries. The surveys were filled in by representatives of these companies which are actively involved in their SCM activities. However, no specific senior position within the company was required to complete the survey.

### Evaluation Method

To evaluate hypotheses H1 to H3, the binomial distribution is employed. This decision was made because the limit of the de Moivre-Laplace theorem for using the gaussian distribution is at a value of 3.0 (Fischer, Lehner, & Puchert, 2015). This limit was not reached by any of the hypotheses. Beyond that, the arithmetical mean and standard deviation of the responses related to hypothesis H3 (the six action fields of the second layer of SCRM) are applied in order to highlight possible outstanding or particularly little considered action fields as well as to highlight certain variations.

As the binomial distribution is only employed to evaluate hypotheses H1 – H3, Spearman's correlation is used to examine the result on hypothesis H4. This approach is used to determine the correlation between two variables, i.e., it is examined whether a certain action field supports the consideration of a related sub-activity as a collaborative action (e.g., sustainability to CSSPs).

Consequently, three different scientific approaches are pursued to analyse the taken hypotheses. Hypotheses H1 and H2 are evaluated based on the binomial distribution, whilst hypothesis H3 is analysed using the arithmetic mean and standard deviation in addition. This supplementary step provides a deeper insight into the different characteristics of the six action fields and supports the interpretation of the responses. Furthermore, Spearman's correlation is used to analyse hypothesis H4, which shows whether there is a correlation between the sub-activations and the related field of action or not.

## Empirical Results

The figures reveal that it can be generally assumed that SCRM attains high attention as a managerial tool within the companies surveyed for this research. 18 out of 25 companies stated that they perform SCRM activities within their day-by-day business. However, in contrast to the simple operation with SCRM rudiments, the inclusion of other internal stakeholders

and related collective learning is a basic fundament of a real SCRM culture. This was also examined within the questionnaire, by a supplementary question, which respondents were explicitly requested to answer. Therefore, it was necessary for a maximum of 11 companies to confirm both questions in order to support hypothesis H1. Hence, hypothesis H1 becomes not supported as 14 companies demonstrate to process SCRM in a recurring cycle of continuous inclusion of internal stakeholder (figure 6).

Figure 6: Matrix of Responses Regarding Hypothesis 1

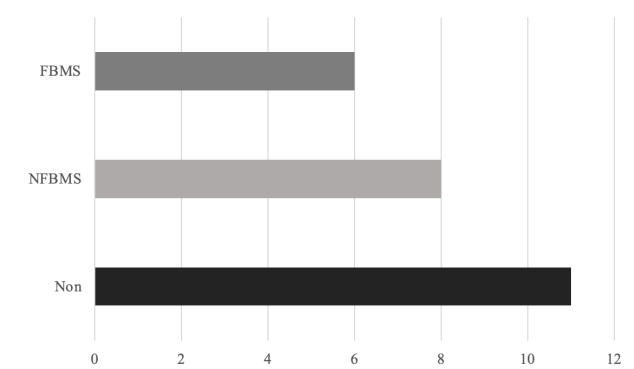
	The Company has Established a SCRM Culture		
	Endorsed	Declined	
H1 Partially Supported	18	7	H1 Not Supported
H1 Supported	14	11	H1 Not Supported
	Endorsed	Declined	
	SCRM Contain the Inclusion of Internal Stakeholder		

Hypothesis H2 refers to the relevance of intangible assets within SCs. Historically, SCRM KPIs focusing mostly on the performance of SCs based on monetary aspects and try to reveal processes with hampering effects to the SC value contribution. NFPMS eventually describe similar aspects but with a strong focus on processes or interrelations, relevant to the fundamental performance of organisations. As only eight companies responded to work with NFPMS (the binomial limit is 14) hypothesis H2 is not rejected (cf. figure 7).

Therefore, the basic assumption that companies only work with NFPMS to a limited extent seem to be correct, but the number of companies that state to not work with SCRM KPIs at all is higher than expected. Including the invalid responses from two companies that indicated that they do not work with SCRM KPIs but chose an underlying principle for their derivation, the number of companies without SC KPI tracking is 13, which is more than 50% of the surveyed companies. Accordingly, four companies responded that FPMS take over a leading role within their SC performance tracking which is a lower number than initially assumed. Overall, the number of companies not using any SCRM KPIs is

surprisingly high, but ultimately the result reflects the current market situation.

Figure 7: Distribution of Responses Regarding Hypothesis 2



In contrast to the rather negative results above, the inclusion level of SC associates into SCRM decision of the six action fields of the second SCRM layer is given in every case. Hypothesis H3 would be supported if at least eight companies declare to not include SC associates into SCRM activities of the six action fields (cf. table 2).

Table 2: Value Rating of the Answers to the Six Fields of Action

Hypothesis	Action Field	No Inclusion of SC Associates	Any Other Inclusion Level of SC Associates
H3.01	Collaborative culture	1	24
H3.02	Organisational learning	0	25
H3.03	Sustainability	4	21
H3.04	Cashflow management	5	20
H3.05	Cyber security	5	20
H3.06	Information sharing	2	23

According to the responses, the action fields of sustainability, cyber security and collaborative culture lay in the area of moderate cooperation (5-6) when applying the arithmetic mean. Greater attention is paid to organisational learning and information sharing, as these action fields are located in the area of strong cooperation (6-7). The only action field which is prominent with a lower score is cashflow management where the responses indicate only a weak cooperation (4-5). These results are shown in table 3 below.

Based on recent research, these results indicate a strong orientation of companies towards higher flexibility, efficiency, and improved dynamics (Zhu, Liu, & Wang, 2019) & (Costantino, Di Gravio, Shaban, & Tronc, 2015). At first glance, these findings seem not to correlate to the current market situation in the special machine building sector where important components and assemblies are available with a lead time of up to 45 weeks, and a delivery date cannot even be given for some accessories. However, some supplier companies are able to offer their goods or services even in this challenging environment with only a slightly longer lead time than before. This result could be explained by the fact that information sharing has a high variety of responses, as the standard deviation is quite high. Thus the result suggests that there are businesses that focus on the dynamics of their SCs more than others. As information sharing is also a major contributor to overall cost reduction, these findings are also supported by the unevenly rising prices in the market, whereby some companies are raising prices dramatically and others only marginally (Costantino, Di Gravio, Shaban, & Tronc, 2015).

Action Field	M	SD
Collaborative Culture	5.88	2.07
Organisational Learning	6.36	1.93
Sustainability	5.92	2.75
Cashflow Management	4.84	2.34
Cyber Security	5.32	2.56
Information Sharing	6.20	2.50

Further, the results indicate that increased SC effectiveness, based on the action field collaborative culture, is an objective equally pursued by the surveyed companies as the standard deviation is rather low. This suggests that jointly agreed and focused-on goals within collaborative SCRM strategies play an important role in today's business environment where both parties are striving towards the same goal and expanding their knowledge together. Other action areas were a very similar mindset was shown are cybersecurity and sustainability, but the answers diverge widely. Sustainability as an amplifier for competitiveness has the largest divergence of answers, which is quite surprising, since companies are observed almost continuously by stakeholders or non-governmental organisations (Taghian, D'Souza, & Polonsky, 2015). An explanation for this phenomenon could be that supplier companies in the special machine building segment are not directly in the focus of the public, since their goods are usually delivered to other companies, who in turn process these goods further. Another interesting finding is that cyber

Table 3: Value Overview of the Six Fields of Action



security also achieves a high standard deviation due to inconsistent answers. Since the effects of cyber-attacks reached a level where companies sometimes experienced a shutdown of their software infrastructure for several weeks, a higher overall importance of this action field was expected. Ultimately, the result could also be representative for the current market situation, since cyber-attacks with a strong focus on vulnerable operating systems are increasing significantly and, according to the answers, not all companies are sufficiently focused on this threat (Setola, Faramondi, Salzano, & Cozzani, 2019) & (Pandey, Singh, Gunasekaran, & Kaushik, 2019).

A higher SC resilience is also supported by cashflow management, which is the only field of action that shows weak cooperation within the cooperative SCRM approaches. This result indicates that companies are more concerned about their own liquidity than ensuring their performance based on novel payment arrangements. As a result, companies may lose long-term partnerships that are critical to their service delivery. Likewise, there may be a lack of core competencies to meet customer needs, which ultimately could result in reduced competitiveness.

A further examination of the second layer of SCRM is carried out using the Spearman correlation, whereby the following tables showing the correlation between the action fields described above and the

identified sub-activities. In other words, it is the examination whether the superordinate action fields have a positive effect to the execution of their sub-activities or not (hypothesis 4).

### Collaborative Culture

Power symmetry ( $r = .780, p < .01$ ) and collectivism ( $r = .538, p < .01$ ) have a significant positive correlation with the action field collaborative culture. This means that a culture of collaboration addresses two main aspects of shared approaches to increasing effectiveness and vice versa. On the one hand, trust-based and thus balanced partner positions are the epitome of this field of action, since good cooperation relates to this aspect. Conversely, unbalanced partnerships lead to reduced SC effectiveness, which in turn negatively impacts the culture of collaboration. On the other hand, generally accepted rules and norms in the collaborative SC system are strong supporters of SC effectiveness, since these are the cornerstones of collectivism, where an individual works for the welfare of the system. Surprisingly, long-term orientation was not found to have a significant association with collaborative culture. This is unexpected because a culture cannot be built up in a short period of time and rapidly changing SC partners burden the system with even more uncertainty, since the quality of these cannot be recognized in advance.

Table 4: Spearman Correlation of Collaborative Culture

			Cooperative Culture	Power Symmetry	Uncertainty Avoidance	Long Term Orientation	Collectivism
Spearman's rho	Cooperative Culture	Correlation Coefficient	1.000				
		Sig. (2-tailed)	.				
		N	25				
	Power Symmetry	Correlation Coefficient	.780**	1.000			
		Sig. (2-tailed)	.000	.			
		N	25	25			
	Uncertainty Avoidance	Correlation Coefficient	.259	.330	1.000		
		Sig. (2-tailed)	.212	.108	.		
		N	25	25	25		
	Long Term Orientation	Correlation Coefficient	.383	.625**	.481*	1.000	
		Sig. (2-tailed)	.059	.001	.015	.	
		N	25	25	25	25	
	Collectivism	Correlation Coefficient	.538**	.746**	.152	.495	1.000
		Sig. (2-tailed)	.006	.000	.468	.012	.
		N	25	25	25	25	25

Note. \*\*p < 0.01, \*p < 0.05

### Organisational Learning

Based on the responses given by the companies, knowledge sharing ( $r = .545$ ,  $p < .01$ ) has a minor correlation to OL. This result indicates that shared knowledge is expected to have a positive effect on SC flexibility and efficiency. Accordingly, a living culture of knowledge acquisition, preservation and transfer across internal borders enables partners of an SC intention to cover strengthening situations more flexibly on the basis of distributed information. This finding also corresponds to the correlation between transformational leadership ( $r = .600$ ,  $p < .01$ ) and OL. The active involvement of

SC partners into the own SCRM approaches and the resulting mutual learning could be a new venture for many companies in the special machine construction area. Transformational leadership actively supports this, as this leadership style is intended to inspire employees and empower organisations to strive for change and innovation. Therefore, internal directives to support the transformational leadership style will have a direct impact on organisational learning and higher flexibility and efficiency can be expected. However, the results indicate also that OL has no significant correlation to learning from errors.

Table 5: *Spearman Correlation of Organisational Learning*

Spearman's rho	Organizational Learning	Correlation Coefficient	Organizational Learning	Knowledge Sharing	Learning from Errors	Promote and Foster Transformational Leadership
			1.000			
		Sig. (2-tailed)	.			
		N	25			
	Knowledge Sharing	Correlation Coefficient	.545**	1.000		
		Sig. (2-tailed)	.005	.		
		N	25	25		
	Learning from Errors	Correlation Coefficient	.352	.593**	1.000	
		Sig. (2-tailed)	.085	.002	.	
		N	25	25	25	
	Promote and Foster Transformational Leadership	Correlation Coefficient	.600**	.629**	.266	1.000
		Sig. (2-tailed)	.002	.001	.199	.
		N	25	25	25	25

Note. \*\* $p < 0.01$

### Sustainability

Since sustainability, including corporate social responsibility, has come to play an important role in society, it also comes into the focus of companies as an amplifier of competitiveness. This development is also represented by the results in this research. Sustainability has a medium correlation to CSSPs ( $r = .748$ ,  $p < .01$ ), which in turn means that joint approaches which aim to create beneficial outcomes for societies affect their competitiveness. In addition, block chain integration ( $r = .479$ ,  $p < .05$ ) has a low but positive correlation to OL. This suggests that if a company pursues sustainable goals, blockchain technology integration is likely and other SC partners will therefore be forced to ensure compliance related to sustainable and responsible goals. The stronger correlation of sustainability and smart contracts ( $r = .796$ ,  $p < .01$ ) also punctuates the importance of block chains the

importance of blockchains as this is a rising feature of them. The result shows that sustainable goals based on binding agreements play an important role for companies, so that interpretation gaps based on these agreements should be ruled out. However, the higher correlation of smart contracts in contrast to block chain integration cannot be explained by this analysis. Another positive correlation was found in relation of sustainability and R&D investments ( $r = .479$ ,  $p < .05$ ). This indicates that companies collaborating in terms of sustainability want to strengthen their competitiveness based on novel approaches to reduce their environmental footprint, although the exact intention of this collaboration is not known. Since sustainability has become a good advertising medium for companies in society, the intention can be based either on responsible goals or on advertising purposes.

Table 6: Spearman Correlation of Sustainability

			Sustainability	Smart Contracts	Block Chain Integration	R&D Investments	CSSPs
Spearman's rho	Sustainability	Correlation Coefficient	1.000				
		Sig. (2-tailed)	.				
		N	25				
	Smart Contracts	Correlation Coefficient	.796**	1.000			
		Sig. (2-tailed)	.000	.			
		N	25	25			
	Block Chain Integration	Correlation Coefficient	.479*	.521**	1.000		
		Sig. (2-tailed)	.015	.008	.		
		N	25	25	25		
	R&D Investments	Correlation Coefficient	.479*	.580**	.591**	1.000	
		Sig. (2-tailed)	.015	.002	.002	.	
		N	25	25	25	25	
	CSSPs	Correlation Coefficient	.748**	.669**	.727**	.586**	1.000
		Sig. (2-tailed)	.000	.000	.000	.002	.
		N	25	25	25	25	25

Note. \*\*p < 0.01, \*p < 0.05

### Cashflow Management

As the evaluation of H3 shows, cashflow management generally receives weak attention in collaborative SCRM approaches by companies. However, even in this weak collaboration, no significant correlation to the identified sub-activities could be proven. This means that collaborative cashflow management approaches pursued in SCRM neither support the implementation of advance payment agreements ( $r = .148$ ), or block chain payments ( $r = .287$ ), nor the security of payment acts ( $r = .198$ ). As a

consequence, this result indicates that German supplier companies in the special machine construction segment are not striving for expanded options for securing the liquidity of SC partners on the basis of the identified sub-activities, so that their SC resilience against unexpected partner or performance loss is not improved. Finally, there is one fact that cannot be explained by this research. As cashflow management contains weak collaboration between SC partners some joint activities in regard of this action field must be carried out. However, these sub-activities could not be identified in this research.

Table 7: Spearman Correlation of Cashflow Management

			Cashflow Management	Advanced Payment Agreements	Block Chain Payments	Security of Payment Acts
Spearman's rho	Cashflow Management	Correlation Coefficient	1.000			
		Sig. (2-tailed)	.			
		N	25			
	Advanced Payment Agreements	Correlation Coefficient	.148	1.000		
		Sig. (2-tailed)	.479	.		
		N	25	25		
	Block Chain Payments	Correlation Coefficient	.287	.643**	1.000	
		Sig. (2-tailed)	.165	.001	.	
		N	25	25	25	
	Security of Payment Acts	Correlation Coefficient	.198	.301	.270	1.000
		Sig. (2-tailed)	.343	.144	.192	.
		N	25	25	25	25

Note. \*\*p < 0.01

### Cyber Security

Cyber security is the second action field in the second layer of SCRM that targets SC resilience. This action field has several positive correlations to the identified sub-activities as indicated in the table above. According to the data, collaborative SCRM approaches support the coding and encrypting of data ( $r = .783$ ,  $p < .01$ ) between SC partners, as well as shared password and account management ( $r = .766$ ,  $p < .01$ ). Additionally, securing data from unauthorized access ( $r = .598$ ,  $p < .01$ ) is a security measure that is positively impacted when companies focus on common SCRM approaches in cyber security. The data also

reveals a low positive correlation of cyber security with increased employee knowledge ( $r = .419$ ,  $p < .05$ ), suggesting that companies adopting a cybersecurity approach are likely to raise awareness among their employees on how to protect their technical infrastructure from external threats. Ultimately, the data shows that German-based supplier companies in the special machine building segment are generally aware of the importance of securing their data from external threats, but also that regular data backup ( $r = .329$ ) is not in their focus. This could be rooted in the growing possibility to outsource data storage on cloud-based platform, where service providers have a responsibility to adequately secure that data.

Table 8: Spearman Correlation of Cyber Security

			Cyber Security	Coding and Encrypting of Data	Password and Account Management	Protection of Information from Unauthorized Access	Regular Data Backup	Increasing Knowledge and Awareness of Employees
Spearman's rho	Cyber Security	Correlation Coefficient	1.000					
		Sig. (2-tailed)	.					
		N	25					
	Coding and Encrypting of Data	Correlation Coefficient	.783**	1.000				
		Sig. (2-tailed)	.000	.				
		N	25	25				
	Password and Account Management	Correlation Coefficient	.766**	.793**	1.000			
		Sig. (2-tailed)	.000	.000	.			
		N	25	25	25			
	Protection of Information from Unauthorized Access	Correlation Coefficient	.598**	.578**	.779**	1.000		
		Sig. (2-tailed)	.002	.002	.000	.		
		N	25	25	25	25		
	Regular Data Backup	Correlation Coefficient	.329	.193	.442*	.538**	1.000	
		Sig. (2-tailed)	.109	.356	.027	.006	.	
		N	25	25	25	25	25	
	Increasing Knowledge and Awareness of Employees	Correlation Coefficient	.419*	.168	.462*	.631**	.809**	1.000
		Sig. (2-tailed)	.037	.423	.020	.001	.000	.
		N	25	25	25	25	25	25

Note. \*\*p < 0.01, \*p < 0.05

### Information Sharing

Collaborating on the same level of authority is another expression of power structure. The correlation between information sharing and power structure ( $r = .843$ ,  $p < .01$ ) indicates that the surveyed companies are focused on improving their SC grid by creating a system in which each company has equal permission to access and direct resources (information in particular). This also corresponds with the correlation to information utilisation ( $r = .515$ ,  $p < .01$ ). In fact, these findings show that equally distributed and accessible information applied from multiple tiers is used to improve SC

dynamics and reduce SC costs through improved planning backgrounds based on this information. Another statistically significant correlation relates to cultural and legal aspects ( $r = .697$ ,  $p < .01$ ). This finding leads to the conclusion that exchange of information across cultural and national borders becomes a mean to address critical problems within international SCs. Further, companies operate in a complex network of national, organisational, and information contexts where contextual differences seem to be managed by focusing on these aspects (Dawes, Gharawi, & Burke, 2012). Beyond that, SCRM guidelines that improve the

exchange of relevant information also influence the synchronisation of business processes and vice versa ( $r = .728$ ,  $p < .01$ ). Hence, when information sharing is considered as a beneficial source for successful risk mitigation, this enhances the implementation of business processes that optimize the sharing of relevant

information. Surprisingly, it was also found that information sharing in SCs, however, does not imply that technology is necessarily utilized to exchange relevant context between companies ( $r = .370$ ). Since this research does not specify which technology is meant, a deeper insight is denied.

Table 9: Spearman Correlation of Information Sharing

			Information Sharing	Power Structure	Cultural and Legal Aspects	Alignment of Business Processes	Information Utilization	Utilization of Technology
Spearman's rho	Information Sharing	Correlation Coefficient	1.000					
		Sig. (2-tailed)	.					
		N	25					
	Power Structure	Correlation Coefficient	.843**	1.000				
		Sig. (2-tailed)	.000	.				
		N	25	25				
	Cultural and Legal Aspects	Correlation Coefficient	.697**	.621**	1.000			
		Sig. (2-tailed)	.000	.001	.			
		N	25	25	25			
	Alignment of Business Processes	Correlation Coefficient	.728**	.686**	.565**	1.000		
		Sig. (2-tailed)	.000	.000	.003	.		
		N	25	25	25	25		
	Information Utilization	Correlation Coefficient	.515**	.584**	.400*	.653**	1.000	
		Sig. (2-tailed)	.008	.002	.047	.000	.	
		N	25	25	25	25	25	
	Utilization of Technology	Correlation Coefficient	.370	.475*	.414*	.628**	.748**	1.000
		Sig. (2-tailed)	.069	.017	.040	.001	.000	.
		N	25	25	25	25	25	25

Note. \*\* $p < 0.01$ , \* $p < 0.05$

## Conclusions

### Management Application

Numerous events in recent years, whether natural or man-made, have shown that SCRM should have become a very important control instrument for corporate success. Contrarily, the findings have shown that only 56 percent of the companies surveyed have established a SCRM culture in which internal stakeholders are actively involved. This is also representative of the tense marked situation for special manufacturers and ultimately a sign that managers should focus more on establishing a SCRM culture in their organisations. This internal improvement to the SCRM application aims to build a more resilient SC grid and address future challenges with less impact on the organisation. They are also advised to aim for a well-functioning and risk-minimizing SC-grid based on collaborative principles after the initial implementation of SCRM approaches, as these are supposed to bring numerous benefits for managing hazardous events. This

recommendation applies despite the rejection of hypothesis H1 because this hypothesis referred to a SCRM culture distribution of 30 percent and thus specified a very low level, which is obviously not high enough to parry challenging situations on the global market.

According to the findings, the definition of KPIs in companies is either based on FPMS or is generally not carried out. In contrast, NFPMS are of marginal importance when defining KPIs. Organisations with an already established KPI system which is based on FPMS are recommended to add KPIs from NFPMS to their already existing KPI board so that intangible assets also contribute to their performance. Ultimately, these KPIs will also describe financial goals, but are derived from a different management perspective, which specifically includes the interrelationship between SC stakeholders. The implementation of such KPIs would be a major extension of their financial goals to expose imminent events that may not be identifiable through financial or time-wise tracking of their activities. However, the initial definition of KPIs is a must for any organisation that

wants to control a fragile system of multiple interconnected stakeholders. Referring to the answers given by the surveyed companies a shocking number of them don't even use SCRM KPIs to evaluate dicey SC activities. These companies are strongly encouraged to implement KPIs to track, measure and improve their SC resilience. Since these KPIs should be derived from specific business requirements that are most important for their SC performance, both NFPMS and FPMS could be suitable. Thereby, a mix of NFPMS and FPMS could bring competitive advantage by utilizing both sides of the medallion to identify future uncertainties.

With the establishment of the collaborative SCRM principle, companies are advised to focus more on long-term orientation towards other SC partners. These long-term partnerships ensure the joint development of an important knowledge base to be able to master with challenging situations in a trusting and reliable manner. In addition, partnerships built over a long period of time will certainly be able to avoid mistakes made in the past. Differing responses regarding sustainable partnerships supported the recommendation to pay more attention to this competitiveness enhancer. Since sustainability is undeniable not only related to the ecological footprint of companies, their responsibility for human well-being must also be considered at least equally. A major step forward in this task can be made with the integration of block chain technology, as the peer-to-peer interactions can shift responsibility to companies operating in regions where people's well-being is less of a priority stands. Therefore, the integration of blockchain technology should receive more attention from managers to fulfil their own responsibility and that of the company to not harm other people's well-being through their own business activities. Another important finding of this study is that cyber security also receives unequal and faintly attention among the surveyed companies. This is extremely worrying as modern businesses typically strive for novel and advanced processes based on modern technology systems that are vulnerable to internal and external threats. Cyber security is becoming even more important when companies strive for networked principles such as the well-known Industry 4.0, where a single cyber-attack could paralyze the entire infrastructure. Therefore, a strong recommendation is issued to focus more on cyber security policies and to use the knowledge of SC associates in this regard as they may have experience in

this regard. In addition, companies are urgently recommended to increase the level of knowledge of their employees, since hackers are increasingly trying to gain access to a company's IT systems through unsuspecting individuals. Ultimately, companies that may not use service providers for their data storage are recommended to carry out regular data backups in order to be able to restore their working basis in the event of possible attacks.

### **Limitations**

In this study, employees of supplier companies for the special machine building segment with a place of business in Germany were interviewed in particular. Therefore, the collected data and derived results may not be applicable for companies in another business segment or even to a different branch of those companies in another country. The data collected is also based on a blend of component manufacturers and wholesalers who are active in different business sectors such as the electrical or plastics industry. Hence, this data is neither representative for a specific industry nor of a specific supplier character, but rather for a holistic view of the supplier market for special machine manufacturers. In addition, due to the limited number of companies surveyed, validity for the entire supplier market is questionable even if statistical evidence is available. Another limiting factor of this research concerns the particular focus on SCRM. All results, even spearman correlation, aim to identify statistical evidence for SCRM initiatives, but do not consider whether these approaches are already being considered in mainstream SCM measures. Moreover, this study examines the interrelationship between SCRM and six specific fields of action and their connection with identified sub-activities. These fields of action and sub-activities have been identified from a limited amount of previous research and are most likely only a limited part of those that can be considered.

### **Recommendation for Future Research**

Complementary knowledge to this research can be created by examining how the identified actions fields and sub-activities influence the ability of companies to avoid or cope with upcoming events. As this research focuses on looking at these activities in general, the assessment of direct impacts on SCRM has not been

performed. In addition, it would also be of great interest to create some knowledge about how supplier companies in other countries deal with these aspects. Future research may also focus on the link between collaborative cash flow management policies in SCRM actions. Firstly, because this field of action seems to be attracting general attention in SCRM, but there is no evidence that the identified sub-activities are related to it. Secondly, to identify which activities of companies' SCRM approaches are really related to this field of action and what effects these have on SC resilience. Since this study examines the SCRM orientation of companies in terms of their attention to the six fields of action and their sub-activities, future research is also encouraged to examine how the current market situation might develop. According to the company's feedback, greater flexibility, efficiency and improved dynamics are clearly the focus, which, however, contradicts the current market situation. Thus, it becomes clear that properly assessing one's SC activities is a must for any organisation to be aware of current and future uncertainties and to be prepared how to deal with them. Therefore, further research could examine how an NFPMS adds value to a company's SCRM fundament and how these KPIs increase the ability of companies to reduce residual risks, so that upcoming events are largely identified in advance. This approach may not require full replacement of existing KPIs that could be based on FBMS, but could also focus on adding relevant operating numbers.

Finally, it would be of great interest how modern companies try to implement blockchain technology. During the literature research for this research, it became clear that blockchain technology has the potential to initiate real changes in SC operations worldwide, so that human well-being can at least be raised to a better level even in questionable sourcing regions. In contrast, the surveyed companies indicated no real intention to incorporate this novel technology opportunity to force their SC partners into better working conditions. Therefore, the barriers that hinder the development and integration of blockchain technology in SCs should first be identified. Based on these insights, implementation guidelines should be drafted so that the rapid integration of blockchain technology can hopefully change the lives of many people worldwide.

## About the Author

National and international project management is the focus of Kevin Lohner-Möslang. In addition, he improves the professionalism of productions through the application of lean management and quality management principles. Many years of professional experience combined with practical and theoretical training have led to in-depth knowledge of these areas of application. This path began with the completion of an apprenticeship as a mechanic and led to a degree as an industrial foreman to the completion of a university degree as an industrial engineer. Finally, this educational background was supplemented by an MBA degree from the Kempten Business School.



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