Chapter 7

A Belief Rule-Based Generic Risk Assessment Framework

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The present work aims to propose a generic risk assessment framework for modeling, analyzing and synthesizing risk-related information with various uncertainties. Such information may be of very different nature: it can be quantitative or qualitative, and uncertain, incomplete, imprecise, conflicting, for which the traditional quantitative approach (e.g., statistical approach) does not give an adequate answer. IF-THEN rules place the key role in this framework which is then combined with Dempster-Shafer theory of evidence and decision theory in order to form a generic IF-THEN belief rule based risk assessment framework with the aim to address different types of information. The general risk assessment specification for the risk assessment of a hazard event is reviewed firstly. The belief-rule-based risk assessment framework is then illustrated and outlined including rule-base representation, inference procedure, rule-base generation and multi-source synthesis aspects. This is then followed by the illustrative analysis of hierarchical structure nature of the real world risk assessment model. How can the above discussed risk assessment framework be incorporated to form a multi-layer risk assessment model is finally specified. In the proposed generic framework, various types of information from different sources can be transformed and used in the inference process. It provides a flexible and effective way to represent and a rigorous procedure to deal with hybrid uncertain assessment information to arrive at rational conclusions.

7.1 Introduction

Risk management (e.g. disaster management), which encompasses monitoring, predicting, preventing, preparing for, responding to, mitigating and recovering from unexpected hazards (e.g., disasters), aims to deal with any potential and actual hazard (e.g., disaster) by effective and efficient organization, communication, interaction and utilization of counter
hazard (e.g., disaster) resources [1]. It is the process of assessing hazard risks and taking steps to either eliminate or to reduce them (as far as is reasonably practicable) by introducing control measures.

Risk assessment is one of the key elements of risk management. Expressions such as “risk assessment”, “risk evaluation” and “risk analysis” are used in a somewhat interchangeable way to describe a variety of techniques and processes involved in the overall management of risk [2]. Despite this lack of clarity, Frosdick [2] and other researchers consistently use the term “risk assessment” as a catch-all to include all those activities that are needed before appropriate risk reduction methods can be decided upon.

Fig. 7.1 A simplified relationship between risk analysis, risk assessment and risk management

Fig. 7.1 shows the different processes in risk management procedure and presents a simplified relationship between risk analysis, risk assessment and risk management. This definition of the risk management process has been adopted from the International Electrotechnical Commission (IEC). There are other relationships between the definitions of risk