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**Conference Paper**

## Identification of Design Variables for a Supply Chain Risk Management Audit

**Provided in Cooperation with:**

Hamburg University of Technology (TUHH), Institute of Business Logistics and General Management

*Suggested Citation:* Schröder, Meike; Beck, Johannes; Kersten, Wolfgang (2015) : Identification of Design Variables for a Supply Chain Risk Management Audit, In: Kersten, Wolfgang Blecker, Thorsten Ringle, Christian M. 978-3-7375-4059-9 (Ed.): Innovations and Strategies for Logistics and Supply Chains: Technologies, Business Models and Risk Management. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 20, epubli GmbH, Berlin, pp. 479-501

This Version is available at:

<https://hdl.handle.net/10419/209266>

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# **Identification of Design Variables for a Supply Chain Risk Management Audit**



# Identification of Design Variables for a Supply Chain Risk Management Audit

*Meike Schröder, Johannes Beck and Wolfgang Kersten*

Due to an increasing vulnerability in today's supply chains a supply chain risk management (SCRM) system is strongly recommended, especially for companies with a high degree of dependence on supply chain partners. However, as a permanent and effective use of the SCRM system is not only ensured by a successful implementation, an appropriate control mechanism needs to be implemented. Auditing the SCRM system can be such a solution. The main objective of this study is the identification of variables and their possible design related to SCRM systems. Based on an extensive literature review aiming to identify those variables, an empirical study with experts in the field of auditing is carried out. The transmission of the results to the concept of SCRM leads to possible configurations of the variables, both for a general internal SCRM self-audit and an audit focused on small and medium sized enterprises (SME).

**Keywords:** Supply Chain Risk Management, Supply Chain Management, Auditing, SME

## 1 Introduction

Today's enterprises are faced with an ever-stronger competition, increased customer requirements and shorter product lifecycles (Simchi-Levi et al., 2004). Along with an also increasing focus on core competencies, leading to outsourcing of specific operations, supply chains become more and more complex (Christopher, 2011) and result in global supply networks (Christopher and Peck, 2004). These networks and the close collaboration between the supply chain partners not only increase the dependence on each other, but also the vulnerability to risks (Christopher and Peck, 2004; Giunipero and Eltantawy, 2004). Occurring risks may spread throughout the entire supply chain (Jüttner et al., 2003). Especially in the recent past supply chain risks have amplified. Hence, more and more companies focus on handling these risks with an appropriate SCRM system. Nonetheless, implementing and operating such systems is yet not sufficient. To secure the sustainable success of a SCRM system it is advisable to introduce a control mechanism such as an audit.

## 2 Theoretical Background

In this chapter, the necessary theoretical foundations will be discussed. Apart from a brief introduction to SCRM this chapter focuses also on auditing in general.

## 2.1 Supply Chain Risk Management

Time has changed and companies are not standalone and independent business units anymore. Instead these companies focus progressively on their core competencies and become part of a global acting and complex supply chain (Christopher, 2005; Christopher, 2011). Christopher (2011, p. 4) defines a supply chain as “a network of connected and interdependent organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users”. Figure 1 illustrates such a supply chain from the perspective of the focal company.

Increasing resilience in the supply chain results in two factors. First, no longer individual companies but entire supply chains compete with each other. Second, but not less important, that consequently induce to the situation that the individual success depends extremely on the cooperation with the supply chain partners (Christopher and Jüttner, 2000; Lambert, 2008; Christopher, 1998). Due to this changed circumstances companies

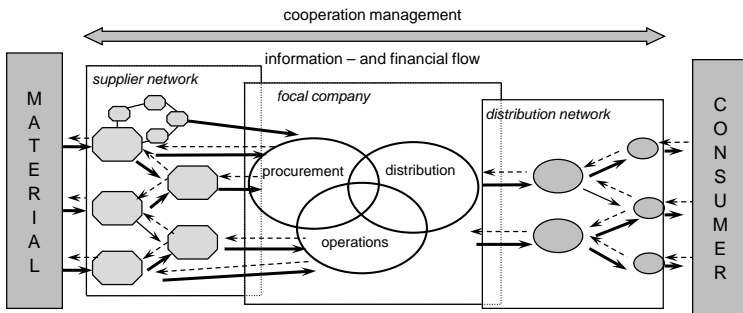


Figure 1 Supply chain structure (Bowersox, 2002)

are no longer only faced with risks from their own business activities but also exposed to risks from the close cooperation with companies in the supply chain. These so-called supply chain risks are described by Kersten et al. (2007) as damage, linked to a probability of occurrence, and concerns several companies at the same time. The reason for that damage could be found within the company, inside the supply chain or the environment. According to Christopher and Peck (2004) figure 2 illustrates a classification of such supply chain risks. Thus, the source of a supply chain risk might be within the focal company itself, in a company that is part of the supply chain or in the environment with a resulting effect on any supply chain partner.

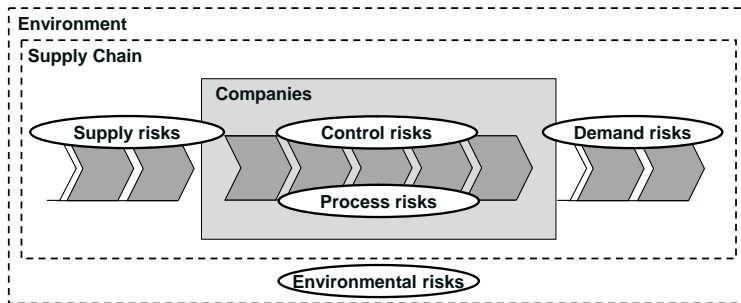


Figure 2 Sources of supply chain risks (modeled after Christopher and Peck, 2004)

## 2.2 Auditing

Initially the concept of auditing was used in the field of business and finance to assess the performance level of a specific object. Later on it was transferred to various other sectors. For a long time an audit used to be only a target-actual comparison, in which the current state of the object is checked against the respective specifications and requirements (Schwarz, 2010). Meanwhile, a more dynamic approach was established as well, which goes beyond the static target-actual comparison but also aims to improve the audited object (Gietl and Lobinger, 2004). Today the most common audit is probably the quality audit which has changed the quality management significantly in the recent years (Wildemann, 2002). Regardless of the field of application audits can be categorized based on two features. Initially the position of the auditor distinguishes between an internal audit (auditor is employed by the audited company) and an external audit (auditor is not employed by the audited company) (DGQ, 2008). In addition the objective of investigation can differ significantly. A process audit aims to investigate a specific process whereas a system audit concentrates on a whole system (e.g. quality system).

According to Neumann (2012) all audits share a common structure and consist of three phases: (1) preparation, (2) realization and (3) tracking.

## 3 Identification of Design Variables

The identification of the design variables follows a three-step process. First, relevant literature was reviewed and identified variables and corresponding characteristics were studied. The second step contains an empirical

study with experts in the field of auditing. Third, in a consolidation the results of the research are summed up and therefore enable a transmission to a possible SCRМ audit.

### 3.1 Literature Review

An extensive literature review provides the basis for further steps. Standards and guidelines for auditing and risk management are considered as an important source for the identification of relevant variables. Furthermore, SCRМ concepts are reviewed. The main goal during the literature review was the identification of the variables, not their specific design. More than 30 sources were analyzed and a total of 16 variables were identified. The theory-based variables can be assigned to – analogously to ISO (2011) – the three phases of an audit: (1) preparation, (2) realization and (3) tracking. Furthermore, they can be classified within the phases based on their content either in organizational, personnel or information and technology (IT) category, as illustrated in table 1.

The variables characterize the development of an audit significantly. E.g. the question concerning the main responsibility for the audit determines the organizational structure of the audit strongly. All other variables are shown and explained in table 2.



Table 1 Theory-based variables assigned to three audit phases

Audit Phase	Organization	Personnel	IT
	main responsibility	audit responsibility	reporting
Preparation	audit organization	audit team	
	audit objective		
	audit policy		
Realization	joint audit vs. single audit		documentation
	audit configuration		I&C technology
	audit criteria		
Tracking	audit methods		
	interface for improvements	performance evaluation of auditors	
	audit scores		

Table 2 Short description of the design variables

Design variable	Description
Main responsibility	Most sources adjudge the main responsibility for the audit to the top management.
Audit organization	Independence and objectivity are essential prerequisites. For that reason it is recommended to establish the audit at an independent unit in the company.
Audit objective	The objective can be diverse: Assessment of compliance with standards or the effectiveness and efficiency. Furthermore the objective may be the finding of potential improvements.
Audit policy	The audit policy defines whether audits are performed regularly or only when necessary.
Joint audit vs. single audit	There is a need to make a decision either the audit should be performed individually as a single audit or together with another audit e.g. quality audit.
Audit configuration	Frequency, scope and focus of the audit need to be clarified.
Audit criteria	The reference base needs to be defined to enable a comparison with the audited object.
Audit methods	Suitable methods regarding other variables must be selected.

Design variable	Description
Interface for improvements	An interface between the results and the object needs to be established to ensure effective improvement.
Audit scores	The audit itself needs to be reviewed to achieve continuous improvement.
Audit responsibility	The decision who will be the auditor (operational audit responsibility) is closely related to the decision if an audit team might make sense. Objectivity and independence are of great importance. Hence, an audit team can fulfill these prerequisites more easily.
Audit team	
Performance evaluation of auditors	To ensure the audit quality a performance evaluation of the auditor(s) is recommendable.
Reporting	An appropriate reporting is essential for the preparation phase.
Documentation	In addition to the results, also roles and responsibilities need to be communicated and documented in an appropriate way.
I&C technology	Necessary Information & Communication technology should be provided to ensure full and confidential communication to all involved parties.

## 3.2 Expert Study

In order to develop a deeper understanding of the practical relevance and the design of the theoretically identified variables a qualitative research design was chosen. This study focuses on the exploration of the relevant variables of an audit and their design in different fields. In particular, obtaining a detailed understanding of the design of these variables aims at enabling a transfer to the SCRM audit. A structured qualitative content analysis is applied which involves the preliminary work from the literature analysis.

### 3.2.1 Approach

The main goal of a qualitative content analysis is to edit and analyze communication material systematically and being able to draw conclusions regarding specific features (Mayring, 2010). In this study the collection of the communication material is part of the research process. By means of semi-structured interviews several experts from different fields were consulted. The selection of the interview partners follows an approach to maximize the contrast by that is ensured a substantiated transfer to the diversified concept of SCRM. Table 3 illustrates the different characteristics of the consulted experts.

Table 3 Characteristics of the consulted experts

Industry	Position	Company size (EE)	Audit field	Type of audit
Rail vehicle construction	Manager strategic sourcing	~ 2700	Quality & supplier	Internal & External
Aviation	Supply chain manager	~ 70000	Quality	Internal & External
Wind energy	Head of quality management	~ 250	Work safety, quality and environment	Internal & External
Consulting	Management consultant	~ 2500	Quality, environment & supplier	Internal & External
Auditing company	Auditor	~ 150	Financial auditing	External

### 3.2.2 Results

The interviews were conducted in September and October 2014 either face-to-face or via telephone with a length between 30 and 60 minutes and transcribed afterwards.

The qualitative content analysis follows the approach of Kuckartz (2014) and consists of 7 phases. During phase 1 the material needs to be read,

marked and commented preliminary for the following steps. Phase 2 aims to develop the main categories, however due to the preliminary work during the literature review most main categories were already identified. Coding starts in phase 3 where text is assigned to the main categories. Phase 4 and 5 includes the consolidation of the coded text by the main categories and if necessary a further diversification or the addition of another main category. The category system is the basis for another complete coding process in phase 6. The material is coded and assigned again and the result is an appropriate matrix and the basis for phase 7 in which the material is analyzed and evaluated. The analysis is category-based and the main focus is to find out which variable has a high practical significance and the different designs of the variables. Based on this information an adaption to the concept of SCRМ seems legitimate.

According to the interview results, all relevant design variables were identified in the preliminary work. Nevertheless the consulted experts noted that the variable I&C Technology is relevant not only for the realization phase but also for the other phases.

Due to a limited amount of space it will be renounced to illustrate every single design of the variables. Instead the most relevant ones will be described briefly. All other design variables are listed in the following tables. There was a general agreement on the design about the variable Responsibility for auditing. All experts have emphasized that the auditor needs to have an overall competence without being able to specify precisely. According to the interviews it is possible to organize the audit very differently.

Table 4 Organizational characteristics during the preparation phase

Phase	Structure	Variable	Characteristics in practice			
		Organizational location (Audit organization)	Auditing as a professional activity	Audit committee	Audit department	Auditing company
Preparation	Organizational	Primary responsibility	Management bears responsibility	Management delegates responsibility		
		Audit policy	Audit program & ad-hoc-audit			
		Audit objective	Target-Actual comparison	Improvement objectives		

Table 5 Personnel and informational characteristics during the preparation phase

Phase	Structure	Variable	Characteristics in practice			
Preparation	Personnel	Responsibility for auditing (Auditor)	Overall competence			
		Audit team	No audit team	Audit team "competencies"	Audit team "complexity"	Audit team "always"
	Informational	Reporting	IT-supported		Personally, verbally	

There was extensive agreement about the audit configuration, too. All experts reported about the need to configure the audit individually. In some cases there might be regulations that influence the configurations but usually the company needs to clarify configuration elements as frequency, scope or focus individually. Furthermore, the interviews showed the broad field of audit criteria. Besides legal regulations, standards, norms or contracts can give clear guidance about criteria. However, in absence of guidelines internal company requirements are the basis for the audit criteria.



Table 6 Characteristics during the realization phase

Phase	Structure	Variable	Characteristics in practice		
Realiza- tion		Audit configuration	Individual audit configuration		
	Organiza- tional	Audit criteria	Legal reg- ulations	Stand- ards, Norms, Contracts	Internal company require- ments
		Audit meth- odology	On-site- methods	Remote audit methods	
	Informa- tional	Docu- men- tary report	Audit results	Audit report	Plan of action

As mentioned before the interviews demonstrated that it is recommendable and state of the art to use I&C technology across all phases. Not only will this encourage the acceptance of the audit in the company, it will also support the improvement process.

Table 7 Characteristics during the tracking and cross phase

Phase	Structure	Variable	Characteristics in practice		
Tracking	Organizational	Interface for improvements	Person mainly responsible	Chief of department	Auditee process
	Personnel	Performance evaluative of auditors	Feedback	Evaluation Grading	
Cross Phase	Informational	I&C technology	Preliminary information exchange	During auditing	Documentary report

To sum up, it can be concluded that the interviews have examined the broad field of auditing.

### 3.3 Transmission of Results

The literature review and the results from the qualitative content analysis enable a transfer to the concept of SCRUM. Nevertheless special features with a direct influence to audit need to be considered. Especially a lack of standards and legal requirements affect the auditing of a SCRUM system. As

a result, a range of individual developed SCRМ projects and systems need to be taken into consideration. Basically companies set up their own system and specify their dealing with risks based on their overall business objectives. For this reason, the design of the variables should be seen as a recommendation, but not as rule.

Table 7 Transferred characteristics to SCRМ

Variable	SCRМ-Audit	SCRМ-Audit in SME
Primary responsibility	Management bears or delegates responsibility	Management bears responsibility
Audit objective	Target-Actual comparison and improvement objectives	
Audit policy	Audit program, ad-hoc-audit	
Audit configuration	Individual configuration of audit	
Audit criteria	Internal company requirements	
Organizational location (Audit organization)	Audit department	Audit committee
Responsible for auditing (Auditor)	Overall process	
Audit team	Expertise, complexity	Expertise, complexity, always

Variable	SCRM-Audit	SCRM-Audit in SME
Audit methodology	On-site-methods	
Documentary report	Audit results, audit report, plan of action	Audit results, plan of action
Reporting	IT-supported, personally, verbally	
Interface for improvements	Person mainly responsible, chief of department	
Performance evaluation of auditors	Feedback	
Information and communication technologies	Preliminary information exchange, during auditing, documentary report	Preliminary information exchange, documentary report

The study with the experts as well as the literature review has shown that the main responsibility for the audit should lie with the executive management. This is, among other reasons, due to the fact that the SCRM follows the objective to secure the company's continued existence. Nevertheless, it is also conceivable to delegate the operational control, e.g. to an existing internal audit function.

The audit objective depends directly and indirectly on several factors. Basically it can be distinguished between a target-actual comparison and an improvement objective. A target-actual comparison requires a desired status, e.g. rules or process procedures. In case of an improvement objective

especially well-funded specialist know-how in the field of SCRM is of great importance. Overall, an individualized audit objective taking into account the circumstances of the company is expedient.

The audit policy distinguishes between an audit program, in which timing and extend of the audit is determined, and ad-hoc audits which are scheduled when required. In general, both forms are useful, cause however possible interactions with other variables. For instance if the main audit objective is an improvement of the SCRM system the integration into an audit program is preferred due to its regularity.

Analyzing the interviews reveals a broad diversification of possible audit criteria. However, the literature review points out the lack of legal requirements or standards in the field of SCRM. Internal company requirements define the desired status and serve as criteria for the SCRM audit.

From the organizational perspective the audit needs to be established either in an auditing division or in an audit committee. This depends very much on the structures in the company. However, independence to the audit object must be retained. An auditing committee which consists of several individuals from different divisions solves the problem of dependence. The selection of the auditor is of great importance. A lack of specialized knowledge in the field of SCRM often prevents a successful implementation. For that reason the auditor should provide specific knowledge in the field of SCRM in order to review a running system. Furthermore, the auditor has to meet the requirements of an overall competence. In circumstances such as none of the employees meet all requirements a compromise has to be made. An audit team ensures more independence to the area and processes to be audited and would solve to the previously mentioned problem.

Another essential factor for success of the audit is an expedient documentation. It is recommendable to not only document the results of the audit but also to carry out a report and a plan for further improvements. This prevents misunderstandings and strengthens both the transparency and the accountability of the audit. The documentation is closely related to the reporting which has a great impact on the audit as well. Especially due to the company-wide influence the reporting should include both personal and electronic reporting. This ensures appropriate feedback on a personal level with a direct link to the audit and the SCRM system itself, but does not exclude any other employees.

The definition of interfaces for improvements is crucial for a long-term success. Besides the person with the main responsibility for the audit it is necessary to involve all SCRM-responsible employees and the department heads.

The interviews as well as the literature review showed that the performance evaluation of auditors is usually organized in the course of feedback sessions. Especially in SMEs it is recommended to carry out a final meeting to provide feedback in order to facilitate further developments.

Information and communication technologies are used in various ways in the field of auditing. Especially systems for information exchange, e.g. SAP, are applied before, while and after auditing. Various information needs to be exchanged between the auditor and the audited persons or divisions, for instance the audit plan or the audit goal. The use of the information systems has the double benefit to track the implementation of improvement activities as well as providing relevant results automatically and company-wide. Since SMEs sometimes lack the use of modern communication and

information technologies the experts pointed out that the use of standard office software or the intranet is expedient as well.

## **4 Conclusions and Opportunities for Further Research**

As mentioned before, SCRM is increasingly important nowadays. Equally to all management systems an effective application is not ensured simply by the implementation, but should be supported by appropriate control mechanisms. An audit is such a control mechanism and by identifying the design variables and their transmission to a SCRM system this work contributes to the development of a standardized approach for a SCRM audit. However, the transfer of the design variables and their configurations are occupied not directly empirically on SCRM. An empirical validation of the transferred configurations on the SCRM audit could therefore represent a next research step.

## **Acknowledgements**

Funding Reference:

The interviews described in this paper were conducted within the IGF-project 18138N of the 'Forschungsvereinigung Bundesvereinigung Logistik e.V.', funded by the German Federal Ministry of Economics and Technology via the Industrial Community of Research and Development (IGF).

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