

# REPRESENTING FIRE EMERGENCY RESPONSE KNOWLEDGE THROUGH A DOMAIN MODELLING APPROACH

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## Abstract

*When any kind of emergency occurs, Emergency Responders (ERs) from different emergency organizations (such as police, fire, ambulance and municipality) have to act concurrently to solve the difficulties which are posed at the emergency site. Moreover, during the immediate response, getting the awareness of the situation is very crucial for ERs to lessen the emergency impacts such as loss of life and damage to the property. However, this can only be done when ERs get access to the information in timely manner and share the acquired information with one another during emergency response. Despite ERs share knowledge with one another they have to use same concepts to obtain the semantic understanding in order to perform actions for achieving goals. In addition, the success of the emergency response lies on the ERs' coordination and their interoperability (information systems interoperability). Therefore, in this paper we provide a formal structure to the concepts that describes the building fire emergency management domain in order to provide a common semantic understanding for ERs. In our study, domain modelling approach has been used to represent the concepts formally. The presented results combine the knowledge from semi-structured interviews, document analysis, and through literature review. The developed domain model includes four aspects: i) characteristics of the event, ii) actors involved, iii) goals to achieve and iv) Building characteristics. Besides, the developed domain model serves as a foundational component to create an information system to unify, facilitate and expedite access to emergency related information for facilitating data exchange format and enable knowledge sharing among different emergency actors.*

**Keywords:** Domain model, Emergency response, Building fire emergencies, First responders, Search and Rescue operation.

# 1. INTRODUCTION

Emergency response is often managed by emergency responders (ERs) from different emergency organizations such as fire protection, police, health care and ambulance service. These ERs always work in teams. The primary goal of these emergency response teams is to protect the people and property. This can only be achieved when the emergency teams get the right information to the right person at the right time to coordinate well and develop and maintain a common operational picture (Dilo & Zlatanova, 2011; Van de Walle, Bruggemans, & Comes, 2016).

During the response, ERs can coordinate well only if they have a common understanding of the concepts used in the management of the emergency. If the ERs do not have common semantic understanding of the situation, the emergency situation is subject to misinterpretation (Ram et al., 2012; Weick, 1993). Moreover, emergencies are dynamic in nature and responders require timely information to coordinate and make decisions.

Developing a common operational picture is often hindered by the fact that ERs follow their own organization's policies, applications, procedures and documents (Comes, 2011; Comfort, 2007). In addition, power struggles and shifting relationships can also play an important role (Comes & Adrot, 2016). Moreover, the involved different ERs use their own applications and data exchange formats. As a result, ERs face difficulty in obtaining a common operational picture (Truptil et al., 2008). Therefore, a conceptualization of emergency response concepts using domain modeling approach is necessary to solve the semantic conflicts (such as representing the same underlying terminology, concepts and relationships in different ways) that are bound to occur among different emergency organizations in building fire emergency management domain (Wybo & Lonka, 2003).

For fire emergency management, public buildings such as universities are an interesting case. In the USA, for example, from 2000 to 2015, 89 fires had occurred on college campuses, killing 126 people. Such institutions and places are interesting to study, because they frequently host large number of people, the building topography is known, but the exact number and nature of visitors, students, or staff is unknown.

The objective of this paper is answering the following research question: *“How to solve semantic inconsistency which has become a major problem of information sharing and data exchange among different emergency organizations' responders during emergency management?”* We address this question by developing a meta-model which includes domain concepts (building fire emergency management) in order to make all involved professional ERs use the same concepts during emergency response. The developed domain model (meta-model) shall provide a basis for understanding the emergency response process. Different methods can be used to model the concepts and relations formally, e.g., description logics (CunXiang, WenJun, & Peng, 2009), ontologies (Barros, Kislansky, Salvador, Almeida, Breyer, Pedraza, et al., 2015), object-oriented modelling (Aydinoglu, Yomralioglu, Quak, & Dilo, 2009; De Silva & Eglese, 2000). According to (Cranefield & Purvis, 1999; France, Ghosh, Dinh-Trong, & Solberg, 2006; Sendall & Kozaczynski, 2003), Unified Modelling Language (UML) can be used to build the domain models. In this paper, we use UML to give an overview of the emergency response process by showing its classes and the relations among them. UML is based on object-oriented design concepts and is independent of any specific programming language.

This paper starts with a literature review in section 2. In section 3, the methodology for developing the domain model is presented. We then present the developed model in detail in section 4. Section 5 concludes the present study with future developments.

## 2. META MODELLING: BACKGROUND AND METHODOLOGY

This section will introduce the overall meta-model and ontology principles and provide an overview of existing crisis/emergency/disaster management meta-models and ontologies.

## 2.1 META-MODELLING AND ONTOLOGY

Research on meta-models and ontologies has tremendously increased over the past decades. According to (Othman & Beydoun, 2010) a meta-model serves as a representational layer of domain expertise. Whereas, Stephen (StephenJ, 2004) describes a model consists of sets of elements that describe some physical, abstract or hypothetical reality. It means, a model is a simplified representation of a certain reality (Génova, 2009). A model is captured by a particular meta-model. A meta-model is simply a model of a model. It defines the structure, semantics, and constraints for a family of models, which shares common syntax and semantics. As claimed by (Clark, Sammut, & Willans, 2008), “A meta-model is a model of a model which captures a particular domain’s essential properties and a list of relevant relationships between these concepts. These include the concepts it supports, its textual and/or graphical syntax and its semantics”.

An ontology is considered as a specification mechanism to formally represent the knowledge based on the concepts for a domain of interest. A conceptualization is represented as an abstract notion which contains domain and a set of relevant relations on the domain (Gruber, 1993). Ontology defines ‘the basic terms and relations comprising the vocabulary of a topic area as well as the rules for combining terms and relations to define extensions to the vocabulary’ (Corcho, Fernández-López, & Gómez-Pérez, 2003). There are other types of ontologies that are identified to fulfil different roles in the process of building information systems. They are (Abecker, Bernardi, Hinkelmann, Khn, & Sintek, 1998; Fensel, 2001):

- *Domain ontologies*: They model the content of the information sources.
- *Metadata ontologies*: These ontologies encapsulate the concepts for describing the content of a specific domain. These are equivalent to meta-model of a modelling language.
- *Generic or common sense ontologies*: The purpose of these ontologies is to capture general knowledge about the domain. These can be valid across several domains.
- *Representational ontologies*: These ontologies are not valid to any particular domain. Such ontologies provide representational entities without stating what should be represented.
- *Method or Task ontologies*: These are the ontologies which provide term specific for particular tasks. These ontologies provide a reasoning point of view on the domain knowledge.
- *Information ontologies*: They describe the different kinds of information sources, their structure, format properties.

## 2.2. CRISIS/EMERGENCY/DISASTER MANAGEMENT META-MODELS AND ONTOLOGIES

In crisis and disaster management literature, most meta-models and ontologies have been developed to improve information interoperability across emergency responders’ functions. However, the information models (Frameworks., 2009) are restricted either to one organization (Kirillov, Metcherin, & Klimenko, 2012); to a specific case (Bagheri & Ghorbani, 2010; Bitencourt, Durão, & Mendonça, 2015; Chen, Sharman, Rao, & Upadhyaya, 2013; Li, Li, Liu, Khan, & Ghani, 2014; Souza, 2013; Xu, Dilo, Zlatanova, & van Oosterom, 2008; Xu & Zlatanova, 2007); to a specific goal (Dilo & Zlatanova, 2011; Onorati, Malizia, Diaz, & Aedo, 2014); to a specific purpose (Barros, Kislansky, Salvador, Almeida, Breyer, & Gasparin, 2015; Little & Rogova, 2005; WenJun, CunXiang, & Peng, 2009).

In (Frameworks., 2009), the W3C Emergency Information model represents the concepts and relationships that define an overall context for sharing of coordination information in an emergency. The model uses the scenario “Who (organizations or people) does, What (activity and event) and Where (location)” as a basis to derive high-level concepts and relationships. This is developed based on data schema from existing emergency information systems. They did not look into when (date and time) and how (cause of the event and performing tasks). Li (Li et al., 2014), reused the W3C Emergency Information model by adding ‘when’ for developing an information system, but did not consider ‘How’ in their work.

Zlatanova (Zlatanova, 2010) used formal modelling in her work to model the tasks to support geo-

information in emergency response in order to give deep understanding about the spatial data structures and corresponding terminology to the emergency experts. In the work (Dilo & Zlatanova, 2008, 2010, 2011), Dilo and Zlatanova developed a data model to capture and manage both operational and situational information along with spatial data structures in emergency response, but they neither mentioned nor included about the required resources for the emergency management in their model.

Onorati (Onorati et al., 2014) has developed an ontology named SEMA4A ontology to for managing knowledge about accessibility and evacuation guidelines during emergency situations. The main classes of the ontology include “Evacuation, Location, Personnel, Procedure and Transportation”. Chen (Chen et al., 2013) has developed a data model for fire emergency response. This data model is applied only to fire emergencies. In (Aydinoglu, Demir, & Ates, 2011), a geo-data model was developed to specify the components to determine the application schemas of geo-data themes and to harmonize geo-data to enable semantic interoperability. In this model, the authors focus only on spatial data structures, but not on the emergency actors and their tasks.

In (Azcona, 2014), an ontology was developed to model the emergency management domain. In this model, the authors included incident classification, agents, roles and profiles, geographical objects, map symbols, time, space, resources, infrastructure, spatial point objects, communication objects, activities (task and movement), but not the severity or emergency impacts and escalation. Barros (Barros, Kislansky, Salvador, Almeida, Breyer, & Gasparin, 2015) along with other researchers, developed an EDXL-RESCUER ontology for semantic integration. The developed model uses EDXL (Emergency Data Exchange Language) to model the coordination and exchange of information with legacy systems. The concepts, included in the model, were alert, info, resource, incident, response type, area, category, message type, status, and scope. In this model, the authors focused mainly on alerting the people. This model however, does not cover time and spatial information.

Bitencourt (Bitencourt et al., 2015) developed an ontology for emergency response protocols, in particular, to fires in buildings. The developed ontology supports knowledge sharing, evaluation and review of the used protocols, contributing to the tactical and strategic planning of organizations. This model, however, is restricted only to fire emergency, but not applied to other emergencies. In this work (Brewster, 2014) a ontology called DIRES was developed . It was developed to describe emergency situations and the key factors that are associated with response activities to the incident. It also defines terms related to scenario, people and organization and others.

Babitski (Babitski et al., 2011) developed a ontology called SoKNOS, which includes resource planning, damages and geo-sensor information. In (Bénaben, Hanachi, Lauras, Couget, & Chapurlat, 2008), a meta model, called ISyCri, was developed to conceptualize the crisis coordination. The developed model includes categories of entities affected by crises, the treatment system, and the crisis description. Othman and Hassan (Othman & Beydoun, 2013) developed a meta model for each phase of the disaster management domain to define the concepts and to serve as a representational layer of the disaster management expertise. The classes that exist in the meta-model were: Event, Organization, Procedure, Requirement, Policy, Actor, ElementsAtRisk, Team, Domain Knowledge, Resource, ActorRole and MessageCommunication. However, this model did not cover the ‘where’ aspect of the emergency.

In (Kirillov et al., 2012; Mescherin, Kirillov, & Klimenko, 2013), an ontology was developed for emergency shared situational awareness. The main components of the model were: Event, Mission, Resource, Context and Actor. In this model only ‘what’ and ‘who’ were included, but not ‘when, where and how’ of the W3Consortium (Frameworks., 2009). In their seminal work, Jihan, Satria and Aviv (Jihan & Segev, 2013) developed a Context Ontology for Humanitarian Assistance in Crisis Response. This context ontology was included with two parts: global ontology and local ontology. The classes in the global ontology were: crisis identification, place, crisis need. The classes in the local ontology were: Event, Actor, Time, Impact and Place. Fan and Zlatanova (Fan & Zlatanova, 2011) proposed a model to explore the semantic interoperability of the terms and spatial information to be used by different emergency response organizations. The proposed model was consisted of dynamic data ontology for assisting responders in decision making.

In our work, we reuse classes of the existing information models from the previous work such as where, what, who, when and how. At the same time, we extend the existing models by adding classes derived from our research with emergency managers, such as `emergency_severity`, `risk_area`, `emergency_cause`, `emergency_speed` in the `Fire_Emergency` component and classes such as `network`, `devices`, `access facility`, and `inbuilt_resources` in the `building` component.

## 2. RESEARCH METHODS

### 3.1. META-MODEL ENGINEERING

A variety of approaches have been suggested for building meta-models in literature (Beydoun, Gonzalez-Perez, Henderson-Sellers, & Low, 2005; Corcho et al., 2003; Fensel, 2001; Fernández-López, 1999; Gómez-Pérez, Fernández, & Vicente, 1996; Grüninger & Fox, 1995; Lenat & Guha, 1993; N, 1997; Michael Uschold, 1996; Mike Uschold & Gruninger, 1996; Michael Uschold & King, 1995). According to (Corcho et al., 2003), a domain model can be built either from scratch or by reusing the existing knowledge (models). In this paper, we build our domain model by reusing the existing knowledge and models and also by adding some extra knowledge.

Uschold and Kings's method (Mike Uschold & Gruninger, 1996) for building meta-model contains four activities: (1) identifying the purpose of the ontology, (2) building it, (3) evaluating it and finally (4) documenting it. Authors (Grüninger & Fox, 1995) propose a methodology for development of knowledge-based systems using first order logic. In the work (Lenat & Guha, 1993), the methodology used for building the ontology consists of three phases. The first phase consists of the manual codification of articles and pieces of knowledge. The second and third phases consist of acquiring new common sense knowledge using natural language or machine learning tools.

The methodology used by the authors (Gomez-Perez, Fernández-López, & Corcho, 2006) for building ontology is METHONTOLOGY. As defined by (Fernández-López, Gómez-Pérez, & Juristo, 1997), Methontology is a well-structured methodology to build ontologies from scratch. This method is developed within the ontology group at Technical University of Madrid. This methodology highly recommends the use of existing models. It consists of 6 tasks (Fernández-López et al., 1997) and which is being used in our work. The tasks are:

- *Build a requirements specification document:* Getting knowledge about the scope of the ontology, intended uses, level of formality, and intended end users.
- *Acquire knowledge:* Knowing the sources of knowledge from which the knowledge can be elucidated by using conjunction techniques such as: brainstorming, interviews, formal and informal analysis of texts, and knowledge acquisition tools.
- *Conceptualize the meta-model:* In this phase, structuring the domain knowledge in a conceptual model which describes the problem and its solution in terms of the domain vocabulary identified in the ontology specification activity. Conceptual model consists of domain concepts, their meanings, attributes, and instances.
- *Implement the meta-model:* In this phase, the ontology is codified into a formal language.
- *Evaluate during each phase:* Evaluation means to carry out a technical judgment of the ontologies, their software environment and documentation with respect to a frame of reference (in our case the requirements specification document) during each phase and between phases of their life cycle.
- *Documentation after each phase:* Documenting after each phase of the ontology development.

This methodology includes several techniques, methods and guidelines, particularly for the domain model building. To solve the semantic inconsistencies, we have used document analysis, semi-structured interviews and targeted literature survey. In the following section, we implement the METHONTOLOGY methodology in order to build a relevant domain model for Building Fire Emergency Response (BFER).

### **3.2. DATA COLLECTION APPROACH**

To build the domain model, first, an indoor fire emergency scenario was designed for a fire case occurring at the university in Southern Norway. This scenario was used to collect the data related to fire emergency management domain concepts and the relation between them through semi-structure interviews. The scenario and interview guidelines were based on a review of guidance documents (Beredskap, 2003; BeredskapOmRøyk, 2003; NPD, 2011) from different emergency response organizations. From those documents, standard emergency plans and procedures were extracted. Seven semi-structured interviews were conducted with three officials from police department, fourteen officials from fire-department and two officials from Grimstad municipality. All interviews were audio recorded, and notes were taken. The audio-recordings were analyzed with NVIVO to identify the domain concepts. The interviews focused on fire emergency management procedures, information requirements, terminologies and applications, involved actors, and characteristics of the emergency.

Similar to (Beydoun, 2009; Beydoun, Low, Henderson-Sellers, et al., 2009; Beydoun, Low, Mouratidis, & Henderson-Sellers, 2009), we extracted concepts manually from all existing meta-models and ontologies. From there, the potential concepts were identified which are required in our BFER domain model.

## **4. FIRE EMERGENCY RESPONSE META MODEL BUILDING**

In this study, the data exchange agreements such as concepts, their properties, terminology and relations in the fire emergency management domain among different emergency organizational responders can be structured and formalized as “*domain ontologies*”. Therefore, the contribution in this paper lies in developing a domain model of building fire emergency management to facilitate the process agreement on data exchange by representing the concepts, terminology and relations between them. This domain model will provide a common basis for understanding the general behavior of information sharing among different ERs.

### **4.1 BUILD A REQUIREMENTS SPECIFICATION DOCUMENT**

In order to build the BFER domain model, we provide, in this section, the key factors of the model such as required terminology, intended uses and users.

In any emergency, there is a diversity of responders from different organizations who need to coordinate to manage the emergency efficiently (Nunavath, Radianti, Comes, & Prinz, 2015). These responders are typically dispersed geographically at the emergency site or remotely in a coordination cell (Comes, Hiete, & Schultmann, 2013). In addition, the responders have different roles to perform, tasks to handle, and modes to communicate. As such, their individual insights need to be shared to attain an overview of the emergency and shared situational awareness (Van de Walle et al., 2016).

A requirement for mismatches in the situational awareness across organizations and fragmented knowledge can be avoided with the help of building a shared knowledge-management system, based on the representation and the characterization of a BFER. The domain model should be able to tackle the problem of revealing and sharing the implicit and explicit BFER knowledge. A dedicated domain model can be considered as a first mandatory step to manage the design of information systems in emergency management. As discussed in the background section above, there is currently no existing model in literature that covers all relevant aspects.

### **4.2 ACQUIRING KNOWLEDGE**

Based on our interviews with first responders from different emergency response organizations and a literature review, we identified two main categories which have to be considered in our domain model:

- Involved stakeholders
- Needed information and flows for achieving an efficient response.

**Stakeholders:** As mentioned before, an indoor fire emergency is managed by responders from different organizations. These resources will be divided into responders, who work at the emergency on-site and at the command and control center. The responders, who work on-site, receive information and support from the command center. Despite the rapid development of ICT for emergency management (Comes, Hiete, Wijngaards, & Schultmann, 2011; Van de Walle & Turoff, 2008) information on-site is still typically collected manually. In addition, each organization stores data in different formats in their own databases, making retrieval and sharing difficult. As a result, the responders, both onsite and remotely face a lot of difficulties in getting the overview of the situation. The time pressure and the urge to respond exacerbate the problem and information may be ignored, even if it is available (Turoff, Chumer, Van de Walle, & Yao, 2004). The domain model is considered as the prerequisite for building a shared knowledge management system.

**Information Needs and Flows:** When responding to a fire emergency, the first information responders look for the number of people stuck inside the building. And then, they will further collect fire related information such as fire location, severity, start date and time and building related information such as access to the building, location of the building, route to the building and other necessary information to save the victims. Usually this information is shared with other responders face to face or through hand-held devices. The information is flown in two ways: top-down and bottom up to get the global view of the situation, however, is poorly structured and managed.

### 4.3 CONCEPTUALIZE THE DOMAIN MODEL

The developed domain model consists of four components (Event, Objective, Actor and Building) and is shown in the figure 1.

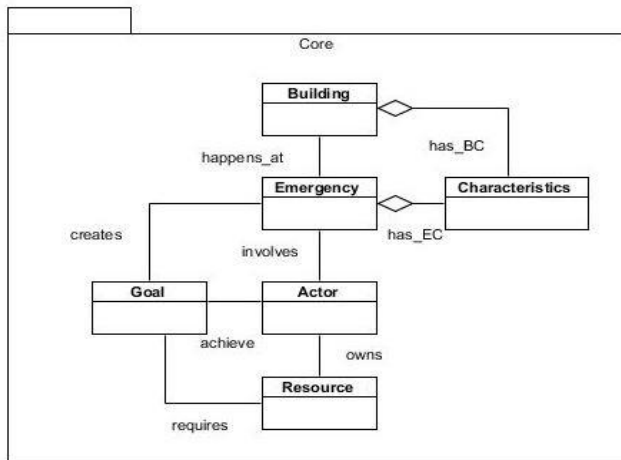


Figure 1. Different Components in the Domain model

The detailed description of components is given below.

- **Event Component:** It contains components and characteristics of the event.
- **Objective Component:** It is about the missions to achieve, which have to be managed by the emergency responders.
- **Actor Component:** This is about involved people, material, tasks and required resources.
- **Building Component:** This includes components and characteristics of the building.

The detailed description of each component is given as follows:

**Event Component:** The event component includes all the elements related to the emergency elements that permit to describe the building fire emergency characteristics and the links between them.

- *Fire Emergency*: Any emergency related to the fire.
- *Emergency severity*: The degree of severity or scale of the fire.
- *Emergency cause*: The cause of the emergency.
- *Emergency start time*: The time when the emergency started.
- *Emergency end time*: The time when the emergency ended.
- *Risk Area*: The information related to areas inside or outside the building that are considered risky or vulnerable when fire emergency occurs.
- *Emergency speed*: The escalation of the emergency speed (ultrafast, fast, slow).
- *Emergency start date*: The date on which the emergency start to occur.
- *Emergency end date*: The date on which the emergency is considered over.
- *Emergency impacts*: The information related to emergency impacts such as damages due to fire emergency.

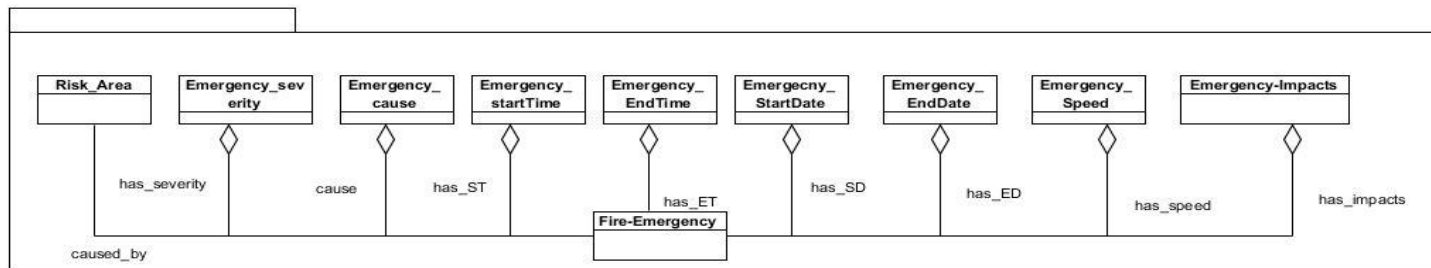


Figure 2. Event Component

**Actor Component:** This component incorporates all the elements that specify the responders' properties (role, task, team, resources, status, etc.)

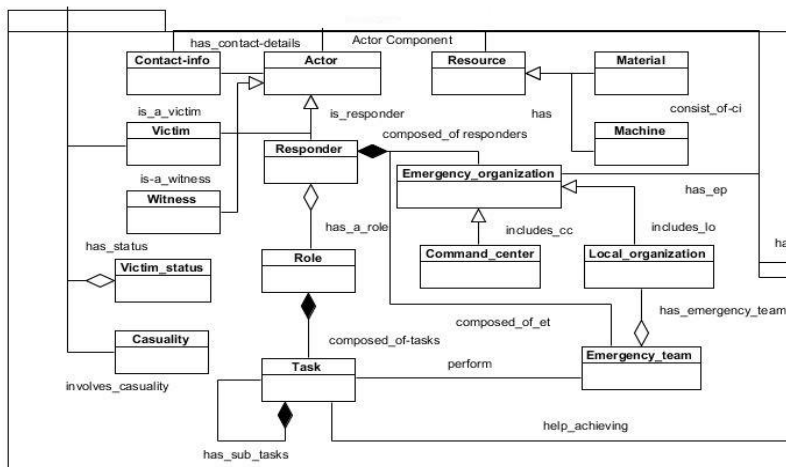


Figure 3. Actor Component

- *Actor*: Any actor involved in the fire emergency (e.g., firefighters, policemen, municipality staff, ambulance personnel, causality, and witness).
- *Role*: The role performed by the actor in the emergency setting (on-scene commander, smoke divers, smoke leaders, crew manager).
- *Task*: Task performed by the actor (search, evacuate, transportation, treating victims, investigation, firefighting).
- *Emergency organization*: Any organization that should be involved in managing emergency situations (fire protection services, police services, hospital services, and municipality services).



- *Command center*: Command center belong to any emergency organization (fire command and control center, police command and control center, hospital command and control center).
- *Local organization*: Any local organization (local fire department, local police department, local municipality, and local ambulance services).
- *Emergency team*: Team belongs to any emergency organization (fire team, police team, ambulance team and municipality team).
- *Resource*: Any additional, non-information resource needed for achieving life-saving objectives i.e., machine (trucks, equipment, and etc.), and material (documents related to emergency plans and procedures).
- *Contact info*: Contact information of the involved actors.
- *Victim status*: Status of the victim (injured, dead, unconscious or either normal or handicapped).

**Objective Component:** This component contains the information related to the goals to fulfill based on the procedure and alternative plans by emergency responders, even if the responders face any obstructions from the weather conditions.

- *Goal*: Objectives that are formulated and prioritized after the emergency occurs and need to be achieved by the responders during the emergency handling (sheltering, protection, preventing fire, treat injured, mitigation, safety).
- *Emergency response procedure*: Emergency procedures followed by the actors to achieve goals.
- *Emergency plans*: Any plans followed by actors to achieve their goals.
- *Weather effects*: Any environmental conditions which influence the actors' capability for achieving their goals.

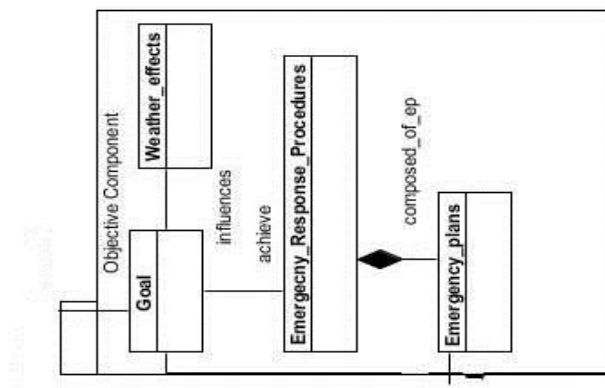


Figure 4. Objectives Component

**Building Component:** The building component depicts the information related to the characteristics of the building and link between them.

- *Building*: Any building where the fire emergency occurs.
- *Building type*: The type of the building that got involved in the emergency.
- *Network*: Wireless network inside the building.
- *Access facility*: Any access facility element that has type of access to the building (such as doors, windows).
- *Devices*: Any device (e.g., sensor devices) that is mounted inside the building.
- *Inbuilt Resources*: Any resource required for firefighting that is located inside the building (e.g., fire hydrants, fire hoses, fire extinguishers).
- *Hazardous material*: Any hazardous material (e.g., chemicals, gasoline, etc.) that is inside the building.
- *Physical places*: Any place where the elevators are located.
- *Factors*: Any factors that influences the fire inside the building (such as wind, moisture).

- *Emergency Area*: Any fire emergency area inside the building.
- *Location*: Location of the building where fire emergency occurred.
- *Address*: The street address of the building where the emergency occurred.
- *Route*: Possible route to reach the building where the emergency occurred.

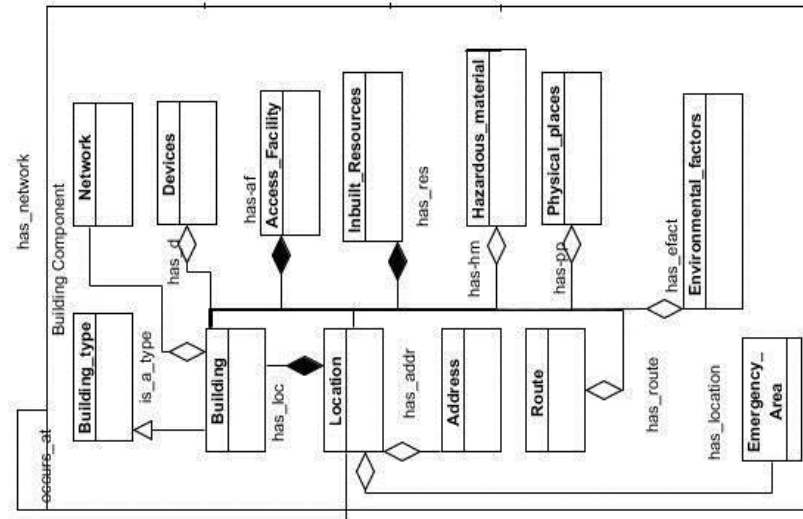


Figure 5. Building Component

Figure 6 portrays the big picture of the developed domain model which was validated by stakeholders' feedback.

## 5.CONCLUSION AND FUTURE WORK

In this paper, a Building Fire Emergency Response (BFER) domain model has been proposed and developed to facilitate to structure and to integrate the knowledge that can be used in fire emergency response search and rescue operations inside the building. The model is drawn from extensive literature review in combination with interviews with emergency organizations. The domain model is conceptualized and composed into four components: Event component (What and When), Actor component (Who), Objective component (How) and Building component (Where and How). Each component contains several different elements and all components capture the complete building fire emergency response. The design of the model was done through domain modeling approach. The main contribution of this paper is the developed domain model that is more comprehensive and aiming specifically at designing the information system for different emergency responders.

### *Future work:*

The current BFER domain model is an attempt to describe and integrate the concept which is related to building fire emergency response. Moreover, this gives a static view of the BFER. By implementing it, we can obtain a "picture" of the BFER as observed in a given moment. As a future work we want to consider this model to build an information system that can facilitate the data exchange between the different emergency response actors and hence improved fire emergency response operations in case of an indoor fire emergency. Another possible work will be introducing actors' behavior component to the developed domain model to define the operational processes that the BFER actors do to achieve the goals in a given context.

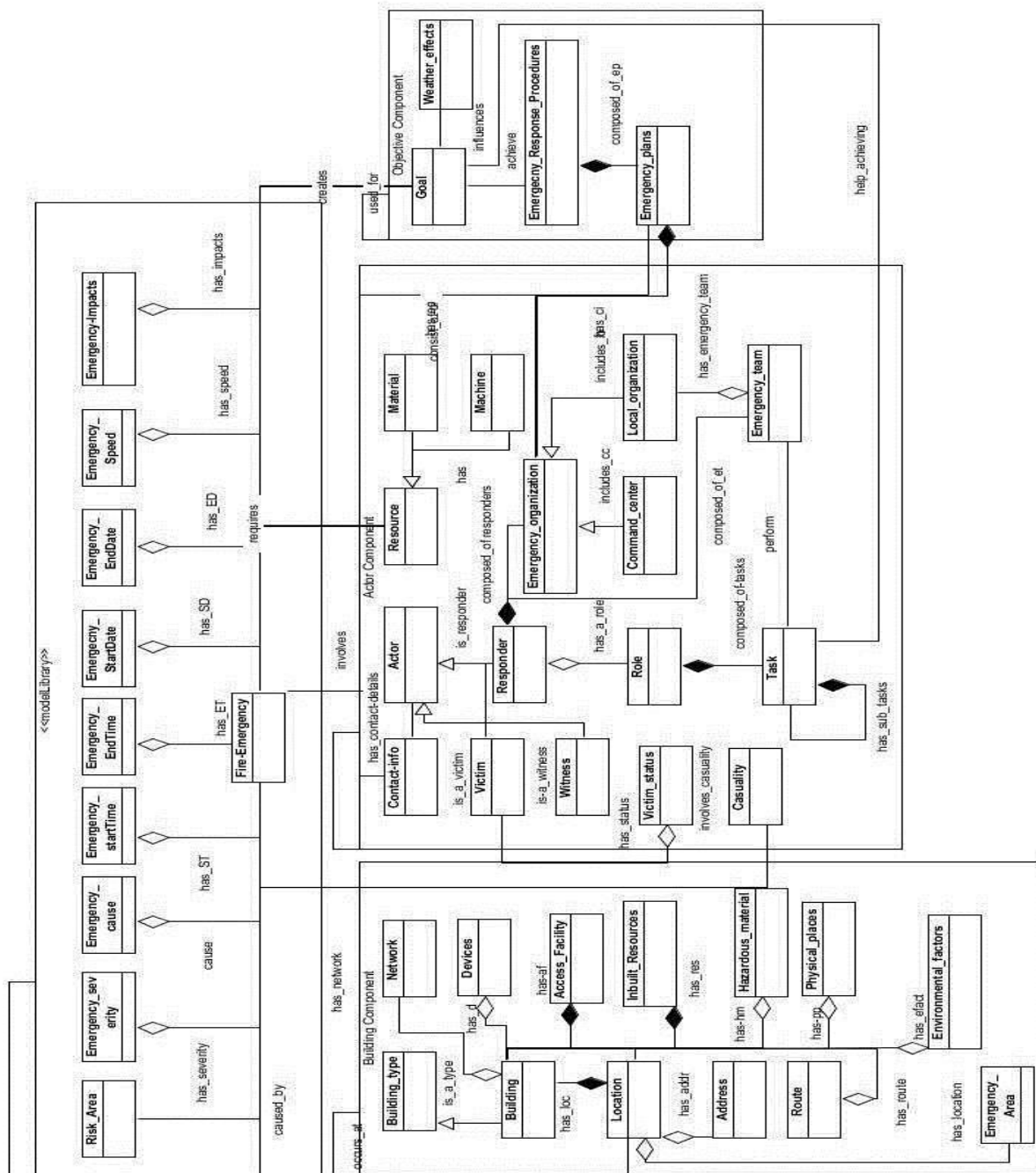


Figure 6. Building Fire Emergency Response Domain Model

## Acknowledgment

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