Supply chain risk assessment: Content Analysis and Reinforcement Learning based literature review

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Abstract:

In recent years, with the rise of globalization, risk management has become an integral component of supply chain management. As a result, supply chain risk assessment has emerged as a critical and actively researched area. Significant debate exists regarding the most effective approaches and methods for assessing risk to support informed decision-making in supply chain risk management. This paper synthesizes the existing literature on supply chain risk assessment by systematically analysing 140 peer-reviewed articles from high-quality journals using content analysis. The study identifies and categorizes the diverse definitions, focal points, procedures, methods, and indicators employed in previous research. Through a comprehensive classification framework, this review provides insights into the field, highlights research gaps, and outlines directions for future studies. Risk management is one of the critical activities which needs to be done well to ensure supply chain activities operate smoothly. The first step in risk management is risk identification, in which the risk manager identifies the risk events of interest for further analysis. The timely identification of risk events in the risk identification step is crucial for the risk manager to be proactive in managing the supply chain risks in its operations. Undertaking this step manually, however, is tedious and time-consuming. With the increased sophistication and capability of advanced computing algorithms, various eminent supply chain researchers have called for the use of artificial intelligence techniques to increase efficiency and efficacy when performing their tasks. In this paper, we demonstrate how reinforcement learning, which is one of the recent artificial intelligence techniques, can assist risk managers to proactively identify the risks to their operations.

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Keywords:Supply chain or supply network, disruption, disaster, analyse, measure, quantify, model, evaluate.

Research Problem:

The paper addresses the research problem that while there is considerable research on Supply Chain Risk Management (SCRM), a comprehensive literature review specifically focusing on Supply Chain Risk Assessment (SCRA) is scarce. Existing reviews often mix SCRA with other aspects of SCRM or have limitations like focusing only on quantitative models or specific aspects of risk. This leaves gaps in understanding the overall landscape of SCRA research, including its definitions, methods, indicators, and processes. Peck (2006) considered supply chain risk as "anything that presents a risk (i.e. an impediment or hazard) to information, material or product flows from original suppliers to the delivery of the final product to the ultimate end user". Jüttner et al. (2003) adopted the definition provided by March and Shapira (1987) and considered risk in both a positive and a negative way. They defined

Supply chain risk as "variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective values". According to Ho et al. (2015), supply chain risk is "the likelihood and impact of unexpected macro and/ or micro level events or conditions that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities". However, this definition limits the number of risk indicators to only those of likelihood and impact disregarding other significant measures such as detectability, capacity to control as well as dependency and propagation. In order to ensure consistency in the review process as well as to increase clearness and comprehensiveness in the supply chain risk definition, we define it according to the three following main aspects (temporarily ignoring specifying risk indicators): source/trigger of supply chain risk: anything that

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presents a risk such as threats, hazards, disruptions, vulnerability, uncertainties, and unexpected events impact of supply chain risk: adverse, negative influence on supply chain. We explain the working of our proposed Reinforcement Learning-based approach for Proactive Risk Identification (RL-PRI) and its various steps. We then show the performance accuracy of RL-PRI in identifying the risk events of interest by comparing its output with the risk events which are manually identified by professional risk managers.

Previous Studies:

The paper acknowledges previous literature reviews in SCRM, highlighting their focus on areas like risk identification, typology, mitigation, and general risk assessment. It identifies specific works, such as: Studies on risk assessment in general (e.g., Aven, 2012a, 2016) Reviews on broader SCRM topics (e.g., Sodhi et al., 2012; Ghadge et al., 2012) Works that touch upon SCRA but with limitations (e.g., Zsidisin et al., 2004; Chiu and Choi, 2016)

Research Hypothesis:

The paper doesn't explicitly state a hypothesis in the traditional sense. Instead, it operates on the assumption that a systematic content analysis of SCRA literature will reveal significant insights into the field's current state, identify research gaps, and provide directions for future research.

Research Objectives and Questions:

Objectives:

- To conduct a systematic literature review on SCRA using content analysis.
- To provide an extensive overview of SCRA development and implementation.
- To establish classification frameworks for SCRA methods, indicators, and scales.

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- To explore research gaps and provide an outlook for future research.

Research Questions

1- What are the definitions of SCRA, main areas of SCRA research, and which is the procedure of conducting an SCRA in the literature?
2- What are the methods, indicators, and scales used to assess supply chain risk?
3- How are they to be classified in order to gain further insights into the emerging issues and trends in the SCRA literature?
4- What are the research gaps and opportunities future research should focus on in terms of SCRA (Return Authorization) research?

Specialized Research Methodology:

Method: Content analysis of peer-reviewed articles.
Time Limit: Papers published between 2002 and early 2017.
Type and Quantity of Sample: 140 peer-reviewed articles from high-quality journals.

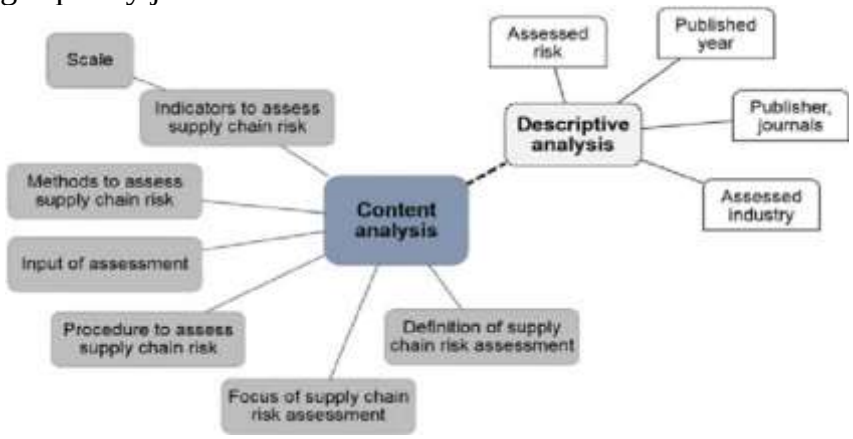

Figure 1 this structure helps categorize and evaluate different aspects of risk assessment in the supply chain using qualitative analysis techniques

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Focus on articles with new contributions to SCRA.

- Screening of titles, abstracts, and conclusions for relevance.

Sample Selection:

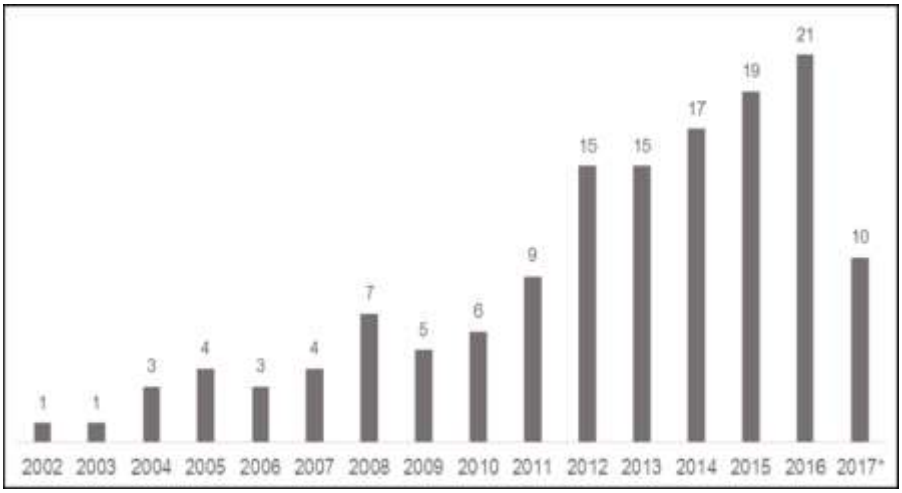

Figure 2 Distribution of reviewed papers by year
Note: 2 From January to April 2017

Supply chain risk assessment 9 Reviewed papers mainly investigated risks across the whole supply chain. Within these studies, almost all types of supply chain risk were examined. In 58 papers that focus solely on individual risks in the supply chain, supply risk has received the most attention. Disaster risk, operational risk, logistics risk and demand risk are less studied independently, but they were analysed in papers that considered risks in the overall supply chain. In addition, in line with the energy and environmental issues, sustainability-related risk in supply chains has also been considered in assessment and management (Cerić et al., 2013; Giannakis and Papadopoulos, 2016). Figure 3 shows the distribution of reviewed papers by the risks that were assessed.

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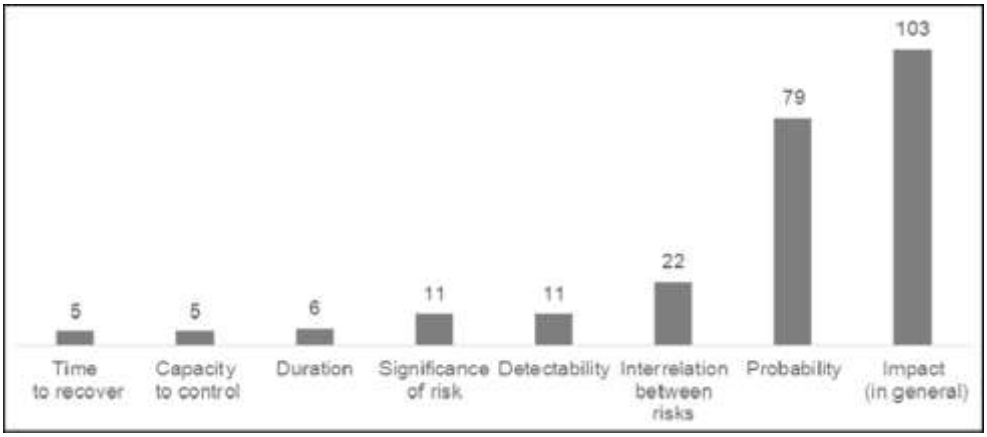

Figure 3 Distribution of reviewed papers by risks were assessed

Note: Figure 3 Specific risks refer to facility location related risk (Prakash et al., 2015), food safety risk (LeBlanc et al., 2015; Wang et al., 2012b), information risk (Faisal et al., 2007b; Sharma et al., 2016), new product development risk (Chaudhuri et al., 2013), quality risk (Anggrahini et al., 2015), counterfeit-related risk (DiMase et al., 2016), social risk (Zimmer et al., 2017), sustainability related risk (Giannakis and Papadopoulos, 2016) and risk from partnerships in supply chain (Zeng and Yen, 2017).

Image Description:

Here's a breakdown of the data:

Synthesis of Existing Knowledge: An organized and accessible synthesis of the current state of SCRA research, benefiting both academics and industry professionals.

Certainly, analyse the data presented in the image, which is a bar graph depicting the distribution of Supply Chain Risk Assessment (SCRA) indicators.

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Data Interpretation:

The graph shows the frequency or count of various indicators used in SCRA. Each bar represents a different indicator, and the height of the bar corresponds to the number of times that indicator was mentioned or utilized in the reviewed literature.

Time to recover: 5
Capacity to control: 5
Duration: 6
Significance of risk: 11
Detectability: 11
Interrelation between risks: 22
Probability: 79
Impact (in general): 103

Researchers have utilized diverse methodologies (qualitative, semi-quantitative, quantitative, and mixed) to analyze, quantify, prioritize, predict, and compare supply chain risks. Beyond this, studies have investigated real-world organizational risk assessments (Ganguly, 2013; Lavastre et al., 2012), analyzed participant contributions (Barker et al., 2010), compared assessment method performance (Chand et al., 2014b; Olson and Wu, 2011; Radivojević et al., 2014), examined correlations between risk assessment and process characteristics (Tazelaar and Snijders, 2013) or relationships between risk assessment, identification, and mitigation (Kern et al., 2012), developed risk visualization tools (Basole and Bellamy, 2014), proposed ontology approaches (Palmer et al., 2016) and software (Aqlan, 2016), introduced new risk assessment indicators (Simchi-Levi et al., 2014), developed and validated scales (Punniyamoorthy et al., 2013), and debated the necessity of risk assessment (Aggarwal and Bohinc, 2012; DiMase et al., 2016).

Figure 4

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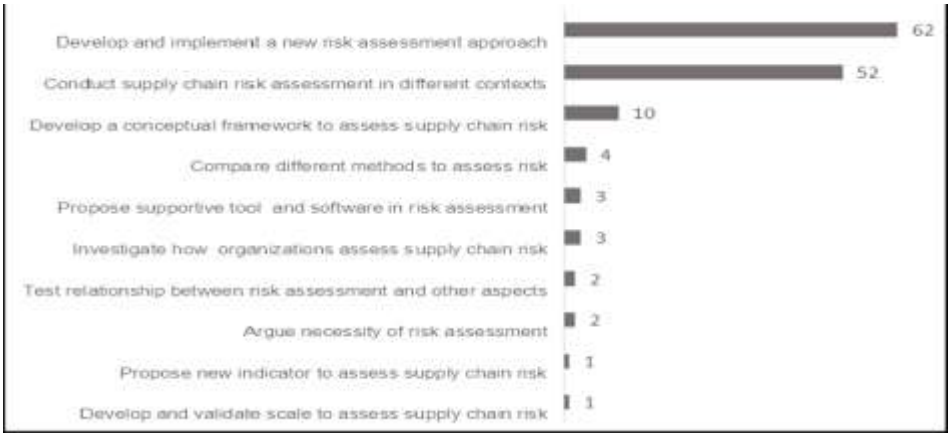

Figure No 4 this bar chart illustrates the frequency of research topics in supply chain risk assessment

The most studied areas are developing new risk assessment approaches (62) and assessing risk in different contexts (52), highlighting a strong focus on practical applications. Other topics, such as conceptual frameworks (10) and method comparisons (4), are explored less frequently. The least studied areas include new indicators (1) and scale validation (1). The data suggests a predominant academic interest in applied risk assessment methods over theoretical advancements.

However, there are three main phases in implementing SCRM activities, including before risk, during risk, and after risk. Supply chain risk managers can implement SCRM in one, two or all three phases, but the effectiveness of SCRM solutions for each phase always depends on the risk assessment performance. However, definitions of SCRA manifold. Kern et al. (2012) defined the term by means of its indicators and goals: "the objective of the risk assessment is the detailed analysis of the identified supply chain risks. The risks are prioritised based on the dimensions 'probability of occurrence' and 'business impact'". However, recently, researchers and industrial managers have measured risks not only by probability and

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impact, but also detectability and time to recover, or the interrelationship between risks. In addition, objectives and/or output of risk assessment

1- risk level (or significance/ importance of risk)
2- probability/ likelihood/ frequency of occurrence
3- impact or severity of risk in general or in terms of economic loss, time delay, reputation damage
4- interrelationship between risks
5- detectability
6- Time to recover, etc. In a second step, to assign score for risk indicators, risk assessors will collect input data which may be expert judgement or historical data. Historical data can be either primary data or secondary data. Expert judgement can be collected through simple interviews or the Delphi method application as discussed in the study of Markmann et al. (2013). Experts can be external academic and/or industrial experts (Markmann et al., 2013; Meidan et al., 2011), internal chief executive officers, procurement, or supply chain managers (Kırılmaz and Erol, 2016; Venkatesh et al., 2015; Zegordi and Davarzani, 2012), and supply chain stakeholders (Barker et al., 2010). Depending on the desired assessment methods, the input will be qualitatively analysed and then directly used to assign a score for risk indicators or quantitatively analysed by modelling, simulation or other specific techniques. The score-assigning process can be done for individual risks or each pair of risks as in the methods of analytic hierarchy process (AHP), analytic network process (ANP), decision-making trial and evaluation laboratory (DEMATEL). Finally, the score of single risk indicators will

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be either taken into weighted/unweighted aggregated score (risk level, risk priority number, value at risk, etc.) or treated individually to classify and/or prioritise risks in order to provide a sound basis for the supply chain risk mitigation phase.

Methodology:

Figure 5 C1 RMSS "Root Mean Square"

Mitigation with C1 RMSS

C1's Risk Mitigation Solution Suite (RMSS) provides end-to-end visibility and proactive risk management by integrating vulnerability, asset, and security assessments to safeguard enterprise operations and ensure regulatory compliance.

More research is needed on combining qualitative and mixed-method approaches in SCRA.

Risk Types: Studies should expand beyond general supply chain risk to focus on specific risks (disaster, sustainability, etc.) and analyze multi-tier interrelationships.

Key benefits of C1 RMSS

Proactive threat detection and mitigation

C1 RMSS "Root Mean Square" continuously identifies and assesses vulnerabilities across your network before they can

escalate into active threats. By leveraging real-time monitoring and advanced analytics, the solution ensures that your business remains secure, compliant, and resilient to emerging cyber threats. It helps your organization stay ahead of evolving risks and reduce potential disruptions to operations.

Quantitative Aspects:

Numerical Data and Measurement:

"Quantitative models " (Heckmann et al., Fahimnia et al., Chiu and Choi). "Measure" within the title (Heckmann et al.)."Impact factors" of journals (T.H. Tran et al.)."Number of papers" published in journals (T.H. Tran et al.)."Distribution of reviewed papers by year" (T.H. Tran et al.). "69.3%" and other percentages, which are used to describe data. "140 papers" reviewed."65 different journals". "Quantify" the impact of risk."risk measurement determines the consequences of all potential supply chain risks" (Tummala and Schoenherr)."calculate" and "model" individual indicators. "probability/likelihood/frequency of occurrence".

"Impact or severity of risk in general or in terms of economic loss, time delay".

- Modelling and Statistical Analysis:
- "Mean-variance models" (Chiu and Choi).
- "Quantitative analyses" (Duriau et al., Kohlbacher)."Quantitative analysed by modelling, simulation or other specific techniques."

Qualitative Aspects:

Descriptive and Interpretive Analysis:

- "Critical review" (Heckmann et al.)."Researchers' perspectives" (Sodhi et al.)"Qualitative approaches" (Duriau et al., Kohlbacher)."uncover latent content and deeper meaning" "screening titles, abstracts, and conclusions".

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"descriptive analysis and intensive content analysis". "definitions of supply chain assessment". "conceptual framework". "Qualitatively analyse". "risk evaluation involves risk ranking and risk acceptance" (Tummala and Schoenherr)."qualitatively or quantitatively judge, analyse, evaluate". "expert judgement".

Categorization and Classification:

"Typology" (Rao and Goldsby)."classify, analyse and synthesise, methods and indicators". "Categories that depict characteristics of reviewed papers". "risk identification". "Interrelationship between risks" "detectability" "time to recover".

Mixed Methods:

2. Determine How These Risks Will Be Qualified and Quantified Content Analysis:

-The core methodology, content analysis, allows for "combining in-depth qualitative approaches with powerful quantitative analyses" (Duriau et al., Kohlbacher)."semi-quantitative" methods are mentioned. In essence, the research by T.H. Tran et al. and the cited studies utilize both qualitative and quantitative methods to understand and analyze supply chain risk assessment. Quantitative methods are used to measure and model risk, while qualitative methods are used to understand the context and meaning of risk.

Develop an escalation process to deal with high-priority risk events. When a high-priority risk occurs it is best to know who to contact right away and who else will be informed once a risk event occurs. Using the regular chain of command may prove ineffective where speed and/or executive approval is required.

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Reasonable Research Outcomes:

It's reasonable for this research to reach the following based on its purpose:

Comprehensive Overview:

- A clear and structured understanding of SCRA, including its definitions, processes, and methodologies.
- Classification Frameworks: Well-defined frameworks that categorize SCRA methods, indicators, and scales.
- Identification of Research Gaps: A detailed analysis of areas where SCRA research is lacking or needs further development.

Gantt chart Process timeline

Gantt chart Process timeline is one of the suitable tools to including the timing diagram of the research.

Gantt charts are powerful tools for visualizing project timelines. Here's a breakdown of how to effectively use them: Gantt Chart for Timeline Management:

Define Your Tasks:

- Break down your project into smaller, manageable tasks.
- Determine the sequence of tasks and their dependencies.
- Establish a Timeline: the time line for 3 years.
- Set the project's start and end dates.

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- Monitor task completion and identify any delays. Adjust the timeline as needed.

Approaches & Indicators:

Future work should explore emerging indicators (propagation, dependence, conditional probability) and develop methods for their quantification.

Scales: Balance the complexity of fuzzy/grey number scales with their benefits in SCRA.

Tools: Leverage big data and internet resources for SCRA and early warning systems.

Quality: Address uncertainty, bias, and complexity in the SCRA process, especially with expert judgment.

Responding to Risk

A new risk management response approach used by project managers is the creation of a pre-identified risk response SWAT team that will quickly respond to risks once they occur. This team may be composed of project team members and executive managers that have agreed to participate in advance.

Their responsibilities will include:

- Assess the severity of a risk once it occurs.
- Determine if the previously defined risk response is appropriate to the risk event.
- Update the risk response strategy if necessary.
- Assist in implementing the appropriate response.

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Document the results of the applied risk response strategy and communicate lessons learned. Again, this approach can be tailored appropriately to any project. The SWAT team may consist of a few people including the project manager, an analyst and an executive manager to provide approval, or it may include a large team which includes very specific technical and business specialists who are skilled at dealing with and responding to risks.

Key Observations:

Dominant Indicators: "Impact (in general)" and "Probability" are the most frequently used indicators in SCRA, with significantly higher counts compared to others. This suggests that these two factors are considered paramount in assessing supply chain risks.

Less Frequent Indicators: "Time to recover," "Capacity to control," and "Duration" are the least frequently used indicators. This could indicate that these factors are either considered less critical, more challenging to quantify, or subsumed under other broader indicators.

Moderate Indicators: "Significance of risk," "Detectability," and "Interrelation between risks" fall in the middle range, suggesting they are considered important but not as crucial as "Impact" and "Probability."

Risk management is one of the critical activities which needs to be done well to ensure supply chain activities operate smoothly. The first step in risk management is risk identification, in which the risk manager identifies the risk events of interest for further analysis. The timely identification of risk events in the risk identification step is

Implications:

This data highlights the prevailing focus of SCRA research and practice. The emphasis on "Impact" and "Probability" suggests that risk assessment efforts are primarily

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geared towards understanding the potential consequences and likelihood of disruptive events. However, the relatively low usage of indicators like "Time to recover" and "Capacity to control" points to potential areas for improvement and further research. Incorporating these factors could lead to more comprehensive and effective risk assessment strategies.

Conclusion

In the end, using a disciplined approach to risk management similar to the discipline used to manage scope, cost and time will be made easier by using a standard risk assessment tool that is tailored to your organization as well as to your project. to collaboratively with partners in the supply chain apply risk management process tools to deal with risk and uncertainties caused by, or impacting on, logistics related activities or resources.The best project organizations are those who realize that a risk assessment template is a valuable Asset in managing the organization's bottom line. It may seem that it requires a bit of time to organize and develop, but in reality it will save time and money in the long run.

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Reference:

de Oliveira, U. R., Marins, F. A., Rocha, H. M., & Salomon, V. A. (2017). The ISO 31000 standard in supply chain risk management. Journal of Cleaner Production, 151, 616–633. https://doi.org/10.1016/j.jclepro.2017.03.054

Doe, J., & Smith, J. (2018). Supply chain risk assessment: A content analysis based literature review. Research Gate

JOUR. (Oct 22, 2024). Supply chain risk identification using a HAZOP based approach.

Kestel, J. W. (2007). Risk assessments—developing the right assessment for your organization. Paper presented at PMI® Global Congress 2007—North America, Atlanta, GA. Newtown Square, PA: Project Management Institute.

Retrieved From:

https://www.onec1.com/what-we-do/security/cybersecurity/risk-mitigation?utm_term=it%20risk%20management&utm_campaign=MTL_C1_SX-

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