Dynamic Monitoring on Operational Risks
~The Bayesian Approach to Key Risk Indicator Framework~

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Abstract

In current Banking industry, a wide range of studies are taking place attempting for effective modeling and measurement of operational risk exposure to meet the regulatory requirement set by Capital Accord II by Basel Committee on Banking Supervision. In contrast, this study focuses on proactive risk monitoring for non-financial institutions and applying best modeling practices of banking industry. Critical Success Factor Methodology and Critical Activities Concept are applied in the process of risk identifying and selecting most important operational risks. Bayesian probabilistic network modeling approach is being used to develop causal network of risk factors and are targeted on monitoring key risk points. These networks enable responsive risk monitoring and proactive risk management as well as certain degree of risk estimation functionality. A software tool - Hugin Lite version 6.8 - is used for Bayesian-KRI networks development and implementation of concepts. Basic considerations of future development framework are outlines and a conceptual model is introduced.

Keywords: Operational Risk Management, Key Risk Indicators (KRI), Bayesian Network (BN), Critical Success Factor (CSF)

1. Introduction

This study focuses on the development of proactive operational risk management framework. In current Banking industry, a wide range of studies are taking place attempting for effective modeling and measurement of operational risk exposure to meet the regulatory requirement set by Basel II [2][3]. In contrast, this study focuses on proactive risk monitoring and management. Critical Success Factor Methodology and Critical Activities Concept are applied in the process of identifying and selecting most important operational risks.

The basic concept of Bayes' theorem on converting to and from of prior and post probabilities is the primary motivation for using them in operational risk causal networks. Bayesian probabilistic network modeling approach is used to develop causal network on risk factors. These networks enable responsive risk monitoring and proactive risk management as well as a certain degree of risk estimation functionality. A software tool - Hugin Lite version 6.8 - is used for Bayesian-KRI networks development and implementation of concepts. The development process of Bayesian-KRI networks is discussed in detail with a sample network. The application of developed network is also illustrated.

2. KRI-Bayesian Network Development Process

2.1. Identifying Critical Risk Points

It is impractical to monitor all pieces of risks in the organization and to report to senior management. With increasing sophisticated corporate governance, management system, operation control and audits, we can considerably leave some risk and move on focusing major killer risks that can adversely impact on attaining the short term and long term objectives of each and every business process. This study uses Critical Success Factor (CSF) Methodology and Critical Activity (CA) Concept t for identifying most important risks.

Rockart [4] was the first to define the concept of CSF as the limited numbers of areas in which result, if they are satisfactory, will ensure competitive performance for the organization. The CSF approach is a top-down methodology to assist business strategy development. Critical activities (CA) [5] have a major impact upon the ability of an organization to achieve competitive advantage either through the ability to reduce the cost and/or create differentiation. Therefore, superior performance in such an activity relative to competitors offers customers a unique value proposition. The CAs can be identified based on well-defined CSFs, organization's competitive capabilities, sound understanding of competitive environment, value concepts and business strategies. A single critical activity may impact more than one CSF. The total number of CSFs being impacted by an activity can be used as a measure for determining the importance level of that activity. (Figure.1)

It is important to identify the key risks lie in the operation of business units that have severe inverse impact upon the operation of critical activities and prevent organization from meeting the specified CSFs. The key risk should be viewed in three aspects as: - how the operational risk impact on overall organization performance measures, how they limit performance level of critical activities and how they prevent the business unit's short and long-term goals.

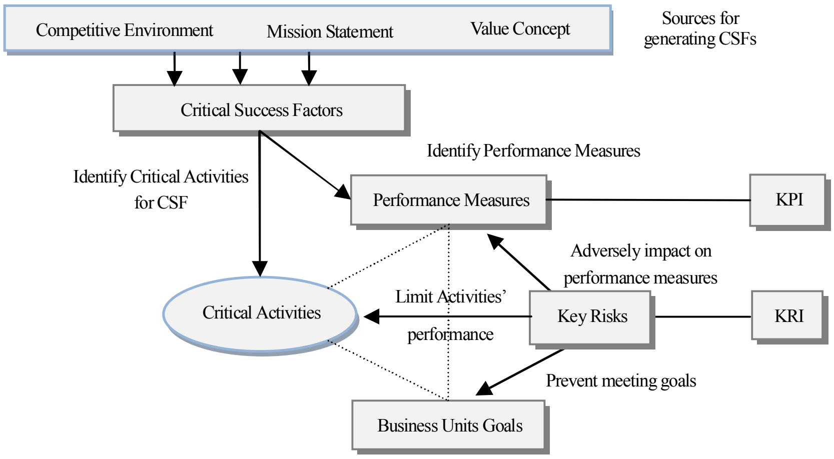
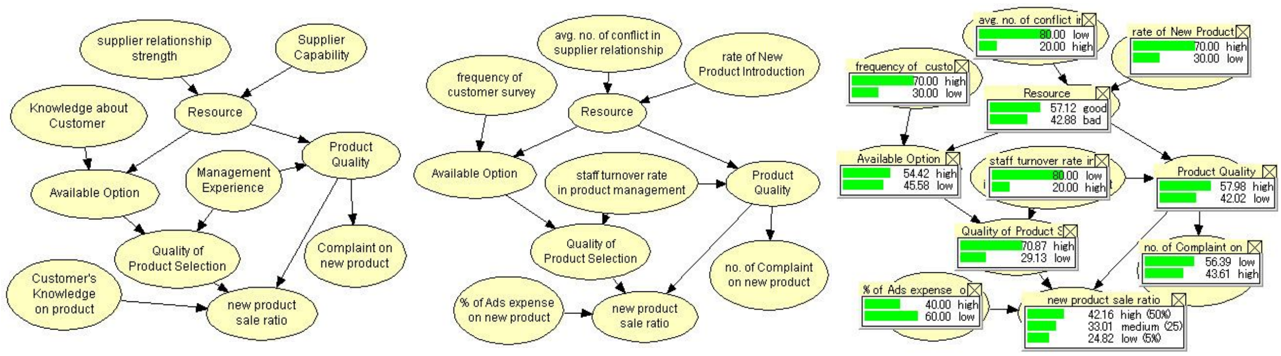


Figure.1 Process of Key Risk identification based on CSF and CA

2.2. Causal Network Construction and Quantification

After identifying key risks, it is to construct a causal network for each. Nodes are replaced with measurable operational indexes (Risk Indicators) and/or explore further, given the expert opinion at hand, for underlying nodes (causal factors) that maximized the ease of use and having strong relationship. Following diagram shows a sample causal network for a Retail Store of cars, bikes and mobile communication accessories, which defines one of its CSF as "Product Range" and CA as "Product Selection". This causal network is developed to monitor the risk of degrading product selecting ability (Fig. 2 - i). The nodes are then to be replaced with measurable indexes as shown in Fig (2 - ii).



(i) Causal Network (ii) Quantifiable Causal Network (iii) Marginal Probabilities

Figure.2 Causal Networks

The next step is to quantify the conditional probability distribution, or local distributions for each nodes using expert opinion and, to generate marginal distributions using Hugin decision engine, which implicitly reflect the dependency structure among nodes (Fig.2 - iii). Practically, any number of states can be assigned to any nodes. The more states we use, the higher the amount of conditional probabilities. Once the structure is defined, it is to perform a series of analysis – sensitivity analysis, worst case/ best case scenario analysis – to adjust the reliability of the developed network.

The next step is to relate these marginal probabilities with Risk Indicator ranges for monitoring and ad-hoc reporting of operational risk exposure. Followings are the rule for relating risk ranges and marginal probability setting of the network.

1. As long as the index stays in the range of low, there is no modification on probability.
2. When the index reaches the range of medium, it is to set likelihood of risk exposure into 2:1 ratio.

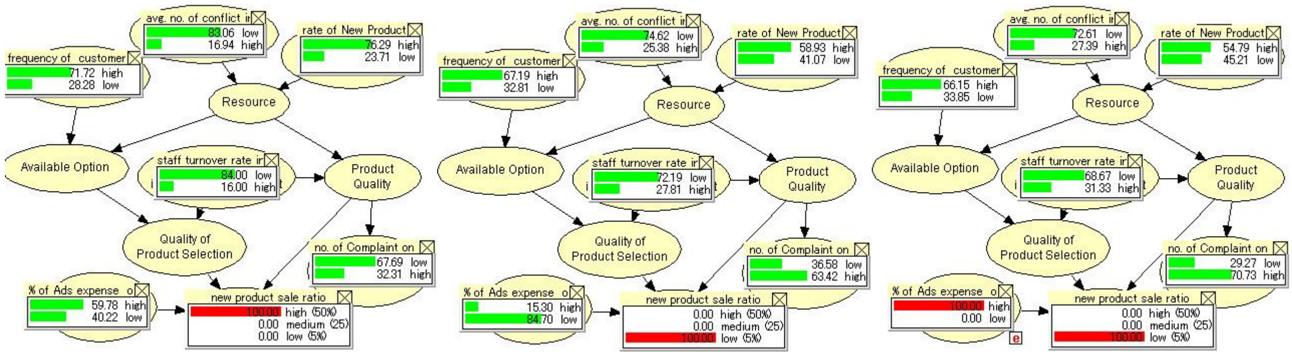
3. When the index reaches the range of high, it is to set likelihood of risk exposure into 1:0 ratio.

Example: Average number of conflicts in supplier relationship

If (0-2 /qtr)	=> risk level (low)	Safe	=>no change on probability setting
(3-5/qtr)	=> risk level (medium)		=> 2:1
(5/qtr or higher)	=> risk level (high)	Risky	=>1:0

Safe	Low	Medium	High	Risky
	(0-2 /qtr)	(3-5/qtr)	(5/qtr or higher)	

3. Application of Developed Network



Case (i) High in new product sale ratio   Case (ii) Low in new product sale ratio   Case (iii) Scenario Analysis

Figure.3 Causal Analyses

Not only simply monitoring the risk exposure, this framework can also assist risk manager in a variety of analysis and forecasting tasks. Under causal analysis, new evidence of operational risk exposure can be used to calculate the updated probabilities (also referred to as posterior probabilities) of all the causal factors (backward tracking). Practitioners can identify the major cause of the problem using causal analysis. Figure.3 (i) and (ii) illustrate the causal analysis of high and low new product sale ratio issues respectively. Additionally, it can combine with scenario analysis. For instance, if the practitioner realizes that sale ratio is still in low state (0-5%) although % of ads expense on new products is being high, he or she can identify the causal factor that need to be improved. (Figure.3 (iii))

To summarize, this study proposes operational risk management framework for proactive risk monitoring. It is to develop separate networks for each critical risk point. Using critical success factor methodology and critical activity concept for identifying key risk point for monitoring is suggested. Monitoring networks are to be developed based on most responsive, cost-effective risk indicators. Bayesian network modeling technique is suggested to be used to quantify the causality of risk indicators. By using it, it becomes easier to structure the dependency of risk indicators.

4. General Considerations

This section outlines general considerations for the future development of the conceptual framework proposed in next section.

- So far, we proposed the framework that identify key risks and suggested to develop separate causal networks for each risk. It was because of the primary motivation i.e., using Bayesian networks for structuring risk indicators instead of using mathematical approach to composite indicator construction. It was, however, realized that it is relatively costly to maintain separate networks and there are a number of redundancy in causal factors (risk indicators) and probability distribution. Therefore, the future development of the framework will focus on developing a multi-layer causal network that monitors a unique set of CSF for a business unit. It is believed to become more complicated comparing to separate networks yet, by introducing layering, complexity supposed to be reduced relatively. Moreover, systemic risk can be reduced substantially by doing so.
- In modeling financial risk and Value at Risk calculation, simulation (specifically Monte Carlo Simulation) is being widely used. It provides effective way for risk exposure estimation with required confident level. One study [1]

proposed an operational risk management model that develops two separate Bayesian networks for frequency and severity for a single business unit respectively. Based on resulting marginal probability distributions of terminal nodes (one from each network) simulation was done for calculating potential loss. In the proposed framework, it is to analyze such kind of simulation can be utilized in the semi-state of causal network or not. For instance, when we have hard-evidence on certain causal node or nodes, can we run simulation to identify any other high sensitivity causal node (or) to generate risk exposure estimation with required confident level? If the proposed framework satisfies these general considerations, the actual dynamic, proactive monitoring of risk exposure can be achieved.

5. The Conceptual Framework

The framework consists four layers – Critical Success factors, Performance Measure, Critical Activities and Key Risks (Figure.4). These are conceptual layers and will not appear distinctly in causal network. Most nodes in the network will appear as Key Performance Indicators (KPI) or Risk Indicators. However, Risk Indicators are for monitoring key risks that have strong impact on critical activities. KPI must be descriptively linked with CSF and must be able to show the level of satisfaction for CSF. Moreover, these KPI must be able to clearly state (track) the performance level of CA. The framework must be transparent to all management levels showing which causal nodes are being used for which CSF and key risks. It makes easier for maintenance and management intervention of the risk control.

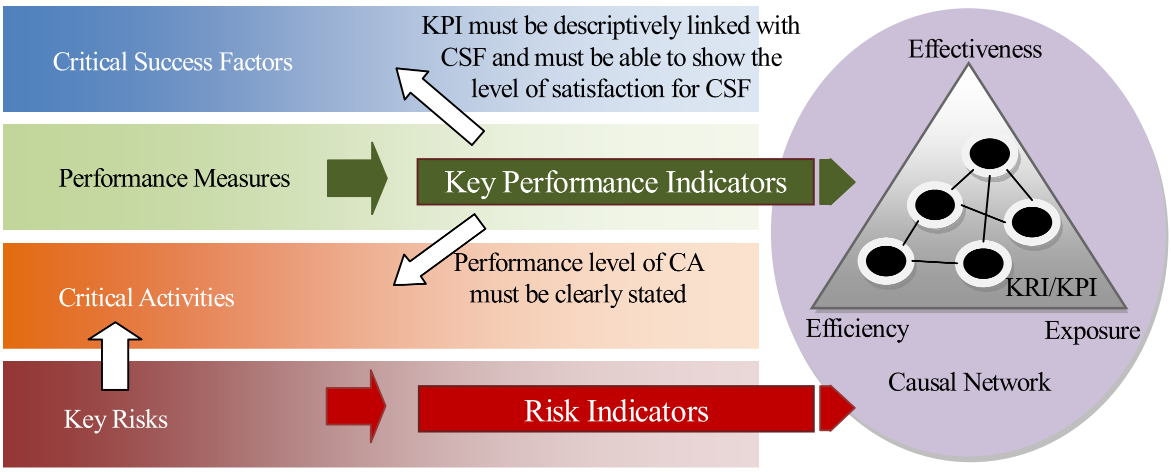


Figure.4.The Proposed Conceptual Framework

6. Conclusion

This study demonstrates the detail development process of risk monitoring framework. The application of Bayesian Network into the risk indicator composition is illustrated and the applicability of these networks in real business is demonstrated. The conceptual model for future risk management framework is proposed and its underlying general considerations are outlined. Although there are some practical limitation on combining Bayesian decision engine and simulation processes, a sound risk management framework that ensures transparency and ease of management intervention is highly expected as future study.

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