

Risk based Decision Making for Infrastructure Systems

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Abstract: - Infrastructure is prone to risks of different nature in all phases of its life cycle. These risks have a multifaceted effect on the operation, safety, and performance levels of the infrastructure systems, thus affecting the social and economical status of communities. Therefore, proper risk management of infrastructure in its whole life cycle is imperative towards attainment of the desired infrastructure systems' efficiency levels. This paper presents the advancement of a new risk based decision making methodology that indicates the preferable risk-response strategy between: a) acceptance, b) mitigation, c) transfer and d) avoidance; the selection of the strategy is based on the quantified risks that are included in the analysis. The methodology is presented through an explanatory example concerning the repair/maintenance costs of infrastructure facilities. The example demonstrates the methodology's capacity to facilitate risk based decision making for infrastructure systems.

Key-Words: - Risk, Decision making, Multicriteria, Risk response, Infrastructure systems, Methodology

1 Introduction

Globally, there is a growing need to replace or expand over the next twenty years infrastructure facilities in sectors such as transport, energy, sanitation, etc. [1]. This is due to: a) aging structures, b) increase in population, c) emergence of new risks (e.g. climate change), d) urbanization, etc. However, the modernization or the creation of infrastructure is associated with enormous costs that even strong economies are facing difficulties to deal with [1].

Infrastructure in a broad context includes all physical and organizational assets required for: a) the operation of an organization and b) the provision of a product or service to various types of end-users. The term mainly refers to technical structures, including facilities, telecommunication networks, and equipment but the consideration of infrastructure systems far exceeds the technical aspect; business, operational, environmental, and societal implications are a primary matter of concern when designing or operating any type of infrastructure facility.

A major characteristic of infrastructure is the interdependencies among the modules comprising an infrastructure system. Although these interdependencies may be identifiable to a great extent, they are difficult to model. The limited capacity to model infrastructure systems and the long period of their life cycle generate both systemic

and aleatory risks. Therefore, critical decisions about the development, operation and maintenance of infrastructure, which involve significant risks of many types, must be taken considering the various risk response strategies that alleviate those risks and constitute the most preferable option among several alternatives.

The proper introduction of risks in the decision making process for issues of great magnitude such as infrastructure requires more than a risk analysis for the anticipated risks; it requires the formal embedding of risk management processes to the decision making process, in order to apply a comprehensive Risk-Based Decision Making (RBDM) approach.

This paper presents a RBDM approach that is considered appropriate to deal with the usual limitations in the decision making process for infrastructure issues. Such limitations are mainly related to: a) the proper inclusion of risks, b) the correct introduction of quantified risks as criteria for decision making, c) the successful integration of quantifiable and non-quantifiable aspects of the risk profile, and d) the effective treatment of inaccurate data, estimates and analyses. The presented approach builds on the previous effort by Xenidis, et al., (2011) [2], which is further evolved towards a more robust methodological and mathematical framework.

The paper is structured in the following way: a) Section 2 reviews decision-making methods, which