Proposal of Risk Mapping Method for Risk Chains

Kazuhiko Kato[1], Daisuke Iwasaki[2], Toshiyuki Horiuchi[1]
1 Faculty of Social Systems Science, Chiba Institute of Technology, Chiba, Japan, 2750016
2 Graduate School of Social Systems Science, Chiba Institute of Technology, Chiba, Japan, 2750016
(E-mail: kato@sky.it-chiba.ac.jp, s0642023ZV@it-chiba.ac.jp, horiuchi.toshiyuki@it-chiba.ac.jp)

Abstract: Risk events that begin with a series of risks of small-scale damage but lead to ones of large-scale damage are of great concern. Risk chains are generally not recognized to be a cause of such risk events, which can lead to improper decision making concerning initial responses. Focusing on the process of risk chains has been described as an effective method of risk chain management. From that viewpoint, performing a visualization of risks and their linked relationships should prove effective for managing risk chains. Visualization of risk chains is made possible by introducing two new steps into the traditional process of risk mapping: "Identification of risk chains" and "Visualization of risk chains." This makes it possible to recognize risk chains from the risk map, and should allow management to take risk chains into consideration.
Key words: Risk chain; Risk map; Enterprise risk management; Internal control

1 Introduction

Risk events that begin with a series of risks of small-scale damage but lead to ones of large-scale damage are of great concern. Accompanying increased diversification and speed of communication methods, we have seen an increasing number of cases where incidents of little risk to the enterprise were communicated to the public and, in a short span of time, resulted in enormous damage to the company. Risk chains are generally not recognized to be a cause of such risk events, which can lead to improper decision making concerning initial responses. In a typical risk assessment, risk is determined through identifying assets and then by analyzing the threats to and vulnerabilities of each asset. Between risks, however, there exists a chained risk relationship by which the exposure of one can lead to the exposure of the other. Furthermore, there are risk chain situations in which intermediate events occurring on the path to risk exposure can branch into new risks. When risk exposure is chained, there is the potential for enormous damage to the organization. Therefore, in order to appropriately control risk, it is necessary to analyze relationships within risk chains. However, no mechanism for systematically analyzing the complex relationships within such chains has been established. Focusing on the process of risk chains has been described as an effective method of risk chain management. From that viewpoint, performing a visualization of risks and their linked relationships should prove effective for managing risk chains.

We therefore consider the creation of a risk map that takes into account links between risks to be effective, and to that end propose a process for creating such risk maps. We also propose a method of application for the process, and will perform research with the goal of making possible risk management that takes risk chains into account. It is assumed that the definition of risk chains with this paper is a risk triggered by the other risk.

Visualization of risk chains is made possible by introducing two new steps into the traditional process of risk mapping: "Identification of risk chains" and "Visualization of risk chains." This makes it possible to recognize risk chains from the risk map, and should allow management to take risk chains into consideration.

2 Problem of Risk Chain

A risk chain is represented by a model such as that shown in Figure 1. The following is a description of the elements found within Figure 1:

(1) Culminating event

An event that is directly triggered by a single or multiple other events as part of a series of events within the risk model

(2) Fundamental causes of risk occurrence

For a given culminating event, a minimum unit of cause of the culminating event, as identified through expansion and stratification using tree analysis of the failure

(3) Intermediate event

During the process of expansion of the culminating event failure using tree analysis, an event occurring in the interim of culminating events and fundamental causes of risk occurrence

(4) Occurring risk event

An event having the potential for occurring in a chain from the culminating event, and one that will lead to actual damage

(5) Environment

Every event contains within itself events that may or may not occur as a result of the external environment[4].

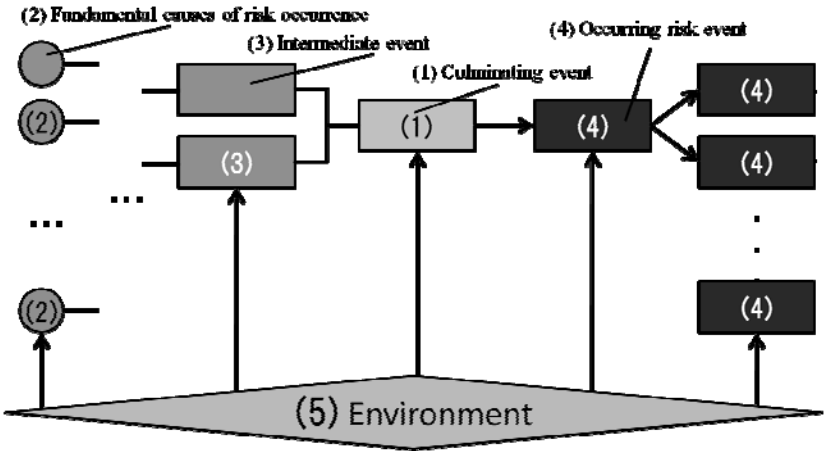

Figure 1 Model of Risk Chains

The most important element of business administration is the appropriate handling of risk. Failure to do so presents the danger of bringing destruction even to an otherwise sound organization. The recent wave of globalization has led to increased rates of change, and as is well known we are now in an environment of increasingly diverse risk.

Specific examples of such risks include terrorism, lawsuits, environmental problems, pandemics, and natural disasters, and in order to handle problems related to regulatory issues that affect global business expansion, the company must also improve its ability to continue doing business even when confronted with such dangers. This requires a focus not only on crisis support for single incidents, but also on the effective implementation of enterprise risk management, the determination of priorities, expansion of operations, staff assignments, and pursuit of efficiency.

It is entirely possible for individual risks to chain, have mutual interactions with other risks that extend beyond national or regional boundaries, and result in damage far in excess of what could have been imagined from a single risk event. Risk scenarios whose danger extends worldwide may begin with a single risk that triggers the occurrence of other risks that form a chain, and the result may be a "perfect storm" of damage. Individual risks can interact with each other, and thus expand. The enterprise must handle such risks immediately, and there is no room for delay[5].

When there is an occurrence of danger, there is also a significant danger of not only direct damage, but also secondary damage that occurs as an aftereffect. When dealing with such dangers, even if emergency procedures are put into place to handle the direct damage, after such dangers have been eliminated there remains a need to pay attention to secondary damage and, expanding even further, secondary effects. Analysis must be performed on them, and when necessary other procedures must be put into place in order to lessen the magnitude of such damage and effects[6].

In a typical risk assessment, risk is determined through identifying assets and then by analyzing the threats to and vulnerabilities of each asset. Between risks, however, there exists a chained risk relationship by which the exposure of one can lead to the exposure of the other. Furthermore, there are risk chain situations in which intermediate events occurring on the path to risk exposure can branch into new risks. When risk exposure is chained, there is a potential for very large damage to the organization. Therefore, in order to control risk appropriately, it is necessary to analyze relationships within risk chains. However, no mechanism for systematically analyzing the complex relationships within risk chains has been established[7].

Because it is necessary for the organization to take effective control of risk handling, it will make efforts to use a single control to handle multiple risks, strive for facilitation between controls, and minimize control costs. In other words, when using risk management to handle risk chains, it is

desirable to, in turn, create control chains and thereby perform an integrated management of risk.

In cases where there are multiple measures that can be taken with regards to a single event, it is necessary to consider their relationship. There are three relationships that exist between risk measures: Disjointedness, priority, and integration[8].

(1) Disjointedness

A disjoint relationship between measures is one in which one measure cannot be put into place simultaneously with another

(2) Priority

A priority relationship between measures is one in which one measure must be put into place before the other

(3) Integration

An integrated relationship between measures is one in which one measure must be put into place simultaneously with another

Such characteristics of risk chains have been identified, and there exists a need for risk management methods that take these into account.

3 Visualization of Risk

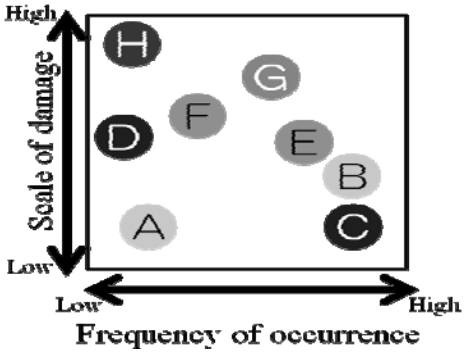

Figure 2 Risk Map

Current methods of risk recognition often involve the creation of a risk map like that shown in Figure 2 as a means to visualize risk and aid its recognition among all of the concerned parties. Risk maps are graphs that plot extracted results along their X and Y axes according to factors such as urgency, probability, scope of damage, cost of response measures, and period of response measures. They are tools used primarily in the acknowledgement of whether or not a given risk is to be made a subject of risk management, and after such acknowledgement, as a method for determining the manner in which risks will be handled, particularly when determining priority rankings[9].

However, existing risk maps do not take into consideration relationships between risks, meaning that for some degrees of risk recognition, the recognition of related risks can become underemphasized, potentially leading to errors in initial risk handling and therefore to chained risks. As a result, risks can increase in scale to become serious ones that the organization cannot manage, thereby causing severe damage. It is therefore important to recognize the path by which small-scale risks develop into large ones.

4 Creating Risk Maps in Consideration of Risk Chains

The following is an outline of a process for creating risk maps that take risk chains into consideration:

(1) Risk identification
(2) Risk calculation
(3) Risk chain identification
(4) Risk plotting
(5) Risk chain visualization

Two methods are used for risk identification: the survey method and the focus group method. The survey method uses a questionnaire. Such questionnaires are frequently created in a form unique to their purpose, and there are no specific definitions as to what form the items should take. For the purposes of

creating risk maps that take risk chains into consideration, we require the inclusion of two question items: 1) Risk event: Please describe the projected event and its worst case results, and 2) Damage and effects: Please provide a description of effected company divisions, functioning, and scope, and any past occurrence data. This, we believe, allows for efficient identification of risk chains.

Risk chain identification is a step in which the existence of links between risks is identified and evaluated. An investigation of risk chains is performed in consideration of past data, and identification performed after consideration of discussions with key personnel. Such discussions are performed as a brainstorming session, which we believe allows for improved identification results. Specific events that lead to the occurrence of identified chains are also discovered. Ranking of the probability of occurrence of identified risk chains is also performed. When ranking the probability of occurrence, a table of standards is created to allow determination of risk likelihood, and rankings made using that table as a basis. Use of decision tree is considered to be valid when the risk chain assessment. To assessment if the risk chain and if the no risk chain.(Figure 3)

Upon considering the risk chain, there is a need to create a risk chain list. Common risk list is comprised of the following items.(Figure 4)

a. Scale of damage: When the scale of the risk occurs
b. Frequency of occurrence: Probability of risk occurring
c. Prevention: Prevention of risk
d. Anti-occurrence: measures of risk occurs
e. Trigger: Phase to determine the risk

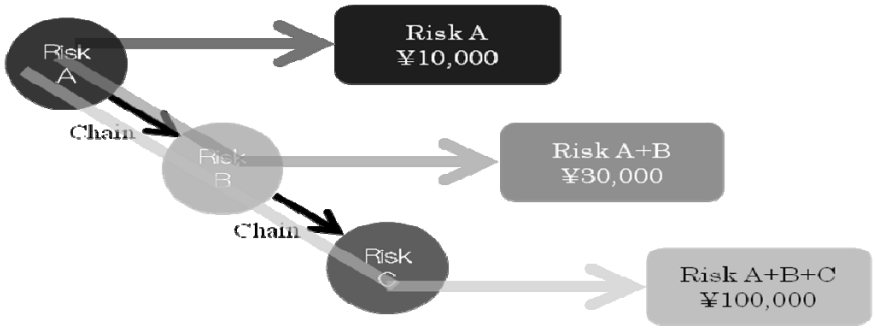

Figure 3 Decision Tree for Risk Chain

Risks	Scale of damage	Frequency of occurrence	Prevention	Anti-occurrence	Trigger	Risks associated with the chain	Chain Risk probability	Chain scale of damage
Risk A	High	Low	Implementation of A	Implementation of D		Risk D	Low	High
Risk B	Middle	High	Implementation of B	Implementation of E	50days	Risk E	Low	Middle
Risk C	Low	High	Implementation of C	Implementation of F		Risk F	High	Middle

Figure 4 Risk Chain List

In addition to commonly used items of the list of such risks, information needs to be mentioned in the risk chain.

f. Risks associated with the chain: the chain risks that could occur when the risk
g. Chain Risk probability: the probability of occurrence of the risk chain
h. Chain scale of damage: when the impact of the risk chain

By creating a risk chain provided a list of these items can help to create a risk map considering the risk chain. In addition, by creating a list risk chain, chain case and the risk accumulates, can be helpful in making similar such projects.

When creating risk plots, item types (e.g., accident and disaster risks, office work risks) are

categorized by color. Risk chains will not necessarily occur between risks within the same category, and have been confirmed as chaining over a wide array of risk types. It is therefore considered most effective not to create individual risk maps according to category, but rather to plot all risks on the same map.

In the risk chain visualization step, chaining vectors are used to visualize chaining relationships between risks. When creating visualizations, those factors identified during the risk chain identification step as causing risk chains are each indicated by a color-coded vector. Standards for color coding are listed in a separately developed table, and vectors should be colored accordingly. The style of the drawn vector should also differ according to the rank of chaining likelihood. Therefore, prior to drawing them, it is necessary to rank the probability of chaining occurrence, and to create the standards table that will determine the symbols used on the risk map.

By following the creation and construction methods described above, a risk map that takes risk chains into consideration can be created. An example is shown in Figure 5.

When implementing the use of risk maps, it is also necessary to update them at regular intervals. The probability of risk chain occurrence will change along with its encompassing environment. Thus, it is necessary to perform updates with information related to such environmental changes in mind.

5 Implementing Risk Maps with Risk Chains

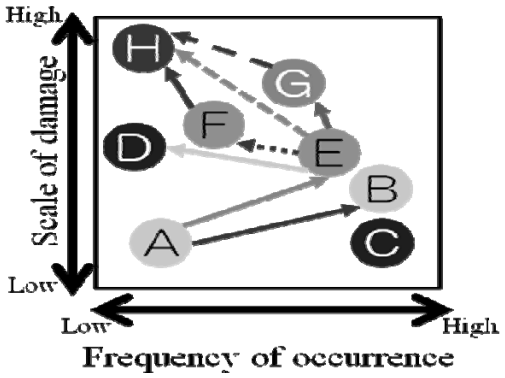

Figure 5 Risk Map that Takes Risk Chains into Consideration

As compared to traditional risk maps that treat risks as isolated events, the use of risk maps that take risk chains into consideration aids better judgment in decision making. Taking as an example risks A and C in Figure 5, we can see that while they both represent similar levels of potential damage, risk C is much more likely to occur than A, and so one might assume that C should be assigned a higher priority. Traditional risk maps would lead to such decision making. However, visualizing risk chains may lead to different decisions. We can see that risk A has a strong chaining relationship with risk B, and that risk B has a higher scale of damage than does risk C. Placing priority on risk C as per traditional methods of risk management, however, may lead to the occurrence of the chain between risks A and B, leading in turn to a higher scale of damage should such an even occur. With risk chains visualized, it becomes possible to assign higher priority to the risk A-B chain than to risk C, and so risk A may be prioritized. In such a manner, it becomes possible to perform decision making that takes into consideration the entirety of risks, not just risks as isolated events.

Because the causes of risk chains are also visualized, it becomes possible to focus on risk causes, and so create risk management plans. Figure 5 indicates eight risk chains. Of those chains, four are color-coded red, making it the predominant color. Assuming, for example, that red indicates a human cause for the risk chain, then the overall probability of risk chain occurrence could perhaps be lowered through employee education and training.

In this paper, we have proposed a method for the creation and implementation of risk maps that take risk chains into consideration so that such considerations can be made part of risk management. Visualizing chain relationships between risks on such maps allows for visual comprehension of risk chain relationships. We have also proposed a method for implementation that takes advantage of the features of such visualized chains, allowing management that takes such chains into consideration. We believe that the proposed method will allow for the implementation of more precise risk management as compared to traditional methods.

6 Conclusions

In this paper, in order to allow for the visualization of risk chains, we have introduced two new steps into the traditional risk map creation process: "Identification of risk chains" and "Visualization of risk chains." This allows for risk chain visualization. We have also proposed a process for the creation of risk maps that take risk chains into consideration, and proposed a method for their implementation. Thus, risk management that takes such chains into consideration is made possible.

We suggest the following future directions for related research:

(1) Detection of risk chains through risk factor analysis

The existence of risk factors can be given as one cause of risk occurrence. We can also assume a relationship between risk factors and risk chains. By clarifying the relationship between risk factors and risk chains, the identification of risk chains in consideration of related risk factors would be made possible, allowing for higher precision identification than is possible with the method proposed here.

(2) Development of quantitative evaluation formulas that consider risk chains

It is considered effective to use quantitative scales of risk as part of the information required to apply priority ranks to risk. The development of quantitative evaluation formulas that take risk chains into consideration would lead to further precision in the assignment of priority rankings.

(3) Systemization of creation and implementation

Because we have added two steps to the traditional risk map creation process, the time required to perform such creation will likely be increased. We furthermore predict that risk chain relationships will be made more complex, and therefore in order to recognize required information, it is necessary to stratify risk chains and sort the obtained information. Systemization of the creation and implementation process would be an effective means of performing such activities more easily.

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