


# Improving Disaster Response Plans With STECA: An Application

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## ABSTRACT

In order to have immediate and effective management of crises and emergencies, natural and technological disaster response plans are created. These plans define the elements of a system responsible to manage a disaster, their roles, and responsibilities together with their interactions. In some cases, however, the system which is formed based on these plans fails to perform as desired. This paper proposes the utilization of systems theoretic early concept analysis (STECA) as an effective approach to efficiently identify loopholes in existing disaster response plans. STECA was applied to the formal evacuation plan of Greece's Civil Protection Agency due to forest fires and identified thirty one loopholes that were validated against the official prosecutors' investigation reports of the 2018 "Mati" forest fire tragedy in Athens, Greece.

## KEYWORDS

Concept of Operations, Contingency Plan, Control Loop, Controller, Emergent Property, Evacuation, Fires, Hazard, Hierarchy, Loopholes, Process Model, Safety Constraints, Stakeholders, Systems Theory

## INTRODUCTION AND BACKGROUND

The need to effectively manage disasters and crises led businesses and agencies to develop contingency plans, which are typically developed based on standards (NFPA®1600, 2013; Ministry of Interior, Public Administration and Decentralization, 2003; General Secretariat of Civil Protection, 2007, 2009). Although that "ideal" preparedness does not reside simply in having a plan (McConnell & Drennan, 2006) disaster plans remain an important element for effective preparedness.

Written plans may vary widely in scope, detail, structure, purpose and elaborateness. In every case, the disaster plan is the product of the planning process, thereby becoming the principal connection between the disaster planning activity and the disaster response (Perry, 2004). On the merits, these plans define inter alia, (a) those involved in the system to be "created" to manage crises when they occur, (b) their responsibilities, and (c) interactions among system elements and their environment. In some cases, these plans define (a) the "mandates" that specific elements of the crisis management system may impose and also the conditions under which these mandates will be given, (b) the response tactics that should be followed to specific emergency scenarios.

There are lengthy plans created with the philosophy to anticipate every possible event and prescribe correctives. Years of field research however reveals that such a conception of planning is at

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best not constructive. In the first place, a plan should not be an all-encompassing document or tome. Plans designed like this tend to sit on shelves collecting dust and giving a false sense of security or preparedness to their writers. In the second place, it is simply not possible to anticipate every event or nuance that may arise in a disaster (Perry, 2004). Thus, the systems which are formed based on these plans occasionally fail to perform as desired. Furthermore, when emergency managers attempt to implement such plans they would find their options restricted in advance, and this limits their ability to innovate and be flexible. Thus, even planners with positive intentions would ultimately slow down decision making processes, endanger response personnel and create confusion when inevitably an unpredictable event occurs during response operations that was not covered in the plan (Perry, 2004).

Unfortunately, in many occasions the loopholes in disaster response plans are realized after the occurrence of disasters, like for example in the Hurricane Katrina in USA in 2005 and in the forest fire disaster in “Mati” in Greece on July 2018. In the former case the report (Townsend, 2006) mentioned that “In terms of the management of the Federal response, our architecture of command and control mechanisms as well as our existing structure of plans did not serve us well. Command centers in the Department of Homeland Security (DHS) and elsewhere in the Federal government had unclear, and often overlapping, roles and responsibilities that were exposed as flawed during this disaster”. In the later, the prosecutors’ findings, (Euronews, 2019; Kathimerini, 2019; Analitis, 2019; Liberal.gr, 2019; dikastiko.gr, 2019; MacroPolis, 2019; The National Herald, 2019) mentioned that “the implementation of the plan has worked well in theory but in practice virtually nothing worked as planned, and the whole management has been spasmodic, without any coordination”.

The phenomenon of identifying loopholes after a disaster in response plans constitutes a major problem that needs to be addressed. Approaches to cope with this problem include: (a) the stakeholders consultation and periodic drills, collaboration exercises and strategic exercises, (Perry, 2004; Berlin & Carlström, 2014; Peterson & Perry, 1999), (b) serious games approaches (Rothkrantz, 2016; Brawley, 2016), (c) computer based simulations (Chen, Zhang, Sun, & Liu, 2016; Khalil, Abdel-Aziz, Nazmy, & Salem, 2009) as well as (d) formal modeling approaches to compare existing disaster plans (Hoogendoorn, Jonker, Popova, Sharpanskykh, & Xu, 2005), (e) a suite of tools for emergency plan management support like SAGA (Canós, Borges, Penadés, Gómez, & Llavador, 2013) and (f) content and semantic analysis methods (Jung, Song, & Park, 2017).

This paper proposes the utilization of “Systems Theoretic Early Concept Analysis” (STECA) as an effective tool to cope with this problem. STECA is a systems theoretic method used for the identification of loopholes in Concept of Operations (ConOps) documents, that is a document for a future or existing safety critical system that describes its desired operation using the terminology of its stakeholders, and up to date has been solely applied in systems safety engineering contexts: (Fleming, 2015; Urano, 2016; Fleming & Leveson 2016).

Specifically, STECA was applied on Greece’s General Secretariat’s for Civil Protection document nr. 2934/06-05-2015 entitled “*Guidelines for organized removal of citizens for the purpose of protection against an evolving or imminent destruction due to forest fires*” (General Secretariat of Civil Protection, 2015) to identify missing elements and loopholes. A significant number of loopholes have been identified and validated by the findings of the prosecutors after the tragedy in “Mati” (Euronews, 2019; Kathimerini, 2019; Analitis, 2019; Liberal.gr, 2019; dikastiko.gr, 2019; MacroPolis, 2019; The National Herald, 2019) area in Athens-Greece.

## SYSTEMS THEORETIC EARLY CONCEPT ANALYSIS

Systems Theoretic Early Concept Analysis (STECA), is a new technique developed by (Fleming, 2015). Its goal is to work at an early stage to enhance the development phase of systems by improving their plans and ConOps documents through the identification of pathogens and loopholes such as undocumented assumptions, inconsistent or conflicting information within a concept that may lead to hazardous behavior, required operational concepts that are missing to understand safety -and

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