

# Chapter 16

## Prescriptive Simulation Scenarios for Hospitals Evacuation Management

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### **ABSTRACT**

*The emergence of a large number of vulnerabilities and the growing interdependence of economic and social activities put vital networks in a particularly delicate situation. These networks constitute the critical infrastructures of which the security of one of them depends on the others. Being more and more interdependent, their failure can have catastrophic consequences on the whole. The main objective of this chapter aims to study the problem of the occurrence of an electrical failure in the hospitals and to provide anticipatory solutions as decisions to be taken and submitted to the stakeholders involved in the intervention in such critical situations. To this end, an emergency response management system was proposed and modeled by the creation of prescriptive and adaptive simulation scenarios. This system was realized via a web-mobile application. The latter, thanks to the advantages that offers, facilitates the tasks of the stakeholders, improves the quality of the communications, reduces the time required for evacuation, and therefore, limits the scope of the damage.*

## 1. INTRODUCTION

Because of technological advances, our societies have become increasingly vulnerable to critical infrastructures failures, such as power plants, gas distribution, water supply, telecommunication systems, transportation, etc (Chen, Scown, Matthews, Garrett, & Hendrickson, 2009). Indeed, on the one hand, they are more and more dependent on these vital networks and on the other hand, these infrastructures have the tendency to be highly interdependent. Thus, a failure in one of them is capable of influencing negatively on the whole by causing faults in the rest of the infrastructures.

In a modernized world with a growing dependence on interconnected systems that rely on electricity, power reliability is becoming more critical. Since people are extremely dependent on their lifestyle, a power outage is revealed as almost catastrophic. Among the strategic elements in healthcare infrastructures is the electricity. Hospitals require a continuous power supply to keep all their services on alert and to protect the patients whose lives depend on electrical equipment. Nowadays, a power blackout in the electricity network due to natural disasters or high-power requirements is a common event that frequently occurs (Bruch, et al., 2011). In fact, a power failure or a malfunction of an electrical transformer or a generator can cause a total paralysis of medical services that usually accommodate many patients in critical situations and under intensive care. Such situation may end up with a disaster like the death of some patients and severe damage in sensitive medications etc. Despite the increased reliability and the resistance of modern power systems to physical damage, the risks associated with electrical failures remain serious.

Unfortunately, the impact of power outages on health is still poorly understood, and thus a deeper research effort is essential to prevent and mitigate adverse health impacts as mentioned in Klinger and Owen Landeg (2014). This paper is interested in the dependency relationship between two life support systems, the hospital infrastructure and the electricity grid. More precisely, it focuses on the impact of the electrical network failures over the healthcare sector.

A special attention is given to the exceptional event of having a partial or general power failure according to which the hospital has to make a decision about the evacuation of the concerned patients and their medical staff. This decision comes up after the failure of a series of preventive steps and measures such as, the use and the depletion of all existing sources of backup power supply, while the power outage persists and the patients' situation deteriorate. According to the nature of the occupants, a complete evacuation is the last consideration of healthcare facilities (Kader, 2008). When patients rely on sensitive electrical equipment that provide vital support, they require a certain amount of time and a set of stakeholders to be evacuated from the hospital (Taaffe, Johnson, & Steinman, 2006). The critical point in this emergency is the establishment of an evacuation process management, which insures a good communication between the different involved stakeholders and avoids disorder, panic and time wasting. This idea has been concretized in this paper using pervasive technologies in the evacuation process. In fact, a web application was developed employing stakeholder's internet connected devices (mobile, tablet, laptop...).

This research work is organized as follows. In section two, a literature based hospital evacuation is presented. In section three, real cases of power outages in different hospitals around the world are presented and analyzed. In section four, the different parameters causing the hospital's evacuation process decision are defined. In section five, the evacuation problems following a power outage are identified. Finally, in section six, the proposed system architecture and the related evacuation support model are presented by the authors and described in detail.

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