

# Improved Emergency Management by a Loosely Coupled Logistic System

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**Abstract.** We investigate a robust and intelligent logistic system for emergency management where existing commercial logistic systems are loosely coupled with logistic systems of emergency management organizations and armed forces. This system is used to supply the population in case of a disaster where a high impact of environmental conditions on logistics can be seen. Very important are robustness as the ability of a logistic system to remain effective under these conditions and intelligent behavior for automated ad-hoc decisions facing unforeseen events. Scenario technique, roadmapping, as well as surveys are used as qualitative methodologies to identify current weaknesses in emergency management logistics and to forecast future development of loosely coupled logistic systems. Text mining and web mining analysis as quantitative methodologies are used to improve forecasting. As a result, options are proposed for governmental organizations and companies to enable such a loosely coupled logistic system within the next 20 years.

**Keywords.** Roadmap, Scenario, Logistic, Emergency Management

## 1 Introduction

After the terrorist attacks of 11 September 2001, it could be seen that a large impact of such attacks on the global economy and on individual sectors e.g. on logistics take place. In general, a supply chain is vulnerable concerning terrorism (destroying of goods), crime (theft of goods) [1], and natural disasters (e.g., earthquakes, tsunamis, hurricanes) [2]. Further aspects - among others - are the damage / destruction of existing infrastructure for the transportation of goods or the means of transportation and the cyber attack on information and communication systems needed for supply chain management [3]. Thus, beside well-known factors in logistics (transportation, inventory, warehousing, material handling, packaging, and integration of information) supply chain security has become a more and more important factor [4], [5].

Emergency management is the process of protecting population, critical infrastructures etc. from hazard risks as occurred by natural and artificial disasters. Literature shows challenges of logistics in emergency management [6]: A challenge is that the

flow of relief services and information is directed from relief distribution centers to a specific point of destination in affected areas where it is difficult to operate because of the environmental conditions. A further challenge is the time aspect. The timeliness of relief supply distribution is hard to control (e.g. considering a critical 3-day period following a disaster). Further, in emergency situations communications challenges occur as well as operational un-certainties (i.e., controlling the inventory of supplies ready for transport). Last, the occurrence of information gap is a challenge because information immediately following a disaster normally is decentralized distributed and it may not be as accurate as needed.

National governments are responsible for emergency management however the governmental capacities in logistics have been reduced significantly (e.g. see the current structure reform of the federal armed forces in Germany). The support of the population can only be implemented as a loosely coupled system where the logistic capacities of emergency management organizations and armed forces on one hand and the - additionally purchased - commercial logistic capacities on the other hand worked together [7].

Thus, this work investigates a loosely coupled logistic system for emergency management that consists of commercial logistic systems and of logistic systems of emergency management organizations and armed forces. Whereas this system is used to supply the population in case of a disaster, unforeseen events often appear that lead to changes in the environmental conditions. Facing these events, the loosely coupled logistic system has to be the ability to remain effective (robustness). An intelligent behavior for automated ad-hoc decisions is also needed.

## **2 Methodology**

The aim of this study is to enable a loosely coupled logistic system for emergency management. We use a methodology that consists of five steps. The first step is to identify scenarios by use of scenario technique [8-11]. A specific scenario is selected considering the occurrence of terrorism attacks and natural disasters in Germany that represents the environment of a logistic system.

Based on the first step, the second step identifies the requirements for a future loosely coupled logistic system. Information about the current situation and about the possible future of such a coupled logistic system is collected. This is done in a qualitative way by human experts. A literature review is done, expert workshops are organized and surveys have been done to get experts opinions about the requirements.

The third step is to evaluate the collected information to improve forecast accuracy. This is done by use of quantitative text and web mining methods. Descriptions about the possible future of the coupled logistic system are analyzed automatically. We use text mining methods (e.g. tokenization, case conversion, part-of-speech tagging, stop word filtering, stemming, term weights) to identify keywords [12-14]. Based on the keywords, multi-occurrences are identified that are multiple terms that occur more frequently together than it would be expected by chance within a specific term distance [15], [16]. Human experts select relevant multi-occurrences that repre-

sent requirements of a future coupled logistic system. Search queries are built based on the relevant multi-occurrences. To consider worldwide available information where web pages are formulized in different languages, the search queries are translated to several languages. A web mining approach based on Google search advanced programming interface (API) is used to identify relevant documents in the internet [17]. For each document, keywords are identified that occur together with the corresponding multi-occurrences within a specific term distance. We translate the keywords to the target language (English) by use of Goolge translate API. They are compared to keywords from further retrieved documents to identify their above-chance frequent occurrence. As a result, new multi-occurrences are identified that are related to relevant requirements of a future coupled logistic system.

In the fourth step, human experts analyses the new multi-occurrences for each requirement. As a result, some requirements are modified. The fifth step is to create a system roadmap [18] that contains a time table for realizing the modified requirements and outlines the recommendations for government and companies.

### **3 Recommendations from the Roadmap**

The created system roadmap shows detailed recommendations for different time steps. The expected year where results should be implemented is mentioned in parentheses. Below, the results are summarized in short notes:

An improvement of the logistical capacities of governmental organizations specifically in those kinds of equipments that are not available in commercial logistics is suggested (2020). An improvement in robustness of commercial logistic systems enables them to operate under difficult environment conditions as expected in emergency situations (2030). An improved cooperation and coordination between governmental organization and companies in logistics is also suggested (2020) as well as the creation of standardized interfaces and of general conditions for legal aspects where much organizational and legal work is to do by governmental organizations to enable cooperation and coordination (2015-2020). A further kind of recommendation focuses on the goods that reach from a more robust water and energy supply (2025) to the introduction of new decentralized stockpiling approaches (2015). Further recommendation concern the creation of emergency management plans for different scenarios (2015) and an increased research and development (e.g. through research funding) (as from now) as well as an increased investment in the technologies 'Future Internet / Internet of Things', 'Cloud Computing', 'Agent based open-loop controller', 'Fleet management', 'Identification', 'Location Determination', 'Artificial Intelligence', and 'IT Security'. Overall, this system roadmap - based on a preselected scenario - shows that such a loosely coupled logistic system for emergency management is not realizable at present time in Germany. However, such a system is realizable within the next 20 years. Estimations about the future of logistics can be received in good quality by human experts. Further, quantitative methods are a good mean to reduce the uncertainty in the qualitative estimations and to increase its accuracy.

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