Towards a Value-based Method for Risk Assessment in Supply Chain Operations

Lingzhe Liu, and Hennie Daniels

ERIM REPORT SERIES *RESEARCH IN MANAGEMENT*	
ERIM Report Series reference number	ERS-2011-014-LIS
Publication	May 2011
Number of pages	3
Persistent paper URL	http://hdl.handle.net/1765/23492
Email address corresponding author	lliu@rsm.nl
Address	Erasmus Research Institute of Management (ERIM) RSM Erasmus University / Erasmus School of Economics Erasmus Universiteit Rotterdam P.O.Box 1738 3000 DR Rotterdam, The Netherlands Phone: + 31 10 408 1182 Fax: + 31 10 408 9640 Email: info@erim.eur.nl Internet: www.erim.eur.nl

Bibliographic data and classifications of all the ERIM reports are also available on the ERIM website: www.erim.eur.nl

ERASMUS **R**ESEARCH **I**NSTITUTE OF **M**ANAGEMENT

REPORT SERIES

RESEARCH IN MANAGEMENT

ABSTRACT AND KEYWORDS	
Abstract	This paper proposes a risk assessment framework as a research road-map, with the aim of developing a protocol that integrates the risk management requirements from the perspectives of the business and the government. We take the viewpoint of value modeling and interpret the risk management problem as a control problem. Four steps of risk assessment are identified in the framework, forming the risk management cycle.
Free Keywords	risk assessment, value modeling, controlling system, auditing
Availability	
Classifications	

Towards a Value-based Method for Risk Assessment in Supply Chain Operations

Lingzhe Liu
Department of Decision and Information Sciences
Rotterdam School of Management
Erasmus University Rotterdam

Hennie Daniels
Department of Information Management
Tilburg School of Economics and Management
Tilburg University

This paper proposes a risk assessment framework as a research road-map, with the aim of developing a protocol that integrates the risk management requirements from the perspectives of the business and the government. We take the viewpoint of value modeling and interpret the risk management problem as a control problem. Four steps of risk assessment are identified in the framework, forming the risk management cycle.
Keywords: risk assessment, value modeling, controlling system, auditing

1 Introduction

The supply chain risk management is emerging to be a new research area, as the market place is becoming more and more globalized and the business is increasingly susceptible to various vulnerabilities, which range from supply chain disruption, organized crime, to terrorists attack. This paper addresses the problem of risk management in supply chain operations from the perspectives of the business and the government, and proposes a research road-map.

On the business perspective, supply chain company is usually affected by the operation of other related organizations in its business network, as its business model has to be built on cooperation with the other organizations. The cooperation is bolstered by *economy reciprocity*, i.e. for all the economy value or value object (service or product) that one organization provide to another, the former organization should get in return an object of equal value (Weigand et al., 2006). Otherwise, at least one party in the exchange run the risk of economy losses and the cooperation is then in-sustainable. This gives rise to the requirements of controlling the value exchange and monitoring the operations in the related organization for managing the operational risks (Kartseva, 2008). Moreover, business operations have to comply with the legal regulations enforced by the government authorities (the change of regulation may also imply business disruption).

On the government perspective, the supply chain-related authorities (like customs, police, and quality inspection agencies) have their specific responsibilities of risk controlling and monitoring by means of inspection and supervision, so as to minimize the potential hazards in the border-crossing supply chain and to ensure the public safety. Meanwhile, they need to maximize the detection hit rate with minimum inspection activities, so that both the inspection costs and the interruption to the normal supply chain operations are minimized.

The distinction in these two objectives of risk management is obvious, but still it would be beneficial to integrate them into the same risk management framework: in that, in either the business-to-business relationship or the business-to-government relationship, one party can have confidence in the counter-party when it is able to monitor the counter-party's operation according to the norm of economy reciprocity and to control (or to coordinate) the counter-party's relevant behavior.

In the case of regulation compliance, mutual trust between the government and the business can be established, when the government has more confidence in the information quality of the declaration from the business, and when its risk assessment behavior is (to certain extend) transparent to the business. In this way, the business would have better cooperation with its business partner and with the government, while the government could be more effective in the inspection tasks.

The risk assessment framework, proposed in this paper, aims at developing such an integrated risk management protocol. We take the viewpoint of value modeling. As the first step, we try to identify the risk sources from a "map" of the supply chain system with the value constellation, value exchange events and processes, and the control mechanism in the system. The risk level of these sources can be further evaluated with certain computation method, like Dempster-Shafer theory and Bayesian Belief Function.

2 Risk Assessment Problem

Given the complexness of the supply chain operations, there has not been an generally agreed definition of supply chain risk management (Sodhi et al., 2011), yet we consider that effective management is based on proper assessment. Supply chain risk management is for the moment interpreted as a control problem in this paper (Leeuw, 1979).

The term *risk* is generally defined as "the effect of uncertainty on an organization's objectives" in the standard ISO 31000:2009. In supply chain operations, risk arises when physical or human factors make it hard to expect whether the execution of activities in transaction cycles deviates from the operation plan.

For analyzing risks in the supply chain system, we are interested in the risk level (or "trustworthiness") of an orga-

nization, i.e. whether the organization under question has enough capability in controlling its operations so that the uncertainty of deviation is contained within certain level. This approach can be used for assessing either an individual organization for itself (internal control) or the supply chain system as a whole (inter-organization control). It is worth noticing that the assessment on the system level may not be as simple as adding up the assessments on those individuals.

We therefore apply auditing theory to the problem, assessing the risk level on three tiers:

1. Primary tier: final conclusion of risk level of the controlled system

2. Secondary tier: the information system and inter-organization system (or, more generally, the controlling system) that provide documentation for the final conclusion

3. Tertiary tier: the value model (or the core business model) that underlies the operation and inter-operation of the information systems in business network

The foundation of the risk assessment is on the tertiary tier, because there lies the value constellation and value flow in the system, which are the objectives we want to protect from risks.

Following the control theory (Hulstijn & Gordijn, 2010) and auditing theory, we consider the risk analysis to consist of two situations: 1) the ideal situation in which the system should execute, the "*To Be*" mode; 2) the situation in which the system has actually executed or can potentially execute, the "*As Is*" mode. The differences between these two modes are the sources of risk.

3 Value-based Method

ISO 31000:2009 gives a guideline of risk management process: risk identification, analysis, evaluation, and treatment. The risk assessment framework discussed in Section 1 shall follow the guideline and adjust it for the application in the supply chain management context (see Figure 1).

The four steps in the framework form the risk management cycle.

Value Modeling step (corresponding to the tertiary tier assessment in Section 2) analyze the value proposition of and the value exchange between the member organizations in a supply chain. The value exchange transactions should be properly documented (see e.g. Hall, 2008). REA (McCarthy, 1982) and e3-value(Gordijn & Akkermans, 2003) are two languages for the modeling.

In the second step, *Process Analysis*, we analyze the "To Be" and "As Is" modes of the transaction processes (secondary tier assessment). For analyzing the human factors like frauds or operating errors, the computation auditing approach (Elsas, 1996) is applied to discover the scenarios of value leakage, in which value can be extracted from the system without being documented. For analyzing the cause and effect, we apply the Event/Fault Tree Analysis in combination with Event-Process Chain (Davis & Brabnder, 2007) to assess the risk impact and its propaganda in the system.

The third step *Uncertainty Estimation* estimates the likelihood of a specific risk to take effect and forms the final

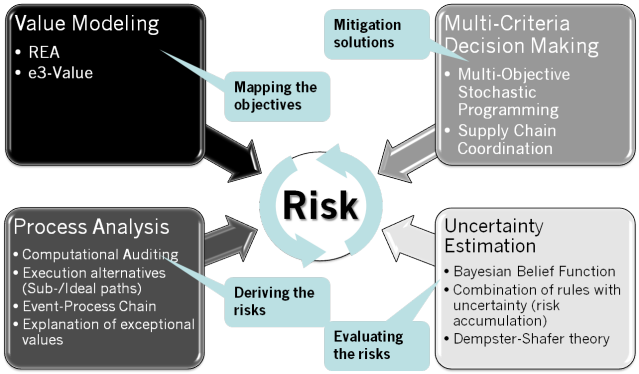

Figure 1. Risk Assessment and Management Framework

opinion of the risk level (primary tier assessment). The estimation can be derived either objectively from statistics of a set of sample data, or subjectively from opinions of domain expert, or both. Here, Dempster-Shafer theory is applicable for synthesizing the objective and subjective estimations.

The last step *Multi-Criteria Decision Making* is a decision making and treatment process that designs a risk mitigation solution, given the risk models derived from the above analysis. As the supply chain risk management problem considers multi-parties operations with uncertainty, methods like multi-objective stochastic programming are needed to coordinate different interests and to optimize the system performance. In case that the mitigation solution re-engineers the value model, it triggers a new round of the risk management cycle.

4 Conclusion

This paper proposes a road-map of future research in risk assessment in supply chain. Supply chain companies and the supervising government authorities have different perspectives of risk assessment, and it is expected that an integrated risk assessment method bears collateral benefits. We interpret the risk level of an organization with its capability in controlling its operations against uncertainty, and propose to assess the risk level on three tiers with a framework of methods in four steps. The framework is still a general conceptual road-map, serving as a guideline for future research. Much work has to be done to make it practically applicable to real world business.

References

Davis, R., & Brabnder, E. (2007). *Aris design platform: Getting started with bpm* (1st ed.). Springer Publishing Company, Incorporated.

Elsas, P. I. (1996). *Computational auditing*. Unpublished doctoral dissertation, Vrije Universiteit te Amsterdam, Amsterdam.

Gordijn, J., & Akkermans, J. (2003). Value-based requirements engineering: exploring innovative e-commerce ideas. *Requirements Engineering*, *8*, 114-134. Available from `http://dx.doi.org/10.1007/s00766-003-0169-x` (10.1007/s00766-003-0169-x)

Hall, J. A. (2008). *Accounting information systems* (6th ed.). St. Paul, MN, USA: West Publishing Co.

Hulstijn, J., & Gordijn, J. (2010). Risk analysis for inter-organizational controls. In J. Filipe & J. Cordeiro (Eds.), *Proceedings of the 12th international conference on enterprise information systems (iceis 2010)* (Vol. 3, p. 314-320).

Kartseva, V. (2008). *Designing controls for network organizations: A value-based approach*. Unpublished doctoral dissertation, Vrije Universiteit Amsterdam. (Research Series 422)

Leeuw, d. A. (1979). The control paradigm as an aid for understanding and designing organizations. In *Progress in cybernetics and systems research* (Vol. Vol. 5, p. 93-100). Hemisphere. Available from `http://repository.tue.nl/334375`

McCarthy, W. E. (1982). The rea accounting model: A generalized framework for accounting systems in a shared data environment. *The Accounting Review*, *57*(3), pp. 554-578. Available from `http://www.jstor.org/stable/246878`

Sodhi, M. S., Son, B.-G., & Tang, C. S. (2011). Researchers perspectives on supply chain risk management [Accepted Paper Series]. *Production and Operations Management, Forthcoming*.

Weigand, H., Johannesson, P., Andersson, B., Bergholtz, M., Edirisuriya, A., & Ilayperuma, T. (2006). On the notion of value object. In E. Dubois & K. Pohl (Eds.), *Advanced information systems engineering* (Vol. 4001, p. 321-335). Springer Berlin / Heidelberg.

Publications in the Report Series Research* in Management

ERIM Research Program: "Business Processes, Logistics and Information Systems"

2011

Sequencing Heuristics for Storing and Retrieving Unit Loads in 3D Compact Automated Warehousing Systems
Yugang Yu and René B.M. De Koster
ERS-2011-003-LIS
http://hdl.handle.net/1765/22722

A Local Search Algorithm for Clustering in Software as a Service Networks
Jelmer P. van der Gaast, Cornelius A. Rietveld, Adriana F. Gabor, and Yingqian Zhang
ERS-2011-004-LIS
http://hdl.handle.net/1765/22723

Implementing Standardization Education at the National Level
Henk J. de Vries
ERS-2011-007-LIS
http://hdl.handle.net/1765/22812

The Power Trading Agent Competition
Wolfgang Ketter, John Collins, Prashant Reddy, and Christoph Flath
ERS-2011-011-LIS
http://hdl.handle.net/1765/23263

Real-time Tactical and Strategic Sales Management for Intelligent Agents Guided By Economic Regimes
Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta , and Paul Schrater
ERS-2011-012-LIS
http://hdl.handle.net/1765/23339

Knowledge Sharing in Non-Knowledge Intensive Organizations: When Social Networks do not Matter?
Joey van der Capellen, Otto Koppius, and Koen Dittrich
ERS-2011-013-LIS
http://hdl.handle.net/1765/23489

Towards a Value-based Method for Risk Assessment in Supply Chain Operations
Lingzhe Liu, and Hennie Daniels
ERS-2011-014-LIS
http://hdl.handle.net/1765/23492

---

* A complete overview of the ERIM Report Series Research in Management:
https://ep.eur.nl/handle/1765/1

ERIM Research Programs:
LIS Business Processes, Logistics and Information Systems
ORG Organizing for Performance
MKT Marketing
F&A Finance and Accounting
STR Strategy and Entrepreneurship