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Supply Chain Stress

Analysis of Supply Chain Influences

Iris Hausladen^a, Beatrice Dachsel^b, Alexander Haas^b, Miroslava Rakovska^c

^a Prof. Dr. Iris Hausladen is Holder of the Heinz Nixdorf Chair of IT-based Logistics at HHL Leipzig Graduate School of Management, Leipzig, Germany.

^b Beatrice Dachsel, M.A., is a research associate and Alexander Haas, M.Sc., is an external doctoral candidate at the Heinz Nixdorf Chair of IT-based Logistics at HHL Leipzig Graduate School of Management, Leipzig, Germany. Email: beatrice.dachsel@hhl.de

^c Miroslava Rakovska, Ph.D., is Associate Professor and Head of the Department of Logistics at the University of National and World Economy, Sofia, Bulgaria.

Abstract:

Seizing the challenges of contemporary Supply Chain Management (SCM), different concepts like risk management or resilience were developed and carried out in praxis. In the scientific literature, the focus lies actually on almost negative and partly on neutral influences on supply chains such as events, risks, disruptions and related terms that play a crucial role in strategic and operational characteristics of SCM as they are strongly related to the performance of supply chains. Compared to existing concepts in this area of SCM which have been reviewed in this paper, a need for a certain paradigm shift has evolved to consider influences onto supply chains in a more holistic perception than solely negative and neutral aspects. Therefore, we apply the term “stress” as an umbrella for all positive, neutral and negative influences that affect the supply chain. To investigate the relevance of supply chain stress management as an emerging concept and to derive the relative importance of prior selected supply chain stress factors, a web-based survey among supply chain practitioners was conducted in Germany and Bulgaria. By the aid of this cross-country analysis, two contributions to research are made. First, the need for a holistic management concept to capture all positive, neutral and negative influences on the supply chain was detected and second, these so-called stress factors were assessed concerning their relative importance and their concrete influence on SCM.

1 Introduction

The ever-rising level of technology and globalization plays a crucial role for the increasing burden and complexity of supply chains. Furthermore, market pressure and rising customer expectations, for instance according to product quality and delivery speed equally, exert pressure among all supply chain partners in terms of their supply chain performance. The list of supply chain influences is long and not negligible, as even unexpected and unlikely or only with small effect assessed influences can lead to a total break-down of the supply chain. Nevertheless, also positive developments like the growing usage of IT solutions that eases a company's operations, can lead to higher burdens for decision makers in the supply chain management since the installation of IT solutions causes costs like maintenance or personnel training efforts.

In recent years, researchers and practitioners alike, put their eyes on supply chain risks, disruptions or events that may endanger the chain's performance. Established management concepts like supply chain risk management or supply chain event management have been investigated and proven in practice. Admittedly, these terms are mostly related to negatively perceived influences that harm the supply chain. A relatively new term in that context is supply chain stress. The term was recently used by DHL in the context of de-stressing the supply chain. Here, the focus lies on tactical slow-downs in the operational level of supply chain management as well as synchronicity and supply chain risk management (Bubner, Helbig and Jeske 2014, 29). Another phenomenon in the context of supply chain stress are stress-tests for the supply chain which describe the general checking of supply chain flexibility, vulnerability or even robustness (Lohr 2011).

Dipping into human psychology (Le Fevre, Matheny and Kolt 2003), the term stress does not only describe negative manifestations. Taking that bigger picture into account, the influences onto supply chains are considered in two more manifestations than solely the negative one: Neutral and positive. Therefore, the term stress is applied as an umbrella for all positive, neutral and negative influences that may affect the supply chain.

The paper is divided in several subsections whereas the first one deals with the theoretical basement that is needed further on. Here, mostly common supply chain management concepts are introduced and delimited from each other. Ongoing, these theories are classified for the purpose of a framework that confirms the necessity for a broader view onto supply chain influences, namely the umbrella of supply chain stress respectively supply chain stress management.

Then, an empirical study is done to provide practical insights on the theoretically from supply chain influences derived stress factors and their perception (either as opportunities – positive, trends – neutral or threats – negative) for decision makers in supply chain management. This cross-country study was undertaken in Germany and Bulgaria to provide diverse perspectives on the same topic gathered from countries which are settled in different logistics maturity levels. In a next step, the clustering of the supply chain stress factors takes place. Coming from that, a generic portfolio is developed that serves as a classification tool for the company-specific stress factors. Consequently, universal recommendations for handling the stress factors are provided.

The paper should serve practitioners and researchers alike as it contributes to a wider understanding of supply chain influences. More precise, it conduces as a pulse generator that sharpens the senses for supply chain members to take all kinds of supply chain influences into consideration when it comes to strategic and operational decision making. Particularly, the importance of positive or neutral assessed supply chain influences next to the negative ones is stated in the paper.

Therefore, the following research questions are deduced:

- 1) Which supply chain influences are covered by existing concepts in supply chain theory?
- 2) How can supply chain influences be bundled in supply chain stress factor groups?

2 Theoretical background

2.1 Supply Chain Management

Nowadays, the majority of companies is connected and organized in supply chains or supply chain networks. Supply chain management (SCM) is meanwhile regarded as an approved management concept to embrace “[...] the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities” (Vitasek 2013, 187). Within SCM, warehousing, distribution and after sales processes with a strong focus on end-to-end value chains and customer requirements are integrated as well.

To delimit SCM from logistics and logistics management, different efforts were undertaken in the past (Lummus, Krumwiede and Vokurka 2001; Larson and Halldorsson 2004; Niine and Lend 2013; Zinn and Goldsby 2014). Larson and Halldorsson (2004) identify four perspectives to distinguish between logistics and SCM. The Unionist perspective, which is followed in this paper, views logistics as a subordinated element of SCM (Larson and Halldorsson 2004, 20). Logistics, as a more operational concept, is basically associated with material and information flows and can be regarded as the management of transport, transshipment and storage activities of goods (Lummus, Krumwiede and Vokurka 2001, 431; Hausladen, Haas and Lichtenberg 2013, 164). Main logistics processes are procurement, manufacturing, distribution, after sales and reverse logistics. Logistics management inputs a strategic component to logistics and can be defined as “that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information.” (Vitasek 2013, 117). Although strong intersections between logistics management and SCM were empirically revealed by Niine and Lend (2013), logistics management encompasses a focal company and its relationship to strongly connected tier 1 suppliers and tier 1 customers. By contrast, SCM extends this scope by integrating all relevant tiers and members of the supply chain or supply chain network. This distinction is illustrated in figure 1.

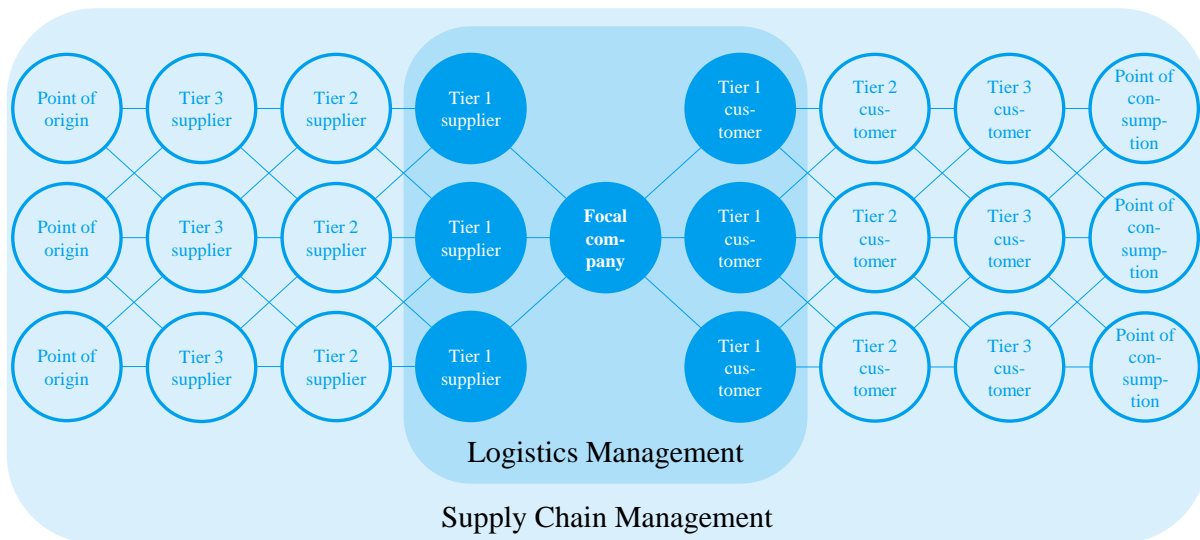


Figure 1: Distinction between logistics management and SCM (source: own illustration)

2.2 Supply Chain Management concepts and conditions

Various concepts and conditions exist in supply chain management that deal with the management of supply chain influences. Therefore, an assessment based on different criteria to evaluate supply chain influences is conducted by the authors (see table 1). The selected concepts are concurrently used in the questionnaire.

The planning level describes the organizational stage of a firm's decision. Even more important is the explication and tendency of the supply chain influences that are subject of management in the concept. As it is remarkable, none of the theories describes the management of all kinds of supply chain influences, i.e. with positive, neutral or negative manifestation. Furthermore the supply chain conditions (supply chain flexibility and supply chain resilience) are not clearly assessable due to their tendency of supply chain influences. The need for research on the handling of all kinds of influences is thereby given (see table 1).

Table 1: Overview of different supply chain management concepts (literature) dealing with supply chain influences (source: own illustration)

Concepts/ Conditions	Supply Chain Risk Management	Supply Chain Resilience	SC Event Management	Supply Chain Flexibility
Criteria				
Planning level - Strategic - Operational - Tactical	Strategic Operational Tactical	Strategic	Strategic Operational Tactical	Strategic Tactical
Explication and tendency of the supply chain influence + positive - negative ./ neutral	Predominantly negative	Very often negative → no clear assessment possible	Predominantly negative and/or neutral	Cannot clearly be assessed

2.3 From supply chain influences to supply chain stress

The literature review shows that efforts in managing supply chain events, risks, disruptions and other related proceedings are limited to a negative and rarely neutral perception. Therefore, a newly understanding called supply chain stress is proposed that widens the perception of influences that affect the supply chain with a positive awareness. Our thinking is substantiated with the fact that not only negative or even neutral influences may affect the supply chain, but also positive activities may have that power. It is highly important to define the positive, neutral and negative perception of supply chain influences. Risks, disruptions and glitches are negatively perceived for this paper and described as threats further on, whereas the term neutral means that a factor is hardly to assess. In the paper, trends are defined as neutral influences. To lead over to positive supply chain influences, we describe opportunities as all kinds of positively perceived influences.

As described in psychology, not only negative stress influences the behavior of human beings, but also positive stress respectively stress which cannot be assigned as positive (eustress) or negative (distress) (Le Fevre, Matheny and Kolt 2003). Stress does not only describe burdens, but also excitements which are not inevitably negatively associated descriptions.

Our understanding defines supply chain stress factors as superior categories that contain a variety of influences respectively disruptions, risks and related terms. An example for stress factors are natural disasters. Here, tsunamis are an equivalent influence. Neutral influences are influences that are not assessable at the moment, e.g. changes in law. The impact in the future is therefore not clear at the moment for neutral supply chain stress factors whereas positive supply chain stress factors like the elimination of customs are unequivocal positive in terms of their impact.

To develop a holistic picture of supply chain stress, supply chain stress factors were gathered from literature and through expert discussions and their importance as well as their assignment to the stress category were evaluated through an empirical study. Factors derived from supply chain risk management or resilience focus mainly on negative aspects of stress (Tummala and Schoenherr 2011; Tang and Musa 2011). Contrariwise, trend considerations are also seen as an interesting source for positive and neutral factors (Fawcett and Waller 2014). In the following, each stress factor is shortly introduced without an evaluation. A common level of detail of all stress factors is provided by subsuming different influences to one stress factor, e.g. earthquakes or volcanic eruptions are summarized into natural disasters.

Ongoing, supply chain stress management should be understood as an evolutionary and integrative concept that contributes to the existing and established theory.

Furthermore, a distinction between external and internal supply chain stress factors is emphasized. External stress factors have their causes outside and are in most cases not controllable, whereas internal stress factors are caused within a supply chain or within an organization acting in a supply chain. Internal stress factors can be better controlled and mechanisms to steer them can be implemented and handled easier than for external factors.

2.3.1 External supply chain stress factors

Obvious external factors which affect supply chains tremendously are natural disasters like earthquakes, tsunamis, volcanic eruptions, floods or winter storms, terrorism and wars like attacks on pipelines, ships, harbors or plants (Sheffi 2001) as well as strikes and labor disputes, for instance in Germany between unions and employers. Tummala and Schoenherr (2011) subsume these three external factors into disruption risks for the supply chain (p. 475). Legal frameworks and legal requirements mark another stress factor for which the opportunity of taking influence is very limited but possible through lobby work. Resource scarcity is widely seen as a sourcing effect (Tang and Musa 2011, 28; Tummala and Schoenherr 2011, 475) and depends heavily on the regional distribution of resources and the political situation in that region. Emerging markets change the whole supply chain landscape worldwide and therefore cause new customer and sourcing regions. Shifts in human behavior in general like urbanization or certain human developments like demographic changes do also affect supply chains, but certainly in a more regionally and customer-oriented manner. Switching demands and changing customer needs like a stronger eco-orientation are manifested in the stress factor changing customer behavior. Globalization itself and economic crises determining prices for resources and materials need to be investigated as well. Emerging trends, especially disruptions in information technology (IT) like Big Data issues and the introduction of Predictive Analytics as an application of Big Data play a significant role in future supply chains (Fawcett and Waller 2014, 156). The pervasion and utilization of IT in all enterprises is continuing. Moreover, additive manufacturing/ 3D printing, the use of autonomous vehicles and new materials developed through expanded research in material science are also displaying stress factors (Fawcett and Waller 2014, 159–160). Concerning energy provision for private and business customers, the usage of alternative engine concepts and beyond is expressed in the holistic concept of E-Mobility. The energy shift itself, primary an issue on the German market, shows a paradigm change on energy production and proclaims an emission-free production for the future. Together with the E-Mobility concept, these energy issues will act as major game changers in the landscape of supply chains and are therefore seen as crucial supply chain stress factors. All external supply chain stress factors are summarized in table 2.

2.3.2 Internal supply chain stress factors

One of the most influencing stress factors in internal supply chains is bureaucracy, which acts as a subsuming term for all administrative tasks like approvals or certain coordination processes between departments that can be mitigated by lean management or process optimization efforts. Volatile demands within the supply chain caused by inefficient forecasts in the different tiers or inefficient interorganizational coordination processes are also a root cause for supply chain stress. A lack of qualified employees is furthermore seen as an internal stress factor, which coincides with a resulting overload of the residual employees as well. Outsourcing of certain business or processes like transport, storage, IT or human resources is assigned to the group of internal stress factors. Cooperation strategies between the different companies organized in a supply chain and between them and their sub-contractors are definitely influencing supply stress, especially concerning the intensity of contracts (e.g. ECR, CPFR, etc.), make-or-buy decisions or the alignment of supporting IT and software systems (e.g. different ERP or WMS utilization). The rising awareness of sustainability and social responsibility marks the importance of the factor supply chain social responsibility (Seuring and Müller 2008). Moreover, new business models, either initiated by technological changes or anticipated demands will mainly affect the supply chain internally. All internal supply chain stress factors are collected in table 2 as well.

Table 2: Summary of external and internal supply chain stress (source: own illustration)

External supply chain stress factors	Internal supply chain stress factors
Natural disasters	Bureaucracy
Terrorism and wars	Demand volatilities
Strikes and labor disputes	Skills shortage
Legal frameworks and requirements	Overload of employees
Resource scarcity	Outsourcing
Emerging markets	Cooperation strategies
Urbanization	Supply Chain Social Responsibility
Demographic change	Emerging business models
Changing consumer behavior	
Globalization	
Economic crises	
Big Data	
Predictive Analytics	
Additive manufacturing/ 3D printing	
Autonomous vehicles	
Evolving materials science	
Emerging IT utilization	
E-Mobility	
Energy shifts	

3 International survey on supply chain stress and supply chain stress factors

3.1 Cross country comparison between Germany and Bulgaria from a supply chain perspective

Bulgaria is one of the most preferred outsourcing destinations in Europe for 2014 being at the ninth position among 51 countries (A.T. Kearney Global Services Location Index 2014). Since its accession to the EU in 2007 Bulgaria has been presenting deep opportunities for foreign investors with its comparatively cheap and qualified workforce, improving business environment, and the positive trend of logistics performance improvement (World Bank 2015). A great part of Bulgarian companies are members of global supply chains and that brings the need for effective and efficient interaction with other supply chain members. Research shows that companies in Bulgaria gradually leave the traditional arm's length relationships and get closer to collaborative ones (Rakovska 2011, 103). Development of inter-firm integration processes is actually faster in comparison with internal integration. This trend can be explained with the fact that a high number of Bulgarian companies are suppliers or customers of more powerful foreign companies that impose on them collaboration practices before the achievement of internal integration. Nevertheless, comparison with world best practices and trends shows that supply chain management development in Bulgaria lags behind due to the existence of challenges concerning knowledge, skills and owned resources, for instance IT capabilities (Rakovska 2014). This reveals considerable untapped resources for improving supply chain management in Bulgaria with the increasing integration within EU countries and continuing dissemination of best practices by foreign investors, suppliers and customers among Bulgarian companies.

Germany can be viewed as a focal country since it plays a major role as a customer for worldwide products and as a worldwide shipper for different products. The exposed location in Central Europe allows German and international companies which have set up subsidiaries and offices there to operate efficiently within a pan-European supply chain network. The manufacturing branch as a major asset in Germany, which is also pushed by a large variety of specialized small and medium-sized companies (SMEs), contributes to the supply chain landscape as well (World Bank 2015). Major drawbacks for industries in Germany are comparatively high labor and energy costs, yet mainly compensated by the innovation potential of German companies and leading position in technology and science overall (OECD Stat Extracts 2015). All requirements to establish world leading supply chains like infrastructure or competences in logistics are more than fulfilled in Germany which boosts the country on the highest position of the logistics performance index of The World Bank in 2014 (World Bank 2015).

3.2 Survey methodology and demographic measures

Two identical web-based surveys among practitioners were carried out in Germany and Bulgaria in January 2015. In Bulgaria, direct contacts from the Bulgarian Logistics Association were used to complete the questionnaire. In Germany, the questionnaire was e-mailed to industry contacts and distributed through highly frequented expert forums. As a result, we gathered 28 completed questionnaires from Germany and 53 from Bulgaria, which depicts a response rate of 22.22% and 54.64%, respectively. Leading branches from both countries in this survey are logistics/ transport (29.63%), consumer goods and services (13.58%), chemicals and life sciences (11.11%) and electronics and high tech (11.11%). The majority of the German respondents work for large-scale enterprise with more than 500 mEUR revenue per year (42.86%) and more than 1000 employees (60.71%), whereas the largest group of Bulgarian respondents works for small and medium-sized companies with less than 50mEUR revenue per year (69.81%) and less than 100 employees (33.96%). Concerning the hierarchy level within the company, employees or experts without staff responsibilities depict the largest group in Germany (39.29%). By contrast, representatives from the lower and middle management form the largest share of the Bulgarian sample (37.74%). The respondents' distribution among the different functions within the supply chain equals in most cases. In Germany, the majorities can be found in the segments of original equipment manufacturers (OEM), logistics service providers (LSP) and other service providers (IT, HR, finance) (each 25.00%). The segment of LSP is also dominating in Bulgaria (26.42%), the residual sample is nearly equally distributed among second and first tier suppliers, OEMs, wholesalers and retailers. Only other service providers act as an outlier with only one response.

3.3 Relevance of peripheral concepts and need for a supply chain stress concept

To scrutinize the relevance and necessity of supply chain stress as a new concept within the landscape of peripheral management concepts and conditions, the knowledge, the relevance and the application status of four approaches was investigated. Two management concepts and two conditions were selected due to a short analysis on direct title hits on Google Scholar (Status: 2016-11-22), which is summarized in table 3. Supply chain risk management, supply chain resilience, supply chain event management and supply chain flexibility were then considered for further investigation.

Table 3: Direct title hits on Google Scholar (source: scholar.google.com [status: 2016-11-22])

Phrase contained in title	Hits
Supply Chain Risk Management	798
Supply Chain Resilience	275
Supply Chain Event Management	151
Supply Chain Flexibility	373

The knowledge of supply chain risk management is very high in both countries (81.31%), the same applies to the relevance for the respondent's jobs (71.03%). The application of instruments of supply chain risk management is higher in Bulgaria (64.41%) than in Germany (60.42%). This effect accounts also the other three investigated approaches and may be explainable by the higher amount of logistics and traditional supply chain representatives in the sample.

In addition, the coverage of SCM's strategic scope through the selected concepts was investigated. Here, the three factor groups opportunities, trends and threats are framing a holistic picture of SCM. A main finding is that none of these concepts supports every three factor groups. Threats are obviously managed by supply chain risk management (59.81%), opportunities by instruments which can be found in the supply chain flexibility area (66.36%). It seems that instruments of supply chain resilience tend to support none of the factor groups in a significant way. Concerning the cross-country comparison, mainly similar results are delivered. It has to be remarked here that the German results are more conservative than the Bulgarian ones, meaning that Bulgarian professionals provide a larger coverage of the factor groups than the German ones. The detailed coverage percentages for both countries together can be found in table 4.

Table 4: Factor groups supported by the respective SCM concept (n=107, source: own illustration)

Concept which covers the factor group	Opportunities	Trends	Threats
Supply Chain Risk Management	32.71%	23.36%	59.81%
Supply Chain Resilience	32.71%	27.10%	29.91%
Supply Chain Event Management	43.93%	36.45%	18.69%
Supply Chain Flexibility	66.36%	39.25%	17.76%

Besides the fact that none of the given SCM concepts supports all holistic factor groups affecting SCM, 60.42% of all respondents do not know a holistic concept which can solve the sketched issue and therefore require such a concept. However, a country comparison delivers slightly different results. Whereas German respondents moderately require such a concept (43.59%), the Bulgarian respondents definitely identify a need for this (71.93%). This can be explained by the difference in knowledge and skills in Bulgaria compared to the European standard. Nearly one quarter of the German respondents have a concept to holistically manage all factor groups, but in Bulgaria the share of this group is below 10%.

3.4 Analysis of supply chain stress factors and their impact on SCM

27 internal and external supply chain stress factors were derived from literature and are assessed by German and Bulgarian practitioners in different ways. First, the practical relevance of each factor was evaluated using a 5-point rating scale from not relevant up to very relevant. To create a robust result composition, German and Bulgarian results are viewed together from now on. The arithmetic mean for all 27 supply chain stress factors was calculated, the results were sorted in ascending order in figure 2.

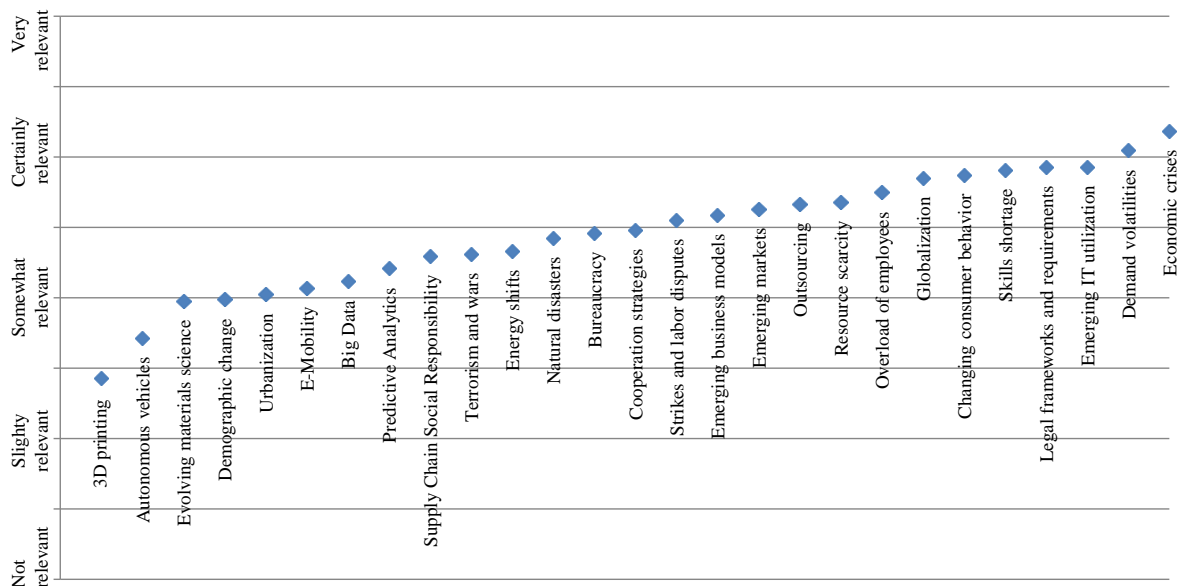


Figure 2: Practical relevance of supply chain stress factors (n=87, source: own illustration)

Second, these supply chain stress factors are assigned to a group of either positive, neutral and negative influences. To create a distinct assignment, the mode from all 27 evaluations is chosen. The assignment of all supply chain stress factors to the relevant stress category is summarized in table 5.

Table 5: Assignment of supply chain stress factors to the stress category according to the mode (source: own illustration)

Positive supply chain stress	Neutral supply chain stress	Negative supply chain stress
Emerging markets	Urbanization	Natural disasters
Globalization	Demographic change	Terrorism and wars
Big Data	Changing consumer behavior	Strikes and labor disputes
Predictive Analytics	Energy shifts	Legal frameworks and requirements
Additive manufacturing/ 3D printing		Resource scarcity
Autonomous vehicles		Economic crises
Evolving materials science		Bureaucracy
Emerging IT utilization		Demand volatilities
E-Mobility		Skills shortage
Outsourcing		Overload of employees
Cooperation strategies		
Supply Chain Social Responsibility		
Emerging business models		

As an alternative to the mode-oriented assignment a cluster analysis combining the arithmetic mean of assignment to the stress category as the first dimension and the relevance of the respective stress factor as the second dimension is proposed. The aim of this analysis is to classify supply chain stress factors according to their practical relevance and positive, neutral or negative tendency. To estimate the amount of clusters, the elbow criterion signals to create three clusters. The Dunn quality measure indicating the cluster separation shows a better value for two (0.33) than for three clusters (0.16). However, Dunn values for three, four and five clusters show no significant difference (Dunn 1974). When applying Davies/ Bouldin quality measure to estimate the cluster configuration, a cluster amount of two (0.66) also shows the best value, but is directly followed by the value calculated from three clusters (0.73). As long as the Davies/ Bouldin measure stays below 1, the cluster configuration can be evaluated as compact and well partitioned (Davies and Bouldin 1979). Three clusters are found using a hierarchical cluster analysis with Euclidean distance in IBM SPSS 22. The results of the cluster process are depicted in figure 3.

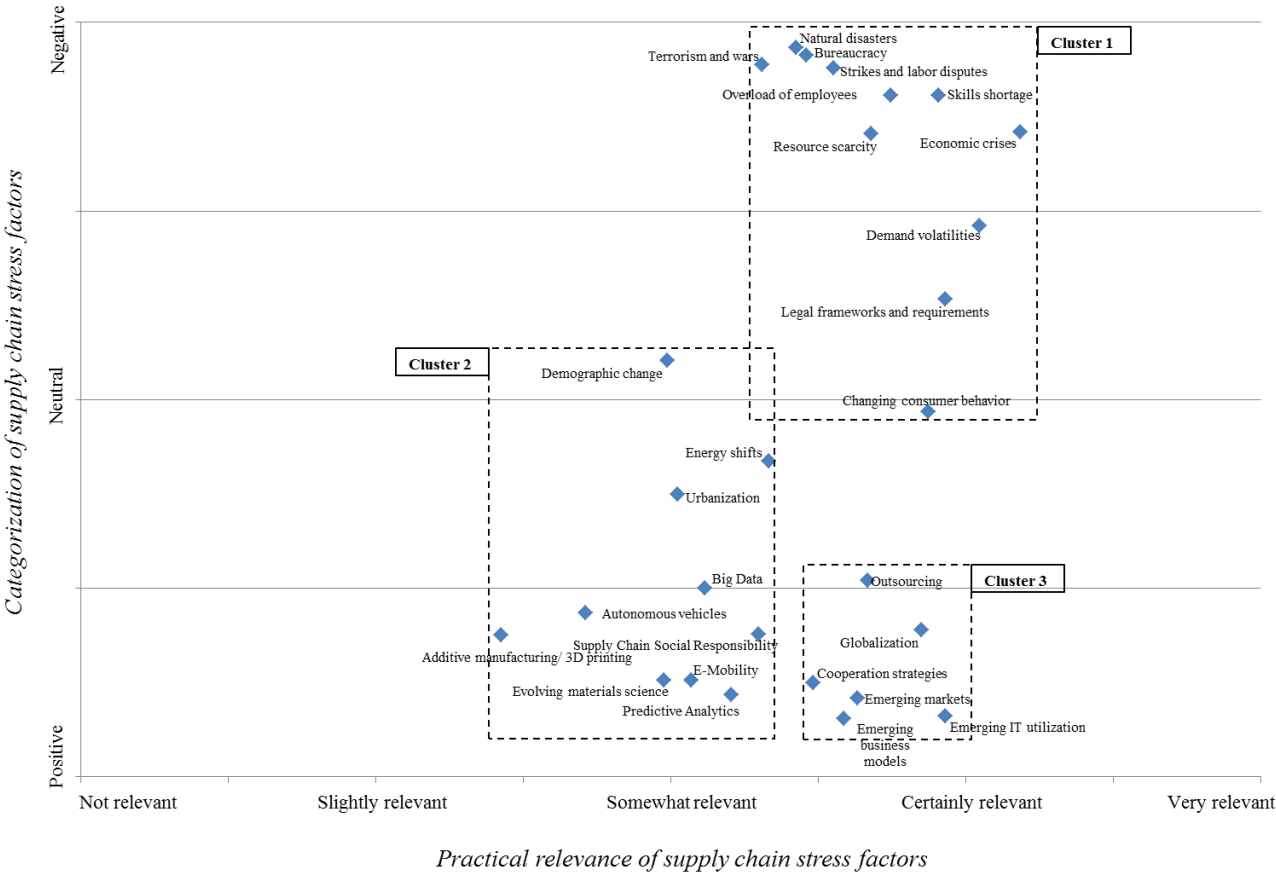


Figure 3: Cluster analysis (n = 81, source: own illustration)

As a third point, the impact of the supply chain stress factors on five generic SCM performance measures is captured. To develop a first overview of the impacts of these factors and not to overburden the respondents, reliability, cost, cycle time, inventory and customer satisfaction as generic but overall significant for supply chain performance measures are selected (Gunasekaran, Patel and Tirtiroglu 2001, 84; Gunasekaran and Kobu 2007, 2835). Here, a 5-point Likert scale was used to assess the impact of each supply chain stress factor on the performance measure from very negative to very positive (Dawes 2008). During the survey, only these respondents who assessed the respective stress factor as certainly or very

relevant were allowed to evaluate the impact on supply chain performance. Therefore, the sample sizes vary from 16 to 64 at each supply chain stress factor. The arithmetic means were calculated for each stress factor impacting each supply chain performance measure and the result is visualized as a spider chart in figure 4.

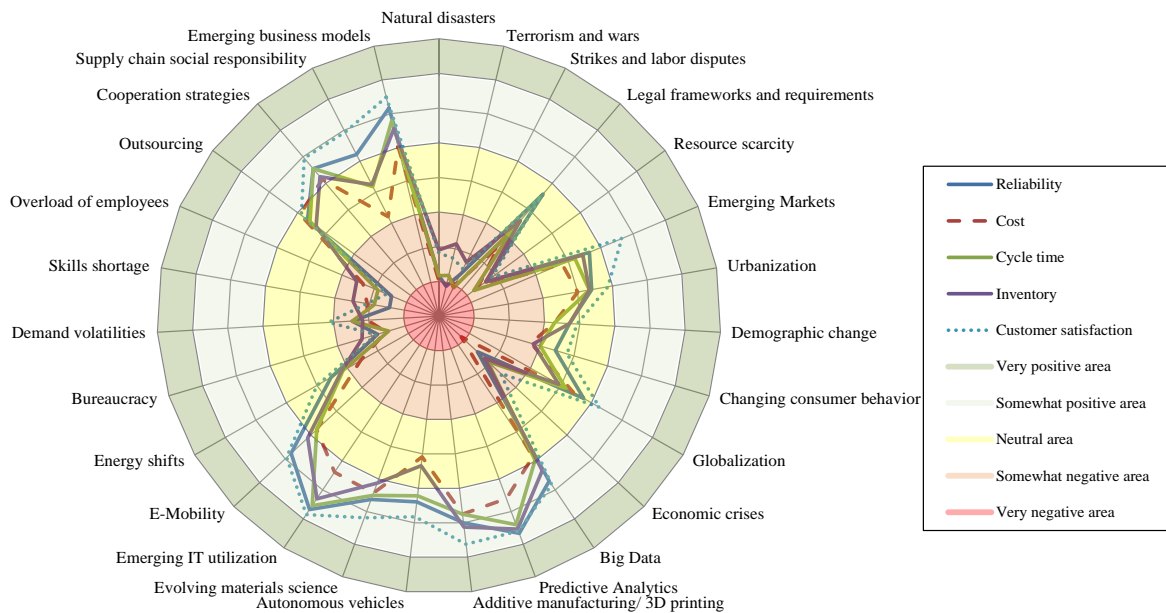


Figure 4: Impact of supply chain stress factors onto supply chain performance (n € [16,64], source: own illustration)

4 Discussion

Most of the given concepts and conditions in the survey are at least known by a majority of respondents in Germany and Bulgaria. Interestingly, there are some deviations between the literature and practical perspective concerning the coverage of opportunities, trends and threats. As supply chain event management is mainly focusing on the minimization of negative consequences of events (Otto 2003, 3), the view out of praxis revealed the opposite. In detail, roughly the half of the respondents evaluate that opportunities are covered by supply chain event management, whereas only one-fifth estimate this for threats. The holistic perspective of supply chain resilience is partly confirmed within the study since the coverage of opportunities and threats are mainly equally distributed. However, this was estimated at a very low level, which can also confirm supply chain resilience as a condition and not as a management concept. Furthermore, supply chain flexibility is, like resilience as well, seen as a condition covering positive and negative facets of influences. Surprisingly, the results of the study show that two-thirds estimate that opportunities are covered by flexibility, but trends and threats do not have the same intensity.

Within a first view at the results one can assume that negative supply chain stress factors are assessed as mostly relevant. However, the assessment of professionals exposed as many positive as negative supply chain stress factors, even with the same degrees of relevance. Furthermore, the presented and assessed stress factors can be classified into three clusters according to the survey results. These clusters also reflect that there is a group of very relevant neutral and negative stress factors (cluster 1) and a strong group of positive and very relevant stress factors (cluster 3). Cluster 2 depicts a group of less relevant stress factors located in the positive and neutral area. Nevertheless, the cluster analysis reveals also a widespread distribution of stress factors which fortifies the need of a holistic concept to manage supply chain stress.

Besides the assignment of supply chain stress factors to the different stress categories, the assessment of the impact of each supply chain stress factor onto supply chain performance delivers other aspects to differentiate these factors. A remarkable finding is that the assessment of the performance measures is driven by a certain content-oriented sensitivity. Basically, all five measures can be located in the same area, but the quantitative or measurable measures like cost and inventory are generally assessed as more negatively affected than qualitative measures like customer service and reliability. In addition, the assessment of how these supply chain stress factors influence the performance of supply chain also corroborate the assignment to the different categories, since negative supply chain stress has a negative impact on supply chain performance and vice versa.

5 Limitations

The paper provides specific knowledge on a quite untreated research field. Nevertheless, several assumptions and subjective assessments had to be done for the paper's purpose.

According to the reduction and pragmatic characteristics of a model that postulates a relevant reduction of features and the usability of a model, the selection of the concepts in the paper's theoretical part does not fully correspond with those in the survey (Kühne 2006, 371). As the survey's target group consists of practitioners who work in supply chain management, the authors decided to limit the number of concepts with the aim of decreasing the survey's complexity. Therefore, the most common theories have been selected in all conscience, but we are aware of the fact that this selection is non-exhaustive.

Technical limitations concerning the survey analysis can be found in the varying sample size of the impact assessment of supply chain stress factors on supply chain performance. Here, a loss of representativeness is detected which needs to be expanded. Nevertheless, the results of this section can be seen as valuable since they are also confirmed by the classification into the stress categories positive, neutral and negative.

6 Conclusion

Ultimately, the fact comes clear that existing investigations on the topic of supply chain influences were mainly done on negative influences, as it is represented in the framework. For that reason, the term supply chain stress encompasses as positive, neutral and negative assessed supply chain influences. Through an analysis of different partly overlapping concepts which describe influences on SCM, its condition and concepts to manage these influences, a need for a holistic perspective on supply chain influences was revealed. Moreover, this need was buttressed by an empirical study in Germany and Bulgaria. The concept of supply chain stress delivers a potential answer to this problem statement as it proposes a classification of supply chain stress factors influencing the supply chain in positive, neutral and negative manners. Different stress factors were derived from literature and assessed by practitioners from both mentioned countries to gather information about their assignment to the stress category, their practical relevance and their impacts on supply chain performance. During the empirical investigation, 13 stress factors are assigned to the positive, 4 to the neutral and 10 to the negative category.

7 Outlook

As the given overview of supply chain stress factors is not exhaustive, the list can be expanded and complemented during further literature reviews, expert interviews or broad surveys. Concerning the assessment within companies or supply chains, the continuous process of evaluating relevant stress factors can be automatized through ERP add-ons or MS Excel-based tools to generate reports and create regular overviews of the current landscape of supply chain stress factors. Furthermore, the presented supply chain stress management concept can be developed further and can therefore be transformed into a management concept comprising detailed strategies and implications. Another interesting research field is the exploration of the impacts of supply chain stress factor onto the performance of a supply chain.

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Appendix: Structure of content-related questions

Management concepts for supply chain influencing factors

- 1) Which of the following concepts do you know? (Multiple answers possible)
 - a) Supply Chain Risk Management
 - b) Supply Chain Resilience
 - c) Supply Chain Event Management
 - d) Supply Chain Flexibility

- 2) Which of the following concepts have been/ are relevant for business and/ or daily work? (Multiple answers possible)
 - a) Supply Chain Risk Management
 - b) Supply Chain Resilience
 - c) Supply Chain Event Management
 - d) Supply Chain Flexibility

- 3) Which of the following concepts have you applied in your business and/ or daily work? (Multiple answers possible)
 - a) Supply Chain Risk Management
 - b) Supply Chain Resilience
 - c) Supply Chain Event Management
 - d) Supply Chain Flexibility

- 4) From your point of view, do the following concepts from question 1) cover the strategic scope of supply chain management? Please estimate whether the respective concept covers the following factors influencing supply chain strategy. (Multiple answers possible)

	Opportunities	Trends	Threats
Supply Chain Risk Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supply Chain Resilience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supply Chain Event Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supply Chain Flexibility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- 5) Do you already know and require a holistic concept to manage opportunities, trends and threats in supply chains?
 - a) I already know a concept, in fact _____.
 - b) I already know a concept, in fact _____, however I do not need it.
 - c) I do not know a concept, but I would need it.
 - d) I do not know a concept and I would not need it.

- 6) (Only if 5a) is selected) Do you plan the usage or do you already use a holistic concept to manage opportunities, trends and threats in supply chains?
 - a) The usage is planned, in fact _____.
 - b) The concept is already in usage, in fact _____.

Supply chain stress

- 1) How would you evaluate the relevance of the following stress factors? (Stress factors as given in table 4)

[stress factor]				
Not relevant	Slightly relevant	Somewhat relevant	Certainly relevant	Very relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- 2) Please assign the factors to the relevant stress categories. (Stress factors as given in table 4)

[stress factor]		
Positive	Neutral	Negative
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- 3) Please estimate its impact on the performance of supply chain. (Stress factors as given in table 4, only accessible if relevance of the respective stress factor is assessed as certainly relevant or higher)

[stress factor]					
	Highly negative	Somewhat negative	Neutral	Somewhat positive	Highly positive
Reliability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cost	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cycle time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inventory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Customer satisfaction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



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