# Holistic Complexity Management During Disasters:
## Enhancing the Resilience of Rapidly-Evolving Viable Systems

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| **ARVSM** | Agile and Resilient Viable System Model |
| **CAT1** | Category One Responders |
| **CC** | County Council |
| **CCM** | Civil Contingencies Manager |
| **CD** | Complexity Driver |
| **CG** | Community Group |
| **CS1** | Case Study 1 |
| **CS2** | Case Study 2 |
| **DE** | Decision Explorer ® Software |
| **E1** | Case Study 1 Live Exercise |
| **E2** | Case Study 2 Live Exercise |
| **EP** | Emergency Planner |
| **EPM** | Emergency Planning Manager |
| **FCP** | Forward Command Post |
| **HAS** | Human Activity System |
| **PPE** | Personal Protective Equipment |
| **S1** | System 1 in VSM |
| **S2** | System 2 in VSM |
| **S3** | System 3 in VSM |
| **S4** | System 4 in VSM |
| **S5** | System 5 in VSM |
| **SCCO** | Senior Civil Contingencies Officer |
| **SCG** | Strategic Coordination Group |
| **SEP** | Senior Emergency Planner |
| **SSM** | Soft systems Methodology |
| **SV** | Spontaneous Volunteer |
| **TCG** | Tactical Coordination Group |
| **VRC** | Volunteer Reception Centre |
| **VSM** | Viable System Model |

# ABSTRACT

*The research proposes that the Viable System Model's (VSM) strategy of managing complexity may be inflexible and costly for responders to disasters. The traditional VSM does not offer solutions on how to address a large amount of emerging complexity by a system that is rapidly changing. In these systems, the autonomy of operations can be very important for resilience. Applying the VSM during a response to a disaster may cause systems' rigidity when agility is required.*

*The VSM perceives external complexity as a threat to viability. As such, it instructs systems to attenuate (reduce) external complexity to maintain viability. Such worldview promotes atomism. Further, it can deprive organisations of utilising critical resources that reside in the environment. Consequently, adopting a traditional VSM strategy can hinder achieving the resilience potential that is crucial to stay viable during disasters.*

*Accordingly, three gaps in the VSM were identified. First, the research argues that the notion of variety as a measure of complexity is not practical nor sufficient to address disasters complexity. Variety does not distinguish between potential and actual complexity. Second, the VSM does not offer a complexity classification that facilitates rapid decision-making and operations autonomy. Third, the VSM does not provide a model that helps the system to efficiently address complexity drivers.*

*To close the gaps, novel conceptual propositions and models to define, classify, and manage complexity and its generators are proposed. In addition, the role of the notions of systems' boundaries and identity in achieving higher resilience and viability beyond survival is discussed.*

*The research addresses the operational complexity that is associated with spontaneous volunteers (SVs) during disasters response. The data were collected in two UK counties that encountered SVs during their response to major disasters. 23 semi-structured interviews were conducted with representatives of county councils, blue light agencies, British Red Cross, and volunteers. Further, two live exercises that were designed to test a new SV policy were observed. The data were analysed thematically through open coding and a focused coding using the VSM and the proposed conceptual models.*

*This research contributes to the VSM, systems thinking, and disaster literatures. It opens the door for further research to develop the proposed propositions and models. Further, the research informs policymakers and practitioners in the field of disasters and beyond.*

# DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning

# COPYRIGHT STATEMENT

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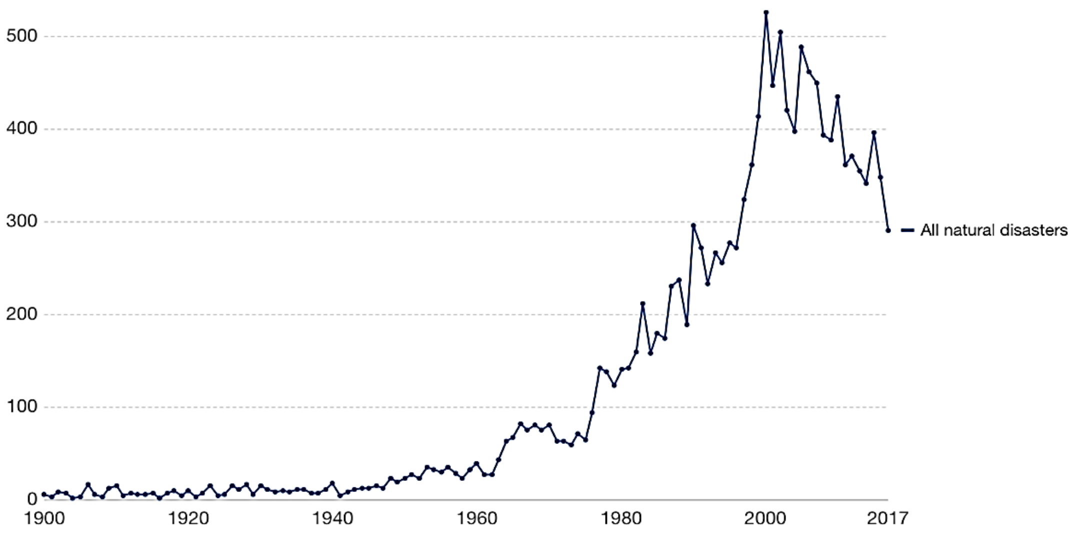
CHAPTER 1

# INTRODUCTION

## 1.1. BACKGROUND

The last 50 years witnessed a significant increase in the number of disasters around the world (Aon Benfield, 2018). Figure 1-1 shows the increase in the number of natural disasters such as floods, earthquakes and drought. However, a diversity of new types of disasters have emerged as a consequence of the evolvement of the technological, industrial and financial sectors – in addition to the political tension around the world. Examples of the latter disasters are the recent case of the Fukushima Daiichi Nuclear Power Station in Japan and the recent financial crisis of 2007-2008.

**Figure 1-1: Number of Recorded Natural Disaster Events Over 117 years**




Source: Natural disasters – EMDAT (2017)

This increase in the frequency and the high impact on societies have brought into focus two main themes: viability and resilience. Traditionally, governments and organisations' approach to enhancing the resilience of their systems and societies in the face of disasters was to increase preparedness. This was mainly attempted by using more resources, personnel, and apply prevention measures (Alexander, 1993) – e.g. building water defence in flood-prone areas. However, the increased complexity and the unpredictability of disasters limit the effectiveness of such approaches. In addition, the strategy of investing in more resources during preparedness has become increasingly challenging following the financial crisis (Atun, 2014). As such, Atun (2014, p. 38) stresses that the quality of the preparedness plans varies internationally and on the borough level according to the budget available.

Recently, there has been a significant emphasis on engaging volunteers before, during, and after disasters as a strategy to enhance resilience (Wilson, 2013; Cox and Hamlen, 2015). The requests for engaging volunteers is found in the disasters literature (e.g. Osti and Miyake, 2011; Zakour and Gillespie, 2013), in the guidance of international organisations (e.g. UNISDR, 2015), in the guidance of governments (e.g. Cabinet Office UK, 2013), and in the recommendation of independent reports (e.g. Pitt, 2008).

A major challenge that is widely reported by responders to disasters is the management of spontaneous volunteers (SVs). SVs are unaffiliated volunteers who attend to the site offering help. The SV phenomenon and the challenges associated with it have widely been observed and reported during disasters around the world (Argothy, 2003; Drabek and McEntire, 2003; Helsloot and Ruitenberg, 2004; Rodríguez, Trainor and Quarantelli, 2006; Orloff, 2011; Barraket *et al.*, 2013; Harris *et al.*, 2017). As such, Barraket *et al.* (2013) emphasise that SVs are an intrinsic characteristic of disasters that needs to be addressed by responders to disasters. Increasingly, an argument in the disasters literature is made that engaging SVs formally during a response to disasters can contribute to enhancing responders and communities' resilience (Barraket *et al.*, 2013; Shaw, Scully and Hart, 2014). If managed well, SVs can indeed be a significant resource (e.g. skills, manpower and physical resources such as equipment) that can be timely available (Fernandez, Barbera and Van Dorp, 2006) for officials and communities.

This motivated the researcher to search the disasters literature to find out whether previous studies on SV management exist.

### 1.1.1. The Limited Research on SV Management

Conducting an online search shows that the systemic and operational research on managing SVs during the disaster is rare. For instance, searching for articles that contain "spontaneous volunteers" and "operations" on Google Scholar results in only one publication that was published in 2016. However, this publication aims at comparing SVs with organised volunteers using a social theory and does not aim at finding operational solutions. Similarly, running the same search by replacing "operations" with "system" results in no relevant publications. Using very broad keywords such as "management (or managing), volunteers, and disaster" resulted in less than 10 publications, the majority of which do not offer systemic and operational solutions. Lindner *et al.* (2018) explain that such research is challenging, complex, expensive, and difficult to arrange.

Many disaster researchers are requesting more studies on a systemic involvement of the community in the disaster response and recovery (Kahan, Allen and George, 2009; Alexander, 2011). Although this request is also made three decades ago (Quarantelli, 1982), it seems that researchers have not done much to address this request (Orloff, 2011). This subject is particularly important in the UK context where floods are expected (Pitt, 2008). This makes operational community engagement research a priority in the UK, as it is in the rest of the world (Alexander, 2005; National Research Council, 2006; Zakour and Gillespie, 2013; UNISDR, 2015).

### 1.1.2. The Need for SV Management System

The need for SV management studies is also intensified by a similar practical need. Coppola (2011, p. 264) points to the fact that SV management *"...falls outside the standard course of instruction generally required of fire, police, or EMS [Emergency medical services] officials".* However, Fernandez, Barbera and Van Dorp (2006) stress that a strong volunteer management system is needed in order to benefit from their potential of enhancing resilience. They add that without such system, SVs will use their judgement and act based on their narrow view of the incident.

In practice, the number of SVs can reach hundreds of thousands as happened in Japan's earthquake in 1994. During the response to this earthquake, SVs found the majority of survivors (Orloff, 2011). However, SVs' engagement can cause tragedies. For instance, a 100 SVs were killed trying to help others during Mexico's earthquakes of 1985 (Soberón, Frenk and Sepúlveda, 1986). Orloff (2011) claims that the latter tragedy could have been prevented through training. Hence, SVs can be a paradox for official responders because they can help or become part of the problem (Barsky *et al.*, 2007). This can explain why it is commonly reported in the disasters literature that officials attempt to keep SVs outside the disasters area. Nevertheless, Orloff (2011) stands against blaming SVs only for being problematic. Rather, she stresses that misperception and lack of planning can lead responders to dissuade SVs from assisting (Orloff, 2011).

Orloff (2011) says that, officials' misperception about SVs concern the latter's efficacy; meaning that officials do not believe in the ability of SVs to deliver the desired response. However, this misperception may not fully represent the complexity of the phenomenon. For instance, Harris *et al.* (2017) list different factors that can fall under the official misperception including: thinking that only two choices are available (e.g. exclude or include), the motives of SVs, the role of SVs during disaster (e.g. whether they are entitled to respond), and the SVs acceptance to collaborate with officials.

The SV debate was brought into sharp focus in the UK after the floods episodes of 2007 and 2013-2014. The independent review that was conducted about the 2007 floods reported the absence of systematic management of SVs and recommended putting more efforts into engaging and managing SVs (Pitt, 2008). After the 2013-2014 floods, the UK government advised local authorities to plan for managing SVs. Accordingly, some county councils in the UK embarked on projects to create policies to manage SVs and planned live exercises to test these policies. During a live exercise, a planned simulation of an incident is run in a physical location (e.g. a village or a city). Official responders, NGOs, and diverse stakeholders engage in the simulation to operate in a way that is closest to a real response to a disaster.

Traditionally, the strategy of facing floods in the UK was mainly through prevention; e.g. building flood defence (Oliver-Smith, 2004). However, this approach to disaster governance is increasingly under debate in the UK (Porter and Demeritt, 2012). The new approach to resilience is more engaging and holistic in nature. Yet, operational solutions are to be found. A systemic study can significantly contribute to solving this issue, enhancing resilience, and maintaining the public well-being.

This research addresses this gap. It operationally explores the complexity that is associated with SVs. Further, it explores solutions to engaging SVs into the official disaster response system. However, before elaborating on the research aims and the motivations of this research, it is necessary to consider the following questions:

- What is volunteerism and what is the complexity that is associated with SVs?
- What is a disaster response?
- What is the UK emergency response system?

These aspects are important to provide the reader with a background that is essential to understanding the context of the research and the considerations that influence the selection of the research methods and the conceptual underpinnings of this research.

## 1.2. VOLUNTEERISM

Volunteerism was first used in the 16$^{th}$ century to refer to people who choose to join the army. The word is derived from the Latin word "voluntarius" which refers to one's free will (*Online Etymology Dictionary*, no date).

### 1.2.1. Definitions

Voluntary Services Unit (1995, p.3) introduced a comprehensive definition of volunteerism as "*the commitment of time and energy for the benefit of society and the community; the environment; or individuals outside one's own immediate family. It is undertaken freely and by choice, without concern for financial gain"*. However, Musick and Wilson (2008) argue that one cannot precisely pin down a definition of volunteerism. They explain that there are no criteria to define social practices as being voluntary. For instance, it might not be clear if activities such as helping an elderly neighbour to carry groceries, helping a family member to paint their home, or taking part of the activities of NGOs can be considered as similar voluntary activities. As such, Musick and Wilson (2008) note that claims of the subjectivity of the term can be justifiable. While economists' perspective of volunteerism can be guided by its financial impact (free labour), charities can perceive the voluntary activities from social and humane perspectives. Others, such as Son and Wilson (2017), go beyond the social definition of volunteerism and related the phenomenon to biology by linking the voluntary behaviour to a genetic attribute that can vary among families and genders. Other political and social thinkers explain the phenomenon from a political perspective. For example, Petras (1997) claims that volunteerism is the phenomenon that the U.S. government uses to deal with the growing social problems and is an *"ideological weapon to change the nature of the political debate from the state's responsibility for its citizens to the private initiatives of the poor"*(p.1587). Similarly, Musick and Wilson (2008) point out that volunteerism can be considered a type of activism to reduce social problems; and Jedlicka (1990) defines volunteerism as the method to escape the organisational culture of bureaucracy, greed and selfishness.

Although the notion of volunteerism is often perceived as a free service (Musick and Wilson, 2008), Wardell, Lishman and Whalley (2000) explain that volunteerism can involve activities that are not *entirely* free. Jackson (2013) agree that volunteerism can be paid and discusses the notion of volunteerism as an act of caring for vulnerable people. Feinstein and Cavanaugh (2009) clarify this issue and explain that before the 1960's a volunteer was defined as a person who provides services to a cause or an organisation without remuneration. However, after the 1960's, this financial link was eliminated from the definition of volunteerism. The new definition defines volunteerism "para-professional" to indicate that volunteers are the individuals who assist professionals in carrying out specific functions, be it paid or unpaid.

The United Nations as part of its celebration of the 'year of the volunteer' in 2001 introduced three broad criteria that can be generalisable to all volunteering activities around the globe. The criteria were used for a survey to distinguish volunteerism from other types of behaviours. Dingle (2001, p.9) lists these criteria as follows:

- It is not taken primarily for financial gain. The monetary reimbursement of the voluntary work should be less than the market value of the same type of work. Nevertheless, it is important that volunteers are reimbursed for their expenses that arise from the voluntary activities. This is important to enable the volunteer to survive and to mitigate against excluding volunteers with limited financial abilities.

- It is undertaken of one's own free will. Free will is a basic principle of volunteerism. However, in reality, individuals can be under social pressure or obligation to volunteer. For example, friends or relatives can exercise direct or indirect pressures on an individual to volunteer, some organisations have volunteering schemes and some countries offer their citizens to volunteer instead of military service.

- It brings benefits to a third party as well as to the people who volunteer. This criterion aims at distinguishing volunteerism from leisure activities. While it adopts a broad definition of beneficiaries, it clearly excludes relatives from the list. The logic is to emphasise mutual aid and participation as key for volunteerism.

Dingle (2001) also emphasises that voluntary work does not mean a long-term or a regular commitment. Rather, sporadic volunteering is natural and observed in the managed and unmanaged volunteers. This sporadic nature of volunteers was previously considered the main character of volunteerism. Fritz and Mathewson (1957) defined volunteers as *"personal convergers"* who are motivated to attend to areas, that are affected by emergencies. However, this definition seems to be outdated and limited to one type of volunteers. The recent studies of volunteerism provided a rich discussion of the typology of volunteerism in light of the new changes in the economic and social systems. Figure 1-2 summarises the main characteristics of volunteerism.

**Figure 1-2: Characteristics of Volunteerism**


## 1.2.2. Volunteerism in the UK

People in the UK tend to volunteer on regular basis. A survey conducted by the UK government in 2015-2016 found out that 70% of the residents have volunteered at least once in the past year and nearly half of the population (47%) were regularly volunteering at least once a month (Cabinet Office, 2016). However, the European Commission Programme considers that these numbers may not be accurate. The reason being the unregulated and loose definition of volunteering that is officially adopted in the UK. This definition does not restrict volunteering to the organisational form (Bekkers and de Wit, 2014). Rather, it defines volunteerism according to activity motives. Nevertheless, Bekkers and de Wit stress that the UK is not unique as such. The majority of the European countries, except Spain, recognise informal volunteerism and integrate the concept into their definition of volunteerism.

### 1.2.3. Types of Volunteers

The volunteerism literature contains different typologies to classify volunteers. Scholars classify volunteers according to the organisational arrangement: formal and informal (Barsky *et al.*, 2007; Geographical Science Committee, 2010); regular and occasional (Auf der Heide, 2003; Cone, Weir and Bogucki, 2003; Musick and Wilson, 2008); and organised emergent, unorganised spontaneous, and formalised organisational (National Research Council, 2006). Alexander et al. (2012) stress that a distinction should be made between the association scope, which is the number of connections or activities that an individual has with an organisation, and the association intensity, which is the time that the individual spends volunteering. Similarly, Bekkers and de Wit (2014) introduce eight types of volunteers based on their voluntary experiences. These range from non-volunteers at the lowest experience level to former volunteers as the most experienced. Other typologies of volunteerism are based on motives (Dingle, 2001), the type of job and skills (Kemp, 2002), and the market involved such as religious, charities, NGOs or governments (Dolnicar and Randle, 2007). On the latter, Alexander (2002) introduces three practical types of volunteers: those who join regular permanent organizations upon a need (e.g. volunteer fireman), those who belong to specific volunteer organizations (e.g. charities), and single unaffiliated individuals or small ad hoc groups. The latter are often called spontaneous volunteers – the focus of this research.

#### *1.2.3.1. Spontaneous Volunteers*

Spontaneous volunteers (SVs) are unaffiliated individuals (Geographical Science Committee, 2010) who attend to a disaster site because they want to offer help or are driven by other motivations. These volunteers may not have the necessary skills, training, and equipment to respond to a disaster (Cone, Weir and Bogucki, 2003). The term 'convergent volunteers' is often used in the literature and some government publications to mean spontaneous. For instance, Cone et al. (2003, p.457) introduce a definition of convergent volunteerism as *"the arrival of unexpected or uninvited personnel wishing to render aid at the scene of a large-scale emergency incident"*. However, Cone and colleagues admit that the origin of this term is unknown. Recently, the report that was published by the Department for Environment Food and Rural Affairs (DEFRA) in the UK used the term spontaneous to standardise the definition nationally and internationally. It defined SVs as *"individuals who are unaffiliated with existing official response organisations yet, without extensive preplanning, are motivated to provide unpaid support to the response and/or recovery to an emergency"* (Shaw *et al.*, 2015). This research adopts this definition because it is approved by the UK government and is standardised in the international ISO22319 standards for disasters.

The notion of spontaneous volunteering is not new. Historical evidence shows that people always converged after disasters to help others as was the case after the Great Chicago Fire of 1871 (Orloff, 2011). Furthermore, most disasters books (e.g. Alexander, 1993; Stallings, 2006; Pribadi *et al.*, 2011) approach this phenomenon as a social character of disasters. Historically, SVs were often seen as neighbours and locals trying to help others in their area after the aftermath of a disaster. However, globalisation and the recent development of transportation and social media resulted in SVs travelling to emergency areas in different parts of the world to offer help; or arranging spontaneous donations and SV groups from overseas through social media. With such development comes challenges for officials to reconsider their definitions of volunteers and to develop systemic methods to manage SVs. Volunteering Australia' (VA) is a leading example of upgrading their old definition of volunteers that included only those who are engaged with businesses, government or not-for-profits and excluded informal types of volunteerism (Barraket *et al.*, 2013; PwC, 2016). Nonetheless, their last report on the state of volunteers in Australia has found out that 33% of people would like to take informal volunteering posts rather than engaging with organisations. Thus, they changed their volunteer definition in 2015 to include informal (or spontaneous) volunteers (PwC, 2016).

#### *1.2.3.2. Motives and SVs*

Motivation can be defined as *“Having an image of the desired result and working toward its achievement”* (Musick and Wilson, 2008, p. 55). Studying people’s motives is about understanding why they do things and what they try to achieve. Motives can give meaning to people’s actions and can change the way others perceive them (Conover, Leonard and Searing, 1993). Before discussing SVs’ motives, it is important to note that theorists have not come to a consensus on the relationship between motives and actions. For instance, many sociologists disagree with the psychologists’ interpretation of the motives roles in societies (Musick and Wilson, 2008). Musick and Wilson (2008) further explain that socialists are sceptical about using a person’s reason for taking an action to understand that action. The reasons given may be disingenuous, unconscious, or unacknowledged by the relevant person. More importantly, people’s actions can always be influenced by their environment regardless of their motivation. Thus, motives are not sufficient to understand people’s actions (Sills, 1957, p. 83). This fact was acknowledged earlier by Parsons (1949, p. 217) when he said: *“the treatment of the concrete differences of behavior as direct manifestations of differences of ultimate motivation alone is clearly illegitimate in that it fails to take account of the institutional factor.”*

The Functional Theory of Motives is considered the most sophisticated psychological theory of volunteers’ motivations (Musick and Wilson, 2008). It facilitates a functional analysis that explores the reasons and purposes that generate beliefs and actions. Clary et al. (1998) used this theory to design the Volunteer Functions Inventory (VFI) as a tool to measure and evaluate volunteers’ motivation. The VFI is one of the most used by researchers (a search on the internet shows that it was mentioned and used in 767 research papers concerning volunteers’ motives since 2007). The VFI suggests six volunteering motives that are derived from conceptualising the psychological and social functions of volunteering (Clary *et al.*, 1998). These functional motives are:

- Values: the volunteer seeks to express or practice important values (e.g. social conscience). In many cases, people work for a certain cause that they believe in. In a Canadian survey in 2001, most of the volunteers (95%) expressed that having a cause or values is the reason they volunteered (Hall, McKeown and Roberts, 2001).

- Enhancement: the volunteers seek to improve psychologically and to enhance their self-esteem through volunteering. It is the need to feel valued and appreciated.
- Social: the individual aims at expanding their social network and build new relationships. The individual's need to fit in and feel that they belong to the larger group. This motive is also one of the top motives for volunteering (Musick and Wilson, 2008).
- Career: the person volunteers to enhance their career-related skills and experience. Examples of such motives are presented in the studies of Pearce (1993) and Abrahams (1996). However, this motivation was only expressed by few surveyed volunteers. Yet, it seems to be more popular among younger people who need to build their experience rather than among the older experienced individuals (Musick and Wilson, 2008).
- Protective: the individual volunteers to reduce or escape personal problems and negativity such as guilt, emotional needs and uncertainties. An example is found in Abrahams' (1996) study when women with breast cancer history volunteered for a breast cancer foundation to connect with women who shared the same experience.
- Understanding: the motive of volunteering is learning, be it to obtain a general knowledge of the world or to develop and exercise certain skills that are not related to the individual's professional job. Examples can be individuals who wish to learn about races, cultures and first aid.

The above motives are insightful. From a practical perspective, however, the disaster literature offers an alternative typology of SVs' motives based on previous disaster research. Barsky and colleagues (2007) explain that volunteering activities spike in the immediate aftermath of a disaster and remain high during the response and the recovery phases. Thus, a person's motivation during that period can be different from that during peace times. Fritz and Mathewson (1957) introduce a typology of SVs' (or the convergent as they call them) based on their motives. This typology is still referenced in recent publications such as Musick and Wilson (2008), Barsky et al. (2007) and Barraket et al. (2013). According to Fritz and Mathewson (1957), SVs are classified according to the following five motives:

- Returnees: the evacuees who live in the area affected by the disaster.
- The anxious: who live in different areas or communities and come to the affected area to find information about relatives or friends.
- The curious: who visit the area just to observe the impact of a disaster.
- The Exploiters: who try to take advantage of the disaster for profit or personal gain.

- The helpers: those who reside in or outside the affected area who come to offer their help to victims or responders.

Since this typology was published, research continued to conclude that altruistic behaviour and the human urge to help is an irrefutable phenomenon in almost every disaster regardless of where and when it happens (McEntire, 2007). This may explain the certain presence of SVs during emergencies.

#### *1.2.3.3. Merits of SVs*

The disasters literature provides plenty of evidence that SVs can be the real first responders in major disasters (Geographical Science Committee, 2010). For instance, SVs were essential for saving lives and helping casualties during the Columbia Shuttle Explosion (Barsky *et al.*, 2007), the 1917 Halifax shipping explosion, the 2004 Indian Tsunami, and the earthquakes in Kashmir in 2005 and Mexico in 1985 (Fernandez, Barbera and Van Dorp, 2006). For instance, untrained and uninjured survivors rescued 90 per cent of total survivors in the southern Italy earthquake in 1980 (Geographical Science Committee, 2010). In agreement, Orloff (2011) stresses that SVs are key during emergencies and supports her claim with the recent report of the Department of Homeland Security (DHS) in the US that extensively documented the important roles that SVs played and the challenges they faced during disasters.

One way of measuring the benefits of engaging SVs is evaluating the economic impact of these volunteers on the response. Firstly, SVs support the response financially and with other donations such as equipment, food, and blood (Orloff, 2011; Barraket *et al.*, 2013; Shaw *et al.*, 2015). These donations are provided either directly to the victims or through officials and voluntary organisations. Second, engaging SVs (as a large number of human resources) can result in reducing the response time. For instance, it was reported by Florida Volunteers that they saved nearly 40% of the time needed to respond to the F-4 tornado in two of Florida's counties in 1998. Third, using SVs can significantly decrease the response cost for the official and the voluntary organisations. During Florida's tornado, engaging SVs saved $6.6 million during the 55 days of response compared to a contractor's service. See Table 1-1 for a comparison between using SVs and a contractor in Florida's tornado disaster.

**Table 1-1: Time and Saving from the Use of Volunteers, Osceola County, FL**

| | | | |
|---|---|---|---|
| **Initial cost for contractor** | $8 million | **Estimated time for contractor** | 90 days |
| **Cost using volunteers** | $1.4 million | **Actual time for volunteers** | 55 days |
| **Total cost savings** | $6.6 million | **Total time savings** | 35 Days |
| **Cost savings** | 83 percent | **Time saved** | 39 percent |

Source: (Orloff, 2011, p. 5).

Coppola (2011, pp.345–346) expands on the previous economic perspective and introduces three categories of the benefits of engaging SVs:

- Economic benefits: the monetary value that officials would have paid in the absence of SVs. The value is enhanced by the SVs extended involvement to the recovery phase and the speedy recovery that they can achieve.
- Logistical benefits: SVs can address local response activities that require immediate attention and extensive human resources. Examples of these activities are counselling, rest centre operations, resources distribution and public information. Taking the responsibility for these activities would free up more official human resources to carry out their central tasks.
- Public perception: the community's perception of the response quality would be more positive when SVs are engaged, managed and treated properly. In many cases, official responders will have higher-level missions to meet. Unaffiliated individuals such as SVs would have more time to take care of survivors, meet their needs, and calm and encourage them.

In addition to scholars, practitioners around the world have also documented the advantages of SVs and the need to engage them. The United Nations' vision 2015-2030 encourages governments to engage SVs in the disasters response and recovery as a strategy for reducing the risks associated with disasters (UNISDR, 2015). In accordance, the International Organisation for Standardisation (ISO) has issued the guidelines for planning the involvement of SVs (ISO22319) in 2017.

### *1.2.3.4. Challenges*

Despite the advantages, there are many challenges associated with SVs presence during disasters. SVs can overwhelm officials when they converge to the scene in high numbers that exceeds responders' ability to manage them. For instance, officials were unable to manage the 30,000 SVs who attended during the 9/11 disaster (Clizbe, 2004). In disasters, it is common that sporadic SVs outpour to the incident area and overwhelm responders and disturb their operations (Orloff, 2011). In such cases, the officials could be forced to reassign their human resources to control this flow of SVs into the risky areas to prevent these SVs from becoming casualties. Also, a large number of SVs can directly interfere with and disturb formal response operations because the officials do not know where and how SVs fit (Auf der Heide, 2003; Cone, Weir and Bogucki, 2003; Fernandez, Barbera and Van Dorp, 2006). Cone et al. (2003) add that it is frequently reported that SVs belongings such as their parked cars prevented emergency vehicles from driving in and out of the site. Auf der Heide (2003) takes the issue further and say that it is common that these SVs would provide a large amount of donations, many of them might be unneeded (Oklahoma City Document Management Team, 1996). Managing and disposing of donations was a severe problem after the 9/11 disaster in the US (Coppola, 2011).

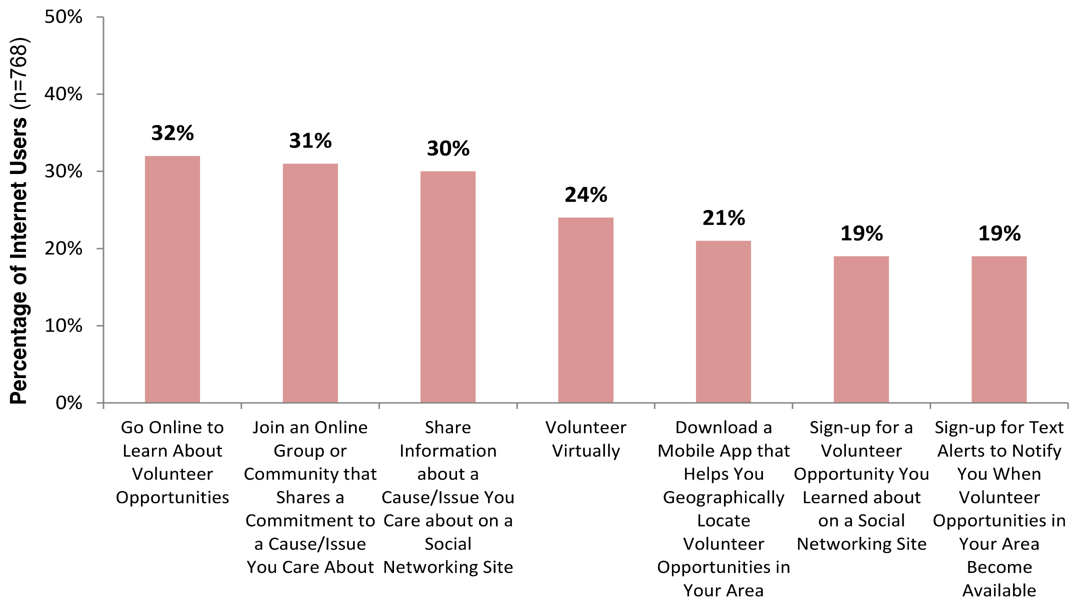
Despite their best intentions to help, SVs may be willing to only offer a specific assistance – a task that they want to do. Unlike formal volunteers, they have a say in it. This can be very challenging for responders who are accustomed to following plans and to task their staff accordingly (Clizbe, 2004). This issue is closely related to the skills, background, and the training level of SVs. Given the nature of SVs, it is difficult for official responders to verify SVs' qualification and experience during the chaotic and hectic situation. SVs come from different backgrounds and their motives are not known for officials. Thus, it would be a risky choice form officials' perspective just to meet the SVs' desire to do a certain task. In addition, the tasks that SVs request may not fit into the officials' response plan, or may not be needed.

Incidents areas are characterised with the existence of a wide variety of hazards be it physical, such as electric shocks or fires, or psychological such as being in contact with people in trauma and emotional shocks and seeing people who are badly injured. As part of their duty to protect communities, official responders are often reluctant to allow SVs, who are usually unequipped and untrained, into these areas (Debchoudhury *et al.*, 2011). For example, in an incident after the Murrah Building bombing in the US, a qualified but unequipped nurse was killed by falling debris when she was volunteering in search and rescue activities (Cone, Weir and Bogucki, 2003).

Communication with SVs is another challenge for officials because SVs are not part of the accountability structure of the response organisations arrangements. Thus, officials may not know if an SV gets into difficulty. For instance, during the 9/11 disaster, the officials' control and command system was not fully established in the first 12 hours due to the huge fires. During this period, the fire team prevented the trained and equipped freelancing physicians (SVs) from accessing the incident (Cone, Weir and Bogucki, 2003).

Recently, after the widespread of social media, virtual spontaneous volunteerism has been flourishing – see Figure 1-3. A popular definition of this phenomenon was introduced by Ellis and Cravens (2000, p.1) as the *"volunteer tasks completed, in whole or in part, via the Internet and a home or work computer."* These activities can also involve risks to emergency victims and to SVs themselves. Unidentified individuals online can provide incorrect or inappropriate health advice to victims, spread rumours, or take advantage by undertaking illegal acts. In their study, Shaw et al. (2015) have observed an increase in online spontaneous volunteerism and self-arranging SV response groups on social media in the UK. Furthermore, these networks tend to motivate large numbers of SVs to attend to the impacted areas.

**Figure 1-3: Willingness to Use the Internet, Social Networking Sites, and Mobile Technology for Volunteering Purposes, by Type of Activity**




Source: (Conroy and Williams, 2014, p. 35)

Despite the request of some researchers (e.g. Cone et al. 2003) and practitioners (Orloff, 2011) to eliminate the presence of SVs during disasters, Auf der Heide (2003) doubts that such requests are realistic and doable. Barsky et al. (2007), Alexander (1993) and

Orloff (2011) agree and insist that SVs presence is inevitable and request for more efforts to design systematic ways to manage them. Further, the need for engaging SVs was emphasised in the recommendations of the Pitt review that was submitted to the UK government after the 2007 floods (Pitt, 2008). Recently, the undeniable need to manage SVs was revealed by a study conducted by Sauer and her colleagues (2014). The study asked 24 non-governmental organisations about their experience with SVs. The majority of these organisations (72%) said that they encountered SVs during a response, most of which (79%) have encountered them regularly. More than half of these organisations (68%) believed that SVs were usually useful during the response (Sauer *et al.*, 2014).

To summarise, despite the challenges associated with SVs' engagement, they have an important potential to enhance the official responders' ability to face disasters. The scarcity of efforts to systemically include society into the response system (Fernandez, Barbera and Van Dorp, 2006; Geographical Science Committee, 2010) may explain the challenges associated with SVs presence during emergencies. It may be better to invest in overcoming the challenges associated with SVs rather than wasting such a valuable resource.

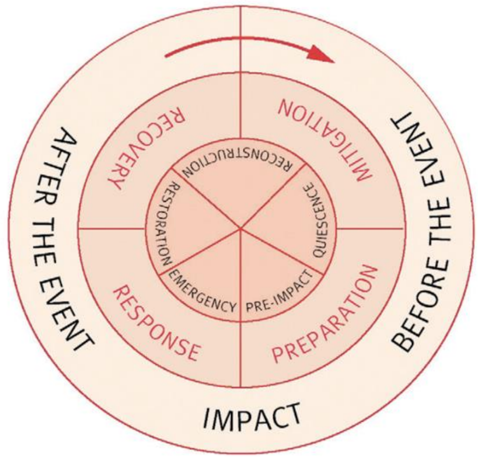
## 1.3. DISASTERS RESPONSE

The disaster response cycle involves four stages (Coppola, 2011; Simonovic, 2011). Coppola (2011) introduces the four stages of managing a disaster as follows (**Error! Reference source not found.**):

- Mitigation: reducing or eliminating the impact of a hazard.
- Preparedness: equipping people at risk or people who may help to minimise the loss.
- Response: taking action after the impact has happened.
- Recovery: returning affected people's lives to normal.

National Research Council (2006, p. 2) argues that mitigation falls under hazard research, rather being a stage of a disaster response. Most disaster scholars, however, adopt the response cycle and recognise mitigation as a stage in the repose process. Nevertheless, mitigation is not the focus of this research. Hence, this debate is not of value for this research and will not be discussed further.

**Figure 1-4: The Disaster Management Cycle**




Source: (Coppola, 2011, p. 10)

The Yokohama Strategy (UNIDSR, 1994) stresses the importance of focusing on mitigation and preparedness rather than the response stage. The argument is that the response stage *"…yields only temporary results at a very high cost"* (Coppola, 2011, p. 7).

However, focusing on the response and recovery stages may be equally important because disasters are unpredictable. Disasters can trigger cascading effects that are hard to predict (Cavallo and Ireland, 2014). For instance, it is still a challenge to predict the number of SVs that may attend to a disaster (Barraket *et al.*, 2013). Hence, enhancing the resilience and the flexibility of the response system to effectively address the unexpected can be significantly important in reducing the negative consequences and maintaining viability.

From this understanding comes the Yokohama Strategy's encouragement for governments to actively involve communities during the response to emergencies (Coppola, 2011). This encouragement is significant and responds to requests by researchers to involve communities (Alexander, 2002; Rodriguez, Quarantelli and Dynes, 2007).

The research was conducted during the preparedness stage. Hence, the data collection and analysis were not performed during a real disaster. However, the research studies the function and the structure of the response system during the response stage. Focusing on the response stage is important for this research for many reasons. First, the response system (system-in-focus) is a multi-agency system. The full operational interaction among different agencies is mainly observed during the response to a major emergency. By the end of the response phase, the system would have finished its main duties and many of the forming elements would have left it. Second, analysing the system's viability and resilience would be more valuable while most of the environmental and internal perturbations are manifesting. Third, the complexity associated with SVs is problematic for the response system during this stage. It is during the impact and the immediate aftermath where most chaos and complexity manifest. The data showed that most of the emergency services would leave the area during the recovery stage and leave the communities to self-manage their efforts to return to normality.

### 1.3.1. The UK Emergency System

The UK's emergency system uses the Gold, Silver, and Bronze model of command. This is similar to the military hierarchal approach that uses the corresponding terms Strategic, Tactical and Operational respectively (Alexander, 2008; Arbuthnot, 2008). The highest hierarchal level is the political and ethical, that makes major policy decisions. Nevertheless, this level does not usually function during emergencies (Alexander, 2008).

The strategic command (Gold) makes major decisions and controls the overall operations during the response. It connects the emergency response organisations with the government, mainly to request for resources. The tactical level (Silver) is responsible for allocating resources. Lastly, the operational level (Bronze) is responsible for responding to the disaster on the ground. The Bronze level is controlled directly by the Bronze and the Silver commanders, and indirectly by the Gold commanders.

The UK government classifies emergency responders into three categories (Cabinet Office UK, 2010) as follows:

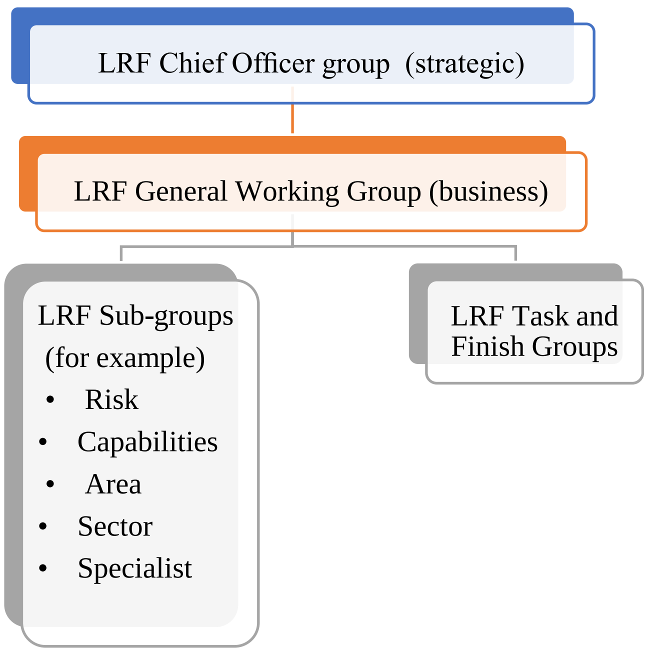
- Category 1 (CAT1): The main organisations involved in most emergencies at the local level, e.g. fire, ambulance, police, local councils, and health services.
- Category 2 (CAT2): They are likely to be heavily involved in some emergencies, e.g. utility and transport companies.
- Non-category organisations: They are organisations that do not fall into the previous two categories and involve the voluntary organisations (e.g. charities and NGOs).

Among these categories, there are three main emergency responders in the UK: police, fire and rescue, and ambulance. The commanders of the three command levels (Gold, Silver, and Bronze) belong to these organisations. However, police units are usually the lead agency in the UK because of the culture that tends to consider any emergency as a public order and safety problem. Generally, the Bronze level operates on the disasters scene while the Silver and Gold are located at suitable police stations (Alexander, 2008).

The Local Resilience Forum (LRF) plans for the local emergency response in the UK. In normal periods, the LRF gathers CAT1 and CAT2 organisations (and optionally non-category organisations) to coordinate their efforts and discuss their preparedness plans (Cabinet Office UK, 2012). During disasters, a tactical command group (TCG) is formed to respond in the one area. However, nominated members of the LRF can form the strategic command group (SCG) when the scale of the event is higher than what the Silver can address.

The UK government follows the three stages of disasters management: preparedness, response, and recovery (Cabinet Office UK, 2012). The Civil Contingencies Act 2004 (CCA) is the legal reference for organisations and institutions in regards to disasters response.

**Figure 1-5: The Structure of the Local Resilience Forum**




Source: (Cabinet Office UK, 2012, p. 29)

## 1.4. PERSONAL MOTIVATION

The author worked for NGOs on community development projects. He experienced how enabling citizens can contribute to enhancing communities and systems' resilience. This was personally and socially rewarding. The author has a background in systems thinking and soft and hard operation methods such as Six Sigma and soft system methodology

(SSM). These two experiences, combined with the author's passion for influencing change, improvement, and human well-being, led him to undertake this research.

## 1.5. THE AIM OF THE RESEARCH AND THE RESEARCH QUESTIONS

This research has practical and theoretical aims. Theoretically, the research explores operations and system thinking literatures for approaches that may be effective in modelling systems and managing complexity. Most of existing organisational models were designed for organisations that function and change in normal and mild stress conditions. However, responding to disasters requires organisations to function and adapt to sudden and extreme change conditions. Gaps in the existing organisational and complexity management theories should be identified and closed to mitigate for these conditions.

Practically, the research investigates the operational challenges that hinder an effective involvement of communities during the response stage of disaster management. It explores operational solutions to integrate SVs into the official response system.

Hence, the research aims at understanding two major aspects.

- The characteristics of resilient and viable systems.
- The methods that can help organisations to effectively manage complexity during rapidly-evolving situations (e.g. disasters).

Collectively, the research aims at understanding how to enhance resilience and viability beyond survival during disasters. Accordingly, the research questions of this study are:

1. How does the multi-agency emergency response system evolve during a response to a disaster?
2. What are the systemic and viable characteristics of the emergency response system that contribute to its resilience?
3. How does this system systemically relate to and regulate SVs' complexity during the response?
   a) What generates the SVs' complexity?
   b) What are the types of the generated complexity?
   c) Where and how is this complexity processed?

## 1.6. STRUCTURE

Chapter 2 examines disasters, system thinking and the VSM literature. In the disasters literature, the volunteerism and spontaneous volunteerism is discussed. Volunteers' motivations and the merits and challenges that are associated with their presence during disasters were discussed in the introduction. In Section 2.2 resilience is studied. The notion is defined and the resilience of organisations and communities during disasters are discussed. The section ends with questioning whether resilience is measurable. In Section 2.3, the notion of complexity from cybernetics perspective, its generators, classification, and measurement are discussed. For complexity measurement, the VSM's notion of variety as a measure of complexity is critiqued and analysed. The aim is to investigate whether this measurement can be used to enable the response system to handle emerging complexity (e.g. SVs) during a response to a disaster.

The VSM literature is reviewed in Section 2.4. The model is explained and its structure, merits and the suitability for this research are discussed. Section 2.5 introduces a reflection on the complexity dynamics during disasters. The complexity gap that exists between the system and the environment is explained. Also, the possibility that SVs might contribute to closing this gap and hence enhancing the system's resilience is discussed. In Section 2.6, gaps in the VSM literature are discussed; particularly the shortcomings that may hinder the VSM ability to enhance resilience and autonomy during disasters and rapidly-changing situations. Accordingly, the section introduces conceptual propositions and models that can help close these gaps and enhance the VSM effectiveness during disasters.

In Chapter 3, the philosophy that underpins this research is discussed and justified. Also, the methods used to sample the research participants and to collect and analyse data are explained. The data collected in two UK case studies. The case studies were selected because the responders in these case studies had responded to disasters and dealt with SVs shortly before the start of this research. Hence, it was possible to obtain relevantly fresh data about the response operations and the experience of managing SVs. The data were collected through (1) semi-structured interviews with CAT1 and CAT2 responders, and volunteers; and (2) observations of two live exercises that aimed at testing the under-development SV policies. Furthermore, the researcher attended all the planning meeting for one of the two live exercises. The data were analysed using two methods. The first was thematic analysis (Charmaz, 2006) to obtain the main themes that are related to the complexity of SVs. The second was a VSM analysis to model the multi-agency response system and to understand its complexity management practices. The two methods were merged where the VSM analysis replaced the last stage of the coding process as suggested by Charmaz (2006). This is explained and justified in Chapter 3.

Chapters 4-5 present the research findings. Chapter 4 analyses and discusses the system evolvement from a moment of a disaster impact until it reaches its full operations. The VSM and system thinking principles are the lenses used to analyse the structure, characteristics and the function of the system. The VSM lens is also used to analyse the complexity management practices of the system during its evolvement. The focus in Chapter 5 is on testing the validity of the conceptual propositions that are introduced in Chapter 2. Hence, the data is examined for complexity generators. Also, the classification of the generated complexity and the operational benefit of using such classification are analysed.

In Chapter 6, the findings are discussed in light of the existing literature and the proposed conceptual models. The discussion includes the importance of the notions of boundaries and identity for the applicability of the proposed conceptual models, enhancing resilience, and achieving viability beyond mere survival. Further, the discussion involves the practices of managing complexity that are proposed by the VSM in light of the research findings. Lastly, a model that incorporates the proposed models are proposed. This approach is called Agile and Resilient VSM (ARVSM).

In Chapter 7, a summary of the contributions of this research is presented. The research aimed at enhancing the resilience of the response system through managing emerging complexity – that of the SVs. The findings and the proposed models of this research contribute to closing the gaps in the VSM that can limit its usability to manage emerging complexity during rapidly-evolving situations. Further, it presents the abstracts of three papers that are considered for publication.

CHAPTER 2

# LITERATURE REVIEW

## 2.1. INTRODUCTION

The literature on enhancing resilience through complexity management is reviewed in this chapter. Resilience is defined in section 2.2 and discussed within the community and organisational contexts. Further, the measurability of the notion is questioned. Lastly, the chapter presents a discussing on ways to build up resilience. The discussion concludes that an effective and efficient management of complexity is a major mechanism for enhancing resilience.

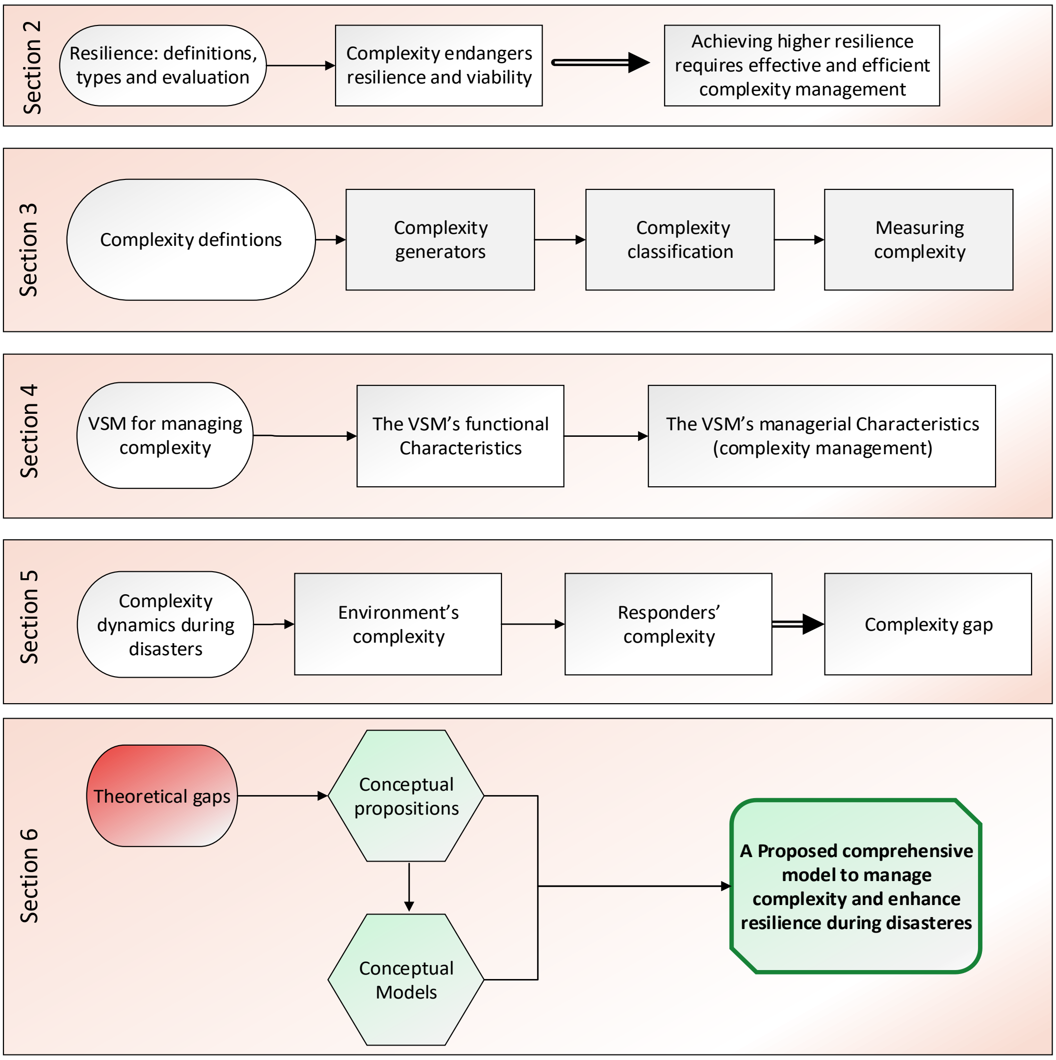
In Section 2.3, the notion of complexity and its generators are discussed. Further the systems thinking literature is explored for a clear classification of complexity. The section concludes with a discussion on how the cybernetics (control and communication in humans and machines) measures complexity. This is precursor to a more in-depth discussion of how to manage complexity for higher resilience.

The Viable System Model (VSM) as a method to manage complexity and a full justification of this choice are discussed in Section 2.4. Further, the relevant foundations of systemic thinking and viability are reviewed. The remainder of the section presents a discussion on the functional and managerial characteristics that make the VSM effective in managing complexity. The VSM praises autonomy as a source of viability and resilience. Autonomy and the dilemma of balancing control and autonomy is discussed in Subsection 2.4.4.

Complexity dynamics during emergencies is discussed in Section 2.5. The dynamics involve the changes in the environment and the response system's complexity over the period of a response. Subsection 2.5.3 introduces a discussion on the behaviours of the two complexities. It concludes with defining a complexity gap that needs to be closed, or minimised, for resilience to be enhanced. Lastly, the potential role that SVs can play in closing the complexity gap is discussed on Subsection 2.5.4.

Gaps in the VSM literature that can limit the VSM potential of achieving higher resilience during disasters are discussed in Section 2.6. In particular, the discusses involves defining variety and complexity and exploring the validity of using variety as a measure of complexity, the practicality of existing complexity classification, and the suitability of the VSM's approach to managing complexity for a resilient disaster response. To bridge the identified gaps, conceptual propositions and models are proposed. The section ends up by merging the proposed conceptual models in a comprehensive model that is argued to be flexible enough to manage complexity more effectively during emergencies. The logic and the structure of this chapter are shown in Figure 2-1.

**Figure 2-1: The Chapter's Logic and Structure**



# 2.2. RESILIENCE

Resilience has been conceptualised and studied in individuals, societies, and organisations. The concept has gained much importance recently; especially after 9/11 attacks and Hurricane Katrina in the US (Kahan, Allen and George, 2009) and the latest terror attacks in Europe. Resilience has been identified as one of the top 10 of challenges that face the Secretary of Homeland Security in the US (Kahan, Allen and George, 2009).

## 2.2.1. What is Resilience?

This notion is originated in physics to describe materials ability to withstand stress. Holling's (1973) theorem on ecosystems adaptive capacity was the earliest published transfer of physics resilience principles to populations. After this publication, studies have since been using these principles to study individuals and their ability to adapt to their environments, be it societies or organisations (e.g. Werner and Smith, 1982; Rutter, 1993; Bonanno, 2008; Gunderson, 2010). Community resilience was then the focus of numerous research to test communities adaptability and resistance to: Change (Steiner and Markantoni, 2014), disasters (e.g. Adger *et al.*, 2005; Pelling, 2012; Fekete, Hufschmidt and Kruse, 2014), policy changes (e.g. Marshall, 2007; MacKinnon and Derickson, 2012; Wilson, 2013), transformation in the economic (e.g. Hopkins, 2009; Wilson, 2011, 2012) and psychological trauma, and coping with adversity (e.g. Walsh, 2007; Berkes and Ross, 2013; Duckworth, 2015).

There is no agreement on a single definition of resilience (Greene, Galambos and Lee, 2004). Horne (1997, p. 27) defines resilience as "*the ability of a system to withstand the stresses of environmental 'loading' based on the combination/composition of the system pieces, their structural interlinkages, and the way environmental change is transmitted and spread throughout the entire system.*" He further stresses that resilience is found in systems, and it is an attribute that can be found in individuals and groups. It facilitates a positive response to a radical change that disturbs the system without resulting in negative behaviours. However, Starr et al. (2003) stress that resilience should be distinguished from risk management. They explain that resilience is about withstanding *"systemic discontinuity"* and adaptation to *"new risk environments"* (p. 3). Other definitions of resilience involve reinventing the business (Hamel and Välikangas, 2003); rapid action and solving supply/demand issues (Sheffi and Rice Jr., 2005); *"maintenance of positive adjustment under challenging conditions"* (Vogus and Sutcliffe, 2007, p. 3418); avoiding, absorbing, adapting to, and recovering from disruptions (Westrum, 2007) and *"…ability to resist and recover from loss"* (Fekete, Hufschmidt and Kruse, 2014, p. 4). Operationally, resilience can be perceived as the ability to stay successful despite adversity and risk in the environment (Greene, Galambos and Lee, 2004).

The term is used in this research to refer to a system's ability to continue functioning successfully during and after sudden and disturbing events, and its ability to rapidly fix any damage. As such, it adopts part of Horne's (1997, p. 27) definition: "*the ability of a system to withstand the stresses of environmental 'loading'…"* without limiting this study to his suggestion on how this resilience is achieved.

### 2.2.2. Resilience in the Disasters Context

The notion of resilience in the disaster context is of such a complexity that it involves a vast number of disciplines. The complexity stems from the fact that disasters, natural and human-caused, cause diverse types of damages. Disasters researchers consider enhancing resilience by enhancing the ability to resist and recover from these damages. For instance, the disaster resilience literature contains studies on the psychological impact (e.g. depression and stress disorder) of disasters and how to reduce it (e.g. Bonanno *et al.*, 2006; Bonanno, 2008; Höfler, 2014); the social factors, e.g. cultural and demographic and social responses, (e.g. Shaw, Scully and Hart, 2014; Bach, Kaufman and Dahns, 2015; Cox and Hamlen, 2015), the economic and political factors (e.g. Debbie van Opstal, 2009; Neumayer, Plümper and Barthel, 2014), and urban and rural designs (e.g. Vale and Campanella, 2005; Cutter, Ash and Emrich, 2016) that make communities more, or less, vulnerable to disasters. As such, governments who are responsible for the complex task of enhancing resilience in the face of disasters would need a new approach that incorporates all the noted disciplines with others such as engineering and physicists (Koslowski and Longstaff, 2015).

Community and organisational resilience are of core importance for governments who face disasters. The government's role is to maintain the well-being of communities and to reduce the injuries among individuals and their environment. However, the effectiveness of achieving these goals requires resilient response agencies that can provide the most effective and efficient response and recovery.

### 2.2.3. Community Resilience

Community resilience is defined as *"…a process linking a network of adaptive capacities (resources with dynamic attributes) to adaptation after a disturbance or adversity"* (Norris *et al.*, 2008, p. 127). Community resilience is a focal interest for the disasters research and practitioners. Greene, Galambos, and Lee (2004) explain that disasters scholars estimate community resilience by the ability to maintain health and mental wellbeing in rapid changing environments. As such, higher resilience advocates higher ability to maintain the community's wellbeing. Cutter, Burton, and Emrich (2010) further explain that resilience is achieved by the community's own resources and is recognised by the community's ability to recover after a disaster.

Norris and colleagues (2008) take the principle further by stating that, organisational resilience is closely related to community resilience. They stress that enhancing the resilience of organisations that belong to a community will enhance the community's ability to face sudden shocks (and vice versa). Whether these organisations are businesses, government agencies or disaster responders, their existence is justified by the existence of customers and stakeholders. Similarly, a community's capacity to survive and thrive is enhanced by the existence of organisations that meet the community's needs (e.g. products, jobs, and economic growth). Indeed, many scholars (e.g. Alexander, 2005; Norris *et al.*, 2008; Orloff, 2011; Zakour and Gillespie, 2013), organisations (e.g. UNISDR, 2015), and governments (e.g. Cabinet Office UK, 2013) advocate that the collaboration between communities and response organisations enhances communities' resilience.

Despite this existential relationship between social and organisational resiliencies, the relationship between communities and organisations seem to be in need of enhancement – in particular, the relationship between public organisations and communities. Duckworth (2015) highlights the issues in the latter relationship by criticising governments level of understanding of how communities function, that motivates communities to fill in this gap solitarily *"Governments had not recognized the extent to* *which communities had reorganized, leaving a gap for citizens eager to participate to create their own activities"* (p. 317). Whether this lack of understanding is intentional or unintentional, it suggests less control of governments (as leaders) over their communities.

Bach, Kaufman and Dahns (2015) make a similar argument to enhance the resilience of communities. They suggest that community leaders should be more innovative and significantly improve their institutional flexibility and adaptability to align with the complexities of local communities. Further, they stress that governments should adapt to conflicting social goals to be able to recruit and harness spontaneous behaviour in societies. Bach and colleagues' assertions are complementary to those of Duckworth (2015). Duckworth signifies the official institution's role in being the leader in supporting communities to enhance their resilience.

### 2.2.4. Organisational Resilience

The focus of this research is enhancing the resilience of the emergency response system as a key aspect of enhancing communities' resilience. Hence, the subject of organisational resilience is of major importance. Organisational resilience is defined as the ability of an organisation to maintain a *"...positive adjustment under challenging conditions such that the organization emerges from those conditions strengthened and more resourceful" (Vogus and Sutcliffe, 2007, p. 3418)*. This definition is compatible with the goal of this research because it goes beyond the mere survival. It requires organisations to positively adjust and emerge stronger and more evolved after the adversity.

In today's complex and dynamic environment, enhancing organisational resilience is as important as ever for survival and success. Vogus and Sutcliffe (2007) stress that the number of organisations that have acknowledged the importance of the notion of organisational resilience is increasing. Accordingly, they suggest that there is a need for an organisational resilience theory to cover the limited ability of the current organisational theory to reflect the notion. This argument was made in 2007. Recently, Samba and Vera (2013) stress that the interest in organisational resilience has soared due to the global instability.

During the 1990s, many organisations achieved resilience through creating or acquiring diverse resources (e.g. cognitive, relational, physical, and relational) that are retained and flexibly used to face strains and sudden shocks (Sutcliffe and Vogus, 2003). Therefore, organisational resilience *"…inheres in beliefs as well as affective, behavioral, and cognitive processes"* (Vogus and Sutcliffe, 2007, p. 3419). Furthermore, adopting a continuous improvement culture is popular among organisations that aim at resilience. The culture is used to regularly evaluate and improve risk management procedures to prepare for the unexpected (Vogus and Sutcliffe, 2007). As such, resilient organisations are distinguished by their proactive approach to identifying and acting upon weaknesses. Woods (2005) exemplifies from the Columbia shuttle disaster when NASA failed to recognise the risks of using some components and the risks of adopting a "production mindset" (p.292). For Woods, failing to take proactive measures regarding these issues (and others) was a sign of poor resilience that led to the explosion of the shuttle.

Some researchers relate organisational resilience to organisational design and decision-making capacity. For instance, Chan (2011) conducted a study in Hong Kong that suggests enhancing a firm's resilience by applying the VSM and a decision-making model. In a previous publication, Mallak (1998) stresses that organisational structures that promote tight control can be a barrier for resilience. The notion of distributing power and decision making and promoting autonomy as strategies to enhance organisational resilience is widely advocated in the systems thinking and VSM literature (e.g. Beer, 1979; Jackson, 2003; Schwaninger, 2006b).

A final key feature of resilient organisations noted in this section is the ability to manage complexity and to live in the uncertainty. Mallak (1998) listed tolerance for uncertainty as a key principle of organisational resilience. Furthermore, Seville (2017) notes that the increased complexity of the modern world requires resilient organisations to abandon the old way of suppressing complexity and uncertainty and learn how to manage complexity and adapt to uncertainty. David Chandler takes this argument further in his book: *Resilience: The Governance of Complexity* to suggest that governing the different types of complexity in the external environment is the way to achieve resilience in its preventive, adaptive, flexible, responsive meanings (Chandler, 2014).

### 2.2.5. Evaluating Resilience

There are many challenges to analysing resilience (Kahan, Allen and George, 2009) and to pin down the added value of enhancing resilience (Stephenson, Vargo and Seville, 2010). The difference in resilience definitions in different disciplines and contexts is a main methodological challenge for researchers. Practically, political complexities, such as gaining public and private stakeholder's support and input, are even more challenging. Furthermore, the spread of the concept over different types of systems, hard and soft, adds to its complexity. While soft resilience concerns elements such as societies; human needs; and behaviour, hard resilience concerns organisations and their capabilities and functions. Despite the differences, the organisation of these components can be collectively considered as a functional system (Kahan, Allen and George, 2009).

Kahan, Allen and George's (2009) assume that resilience has a measurable end goal. Kahan and colleagues argue that resistance, absorption, and restoration can achieve these end goals; and notably, they consider SVs as a resource that enhances resilience. Finally, Kahan, Allen, and George (2009) stress that the identification of resilience variables to integrate and analyse them is challenging. While they state that more qualitative and quantitative research is required, they stress that it is impossible to incorporate the principles into all systems simultaneously and efforts should be prioritised.

Although resilience can be examined as a snapshot of a system at a particular time, it is generally accepted that the notion of resilience is dynamic when it is applied to socio-economic systems (Greene, Galambos and Lee, 2004). Rutter (2012) justifies the dynamic nature of resilience by referring to the different kind effect of past experiences on how people respond to stress or adversity. Some individuals have better outcomes from experience than others, which can enhance their resilience in facing comparable stressful experiences. Societies are dynamic. Their individuals are in a continuous learning process. Consequently, it can be justified to accept that societies and individual's level of resilience is continuously changing. This can be the main reason why a pioneer resilience scholar as Norm Garmezy to decline the practicality of having a resilience theory (Rutter, 2012, p. 335).

The challenges of measuring resilience are apparent in the resilience literature. Attempts to measure resilience have used numerous tailored scales, variables and approaches to fit the studied contexts. Barrett and Headey (2014) stress that measuring resilience requires *"**context-specific** measurement and the right mixture of quantitative and qualitative approaches, with the latter particularly important for understanding the social and political dimensions of resilience"* (p. 189).

### 2.2.6. Building Resilience in Communities

Although there is no one way to measure resilience, the disasters scholars suggest different ways through which resilience in communities can be enhanced. These involve reducing vulnerability (Maru *et al.*, 2014); building communities competence (Norris *et al.*, 2008); community engagement before, during, and after disasters; and through collaboration between governments and communities (Geographical Science Committee, 2010). The last two are increasingly gaining more attention (Edwards, 2009; Ainuddin and Routray, 2012; UNISDR, 2015). Further, it can be argued that these two approaches to building resilience are closely related; meaning that enhancing community resilience in the face of disasters can positively impact the resilience of disasters responders and governments and vice versa.

Engaging communities is mainly achieved through volunteerism – including SVs (Cox and Hamlen, 2015). The benefits of volunteerism and engaging communities during disasters were discussed in Chapter 1. However, this effective engagement needs to be coordinated with and benefit from the official response. Governments and response systems are mainly in a position of responsibility to design the policies and the procedures that can ensure that their systems are able to engage and manage the complexity that is associated with community engagement.

### 2.2.7. Summary

This section reviewed the literature on resilience and examined its features in communities and organisations. It also reviewed approaches to enhancing resilience. The review showed that there is a general agreement among researchers of diverse disciplines that resilience is subjective, dynamic and is closely related to complexity. Hence, enhancing the resilience of communities and organisations can be effectively achieved by an effective and efficient management of the complexity of both the environment and the organisation, that is prone to external complexity. The next section reviews the literature for definitions, classification, and sources of complexity. It also identifies gaps in this literature and conceptually discusses how these gaps can be closed.

## 2.3. COMPLEXITY

### 2.3.1. Definitions

Schwaninger (2006) introduces, what he claims is, a standard definition of complexity as *"…the potentiality of a system to assume many different states"* (p.11) and explains that complexity *"…consists in a large number of distinct (potential or actual) states or modes of behaviour"* (p.12). However, defining complexity can be subjective. Researchers from different disciplines approach the subject by driving examples from the real world of their scientific field. As such, numerous perspectives of complexity exist in complexity publications. For example, managers tend to describe situations as complex when they are overwhelmed by the number of employees, the amount of information they receive, and the load of work that they encounter (Beer, 1985). On the other hand, emergency responders say that major disasters are complex because they are uncertain, and their scale is beyond officials' capacity to meet them (Alexander, 1993). In publications, complexity is often linked to uncertainty (e.g. Suh, 2005), the number of components and interactions (Ashby, 1957; Beer, 1966; Mandi and Jackson, 2009; Espejo and Reyes, 2011), the quantity of information that is needed to describe the system and the number of the networks (Ane, Maznevski and Mendenhall, 2004), and the number of interactions that the system has (Jackson, 2003).

Some social scientists who specialise in simulations and modelling approach complexity from a mathematical perspective. For these scholars, complex systems are non-linear. While linear systems are characterised by having a single optimum solution (equilibrium), non-linear systems have multiple optimum solutions (Helbing and Lammer, 2008). Haynes (2003) supports this perspective and explains that the cause and effect relationship that governs linear systems does not exist in complex systems. As such, Haynes stresses, unsuccessful attempts to model societies and organisations results from approaching social systems in a linear way.

From a cybernetics perspective, Ashby (1956) describes complex systems as *"large"*. The largeness that he promotes stems in the number of distinctions that the observer makes. These distinctions can be made of either the number of the states that are available for the system or the number of the variables (or components) of that system. He highlights the subjectivity of the notion and adds that precise measurement can make the system larger because it can help in distinguishing more states. However, Ashby uses the phrase *"very large"* to refer to the system that is too large in relevance to the observer's resources and techniques; so that this observer cannot completely observe, control, or make accurate predictions of that system (Ashby, 1957, pp. 61–62). Thus, complexity for Ashby is a description of a system's elements and the distinctions that an observer makes. This state overwhelms the observer only when it is beyond the observer's ability to distinguish or manage its elements.

Ashby's explanation of complexity involves references to observation and prediction. These two actions correspond with the distinction that Schwaninger (2006) makes between potentiality and actuality. While observation occurs in a present moment, prediction is about speculating how the observation can look like in a future moment. This distinction is discussed in section 2.5. Ashby's second distinction concerning complexity is made between *"large"* and *"too Large"* systems. This distinction means that complex system may (or may not) overwhelm the observer (or a manager). The implications of having an overwhelming situation are used in this research as a key criterion for defining and classifying complexity as can be seen in subsection 2.6.2.2.

Johnson (2009) introduces eight features of complex systems that most complexity researchers would agree on. These features are relevant to this research because they can explain the complexity that official systems face when dealing with the complexity of SVs during disasters. These features are:

- They contain a collection of many interacting objects or "agents"
- These object's behaviours are affected by memory or feedback.
- The objects can adapt their strategies according to their history.
- These systems are open.
- These systems appear to be "alive"
- They exhibit emergency phenomena which are generally surprising and may be extreme
- The emergency phenomena typically arise in the absence of any sort of "invisible hand" or central controller
- They show a complicated mix of ordered and disordered behaviour

For simplicity and applicability, this research adopts the notion that complexity involves only the distinctions made in the current state of a system or a situation. These are distinguished from the distinctions that are made on the potentiality of the system. The importance of this distinction will be discussed in the remainder of the literature review and while building the theoretical models. Before proceeding to this discussion, the next subsection examines the sources of complexity because they are a core component of understanding complexity.

### 2.3.2. Complexity Drivers

For this research, complexity drivers (CDs) are what generate complexity. They can be the things that obstruct engineers from meeting their design specifications, the factors that cause an increase of cars on the roads, the elements that construct a social system, or the number of interactions among a system's elements. CDs can be people, events, machines, weather conditions, or people's behaviours. In the cybernetics literature, Espejo and Reyes (2011) define CDs as *"aspects of the situation"* that are relevant to the system according to predetermined criteria. (p. 55); and *"the main source of perturbations that have to be taken into account for an effective performance of the organization"* (p. 122). Linking CDs to perturbations makes them a matter of concern and a potential problem because they are likely to hinder organisations' ability to achieve their goals. However, such conclusion may be invalid in light of the distinction that was made between supportive and problematic complexity in this research. Hence, generalisations should not be made on the nature of the impact of CDs. Rather, this study considers them as merely complexity generators. An assessment of CDs requires an understanding of the nature of complexity that they generate. In many cases, the generated complexity is time and context relative.

In many cases, CDs cannot be classified into problematic and supportive as is the case for complexity. The same CD can generate problematic complexity at some time (or in certain circumstances) and supportive complexity at others. For instance, a building as a CD during a flood can save lives by serving as a shelter for evacuees. However, the same building can become a death trap if it collapsed. Similarly, an SV can be a paradox for officials because they may be helpful and concurrently a health and safety concern (Harris *et al.*, 2017).

Since CDs are the source of complexity (Espejo and Reyes, 2011), it is easy to assume that more CDs can result in more complexity. However, it can be strongly argued that the number of CDs does not necessarily determine the degree of a situation's complexity. Different CDs generate complexities that differ in their nature and impact on an organisation. For instance, three response personnel of a large team on a sick leave can be considered three CDs. The impact of them being absent on the response is far less than the impact of a breakdown in a single communication system.

In a relatively stable and slowly changing environment, managers may predict the CDs that have the most impact on their organisations. Hoverstadt (2008) identifies four CDs that have an impact on organisations' primary activities. Primary activities are the activities that generate values for the external customers. These CDs are:

- Technology: the degree of technology that the organisation possesses.
- Geography: the geographic structure of the organisation.
- Customers: the activities structure based on customers (e.g. having a designated team to deal with big customers).
- Time: being able to work for longer hours beyond the staff's ability to stay in the organisation.

While Hoverstadt's CDs may be useful for planners and managers, they may not be the most significant in the disasters context. However, the importance of Hoverstadt's (2008) drivers lies in the way he uses them. He suggests using these CDs to study organisational complexity by unfolding the organisational structure according to these categories. This suggestion concerns the recursive (or fractal) nature of complexity, that is of core relevance to the VSM that is used in this research.

#### *2.3.2.1. The Recursive Nature of Complexity Drivers*

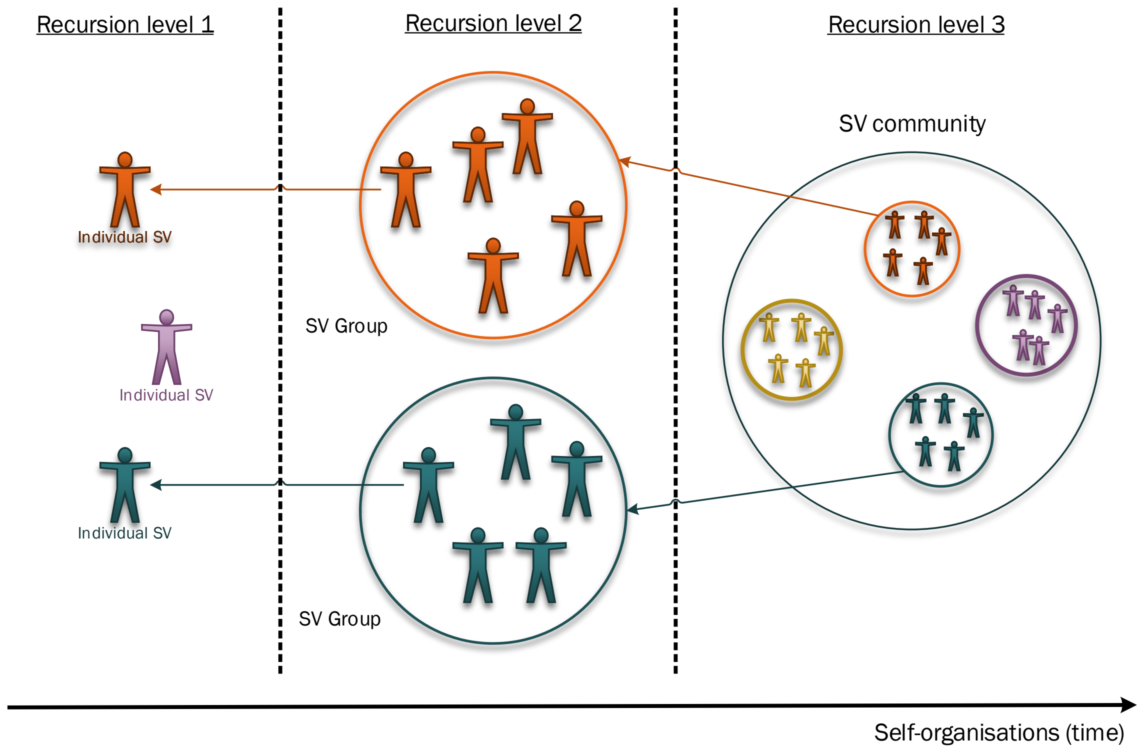
Stafford Beer borrowed the term recursion from mathematics (Christopher, 2007) to refer to the notion that all viable organisations contain viable organisations within them and are contained in a larger viable organisation (Beer, 1985; Hoverstadt, 2008). Beer (1985) argues that this principle applies to all viable system in nature. In biology, the term 'structural recursion' is used to replace the notion of hierarchy (Espejo and Reyes, 2011). The notion of recursion is discussed in detail in subsection 2.4.1.3.

CDs are recursive. Each of the drivers reported in the previous subsection is a theme of numerous lower level CDs. For instance, the technology CDs includes software, computers, networks, communication devices, electronic equipment, and so forth. Each of these also has different elements that can generate their own complexity. Similarly, an SV can be considered a CD during the response to a disaster. This SV can belong to a group of SVs, which in turn can belong to an affected neighbourhood in the area; and so on. This phenomenon (recursive SVs) is often described in the disasters literature through the notion of the self-organisation of volunteers and social networks during disasters (Rodriguez, Quarantelli and Dynes, 2007, p. ix). Self-organisation happens when volunteers decide to organise themselves in groups. These groups can network with other groups to form a larger SV community – see Figure 2-2.

Hoverstadt (2008, p. 69) argues that the order in which an organisation addresses these CDs has a significant impact on the organisation's performance and characteristics. For example, in the disasters context, a response agency can address their limited capacity to deal with incoming communication during a disaster by assessing the number of phone lines, computers and telecommunication equipment in their agency (i.e. the hardware CD). The result of the diagnosis and the changes adopted to resolve the issue can be different if they had started by diagnosing the level of artificial intelligence (e.g. the algorithms that analyse information) that existed in their communication analysis software.

Studying CDs in a recursive manner can help management in dealing with complexity more effectively and efficiently. Having the complexity divided into sub-CDs makes it easier to delegate responsibilities. In other words, an organisation's management would be able to decide which organisational recursion level (e.g. function or department) can best address different CDs. For instance, while the responders' operational units can focus on delivering personal first aid to causalities, strategic management can pre-empt escalating the impact of a disaster by improving hospitals capacity to treat a large number of casualties. Providing first aid and improving health facilities are CDs in the higher-recursion-level health and safety CD.

**Figure 2-2: Self-Organisations and Recursion in Volunteerism**




## 2.3.3. Types of Complexity

From a cybernetics point of view, complexity concerns individuals, situations, and groups. Accordingly, Espejo and Reyes (2011) introduce three types of complexity: situational complexity, individual complexity, and collective complexity. However, two additional classifications of complexity are proposed in Section 2.6.2.2. The first classifies complexity to supportive and problematic according to its impact on a system or organisation. The second classifies complexity to internal and external according to its location in regard to a system's boundaries; whether this system is an individual, a group, organisation or a society.

Espejo and Reyes (2011) classification of complexity is useful when studying organisations. It helps to understand if the observed complexity is a staff, a team or from a certain situation. However, the proposed classifications provide more generalisable criteria to classify complexity in diverse contexts and different types of systems.

#### *2.3.3.1. Situational Complexity*

Espejo and Reyes (2011, p.43) define situational complexity as *"the number of behavioural distinctions we make in it"*. This means that this complexity is relative to the person who is making the distinctions and to the measurement or observation tools he or she uses. Consequently, complexity is not an intrinsic property of a system or a situation but an attribute assigned by an observer (Espejo and Reyes, 2011).

Traditionally, cybernetics does not consider situational complexity as an intrinsic property of a system (Ashby, 1957). Rather, it attributes it to the distinctions that an observer makes of the elements and the relationships. Therefore, complexity is a subjective property that an observer assigns to a system and is influenced by the observer's discrimination (Ashby, 1957). However, in business and social contexts, agreement on the criteria that are used to define this complexity is important. In particular, stakeholders need to agree on the domain used to interact with the situation and level and observation resolution (how much detail to observe). Agreeing on this criteria is also important to compare different systems complexities (Espejo and Reyes, 2011).

#### *2.3.3.2. Individual Complexity*

Individual complexity is the set of practices that a person has at a certain time. These practices are a response to a problem that a person faces when they interact with their surrounding (Espejo and Reyes, 2011). Thus, someone's individual complexity expresses their experience; i.e. a person gains more experience by facing problems *and* developing practices to deal with them. The type of practices that the person develops can define their profession and skills (e.g. an engineer, responder, or multi-skilled). This is particularly beneficial to assess the value and impact of engaging external individuals in organisations and to assess and delegate to existing staff.

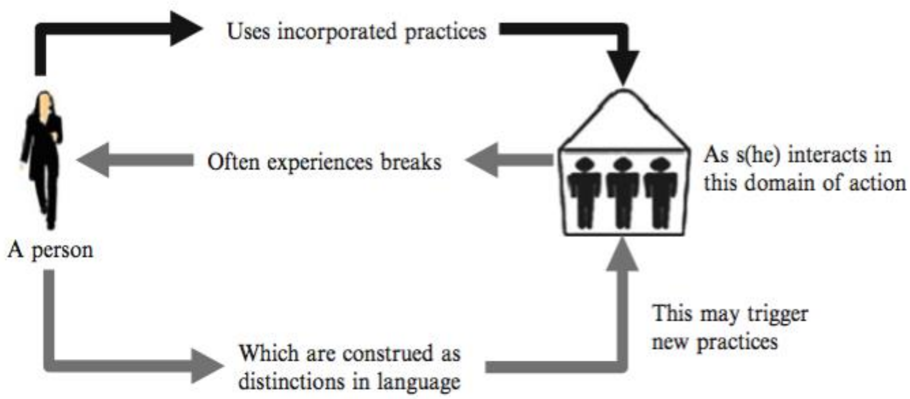
Learning alone is not sufficient to act effectively in a certain situation. A degree in management is not a guarantee of a good manager. Similarly, an educated disaster responder can have extensive knowledge about saving vulnerable people or about SVs motives during a flood. However, this will not be sufficient for them to perform effectively if they do not develop suitable practices to respond to these scenarios – usually through practical training, exercises and practical experience.

As such, Espejo and Reyes (2011) stress the need to distinguish between the informational domain, that is thought based and the operational domain, which represents the moment-to-moment interactions. Espejo and Reyes (2011) stress that the distinctions that stay in the informational domain are wasted distinctions. Indeed, theoretical knowledge is not sufficient to make a person capable of responding to complex situations. Theoretical knowledge tends to have a shorter lifetime than practice and is usually forgotten if not used for a certain period of time.

A final important concept that constitutes individual complexity is detailed complexity (Espejo and Reyes, 2011). Detailed complexity is the practices that individuals incorporate and become transparent to them. Driving a car on an 'automatic pilot' mode is a popular example. Experienced drivers become unaware of the distinctions and incorporated practices that they have in their operational domain.

Therefore, the individual complexity definition can be developed as *"the current set of practices that we have embodied for the distinctions that we have made over time in all the multiple domains we have been engaged on.*" (Espejo and Reyes, 2011, p. 44). figure 2-3 illustrates the individual complexity and the learning process (complexity evolution) that involves both the informational and the operational domains.

**figure 2-3: An Operational Description of the Individual Complexity in a Situation**



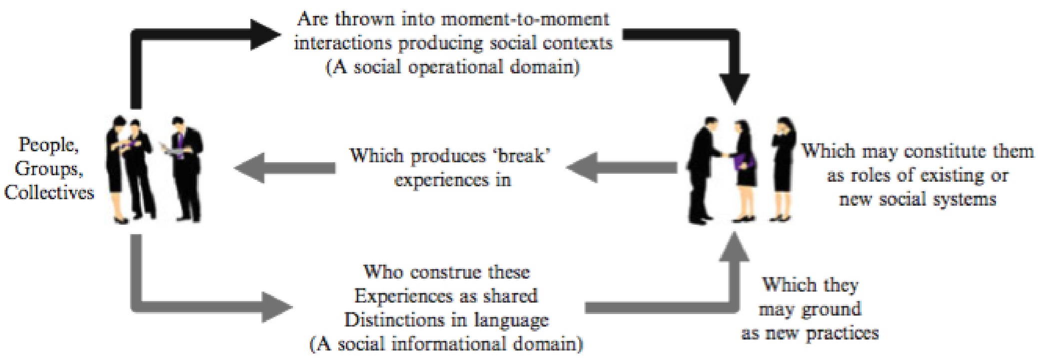

Source: (Espejo and Reyes, 2011)

### *2.3.3.3. Collective Complexity*

People share and develop norms, cultures, and linguistic structures when they interact. This network of interaction is called a Human Communication System (HCS). The Complexity of a collective is the complexity of the HCS. It is defined as *"The tacit, culturally grounded distinctions and practices shared among the members of the HCS, to the point where they coordinate their actions transparently, without apparent effort,…"* (Espejo and Reyes, 2011, p. 45). Notably, the learning process (by problem distinction) that is observed on the individual level is also observed in groups. This learning process results in an evolving complexity of a group or a community. Furthermore, the individual's detailed complexity is also observable in the social operational domain when people communicate effortlessly. This is a result of embedded unconscious norms, cultures and values that became an intrinsic characteristic of a community. See Figure 2-4

Although the above types of complexity are informative, it is not clear how they are operationally useful. Espejo and Reyes' (2011) typologies might be difficult for operational staff to process, especially in chaotic and rapidly changing environments. In addition to the challenging task, an operational responder might find it irrelevant if an SV's behaviour is a manifestation of a contextual complexity of an individual complexity. Such information might be more relevant to social scientists, and maybe for policymakers, who are trying to study and plan responses to human behaviour. Thus, the VSM might be in need of a simple and operationally-useful complexity classification. This will be discussed in Section 2.5.

**Figure 2-4: The Constitution of the Complexity of a HCS**




Source: (Espejo and Reyes, 2011)

### 2.3.4. Measuring Complexity (Variety)

Beer introduces the notion of variety to measure complexity objectively and to represent it in a numeral form. Beer argues that such measure can enable comparing complexities in different organisations and give insight to managers on how to manage their organisational complexity. The notion of variety as a measure of complexity is adopted and accepted by organisational cyberneticians (e.g. Jackson, 2003; Schwaninger, 2006b; Espejo and Reyes, 2011). The notion was previously used by Ashby (1956) to refer to all possible outcomes of a system. Similar to Beer's thesis, Ashby introduced variety as an objective value that can be mathematically measured.

Generally, variety is defined in the systems literature as *"the number of possible states a system can exhibit"* (Jackson, 2003, p. 9). For Beer (1979, p. 32), variety is *"the number of possible states of whatever it is whose complexity we want to measure"*. However, Ashby (1956) stresses that calculating these states is subjective. For instance, the variety of the set "a,b,c,a,b,c,c,b" is three considering only the unique elements in this set. Yet, the set can exhibit much more states if the observer gave value to the relative location of each of these elements. Also, the variety would be different if these elements had more than one value. To limit the confusion, Ashby (1956, p. 126) suggests two standard ways of calculating the variety of a system that has a defined number of elements:

- The number of distinct elements
- The logarithm to the base 2 of the number of elements. This will generate variety that is presented in a unit that Ashby calls "bit" as a contraction of 'BInary digiT'.

Both of Ashby's ways of calculating variety require knowing the number of a system's elements. However, Ashby admits that this task is challenging because of what he calls the notion of *constraint*. A constraint is what makes a set smaller than its potential. For instance, limiting the age and the gender of students in a school will reduce the number of the school's elements than what it could have been should these constraints did not exist. Ashby continues to stress that these constraints cannot be simply classified because they are indefinite, or as Ashby puts it *"…they include all cases in which a set, for any reason, is smaller than it might be."* (p. 128).

Beer (1979) agrees that it is challenging, impractical, and maybe impossible, to know the number of elements and all the relationships in a system. Yet, he stresses that it is not necessary to know what is inside a system to know its variety. Rather, Beer suggests treating systems as black boxes (not transparent and their contents are unknown) and calculate their variety based on the number of inputs and outputs of the system. The rule for computing variety is:

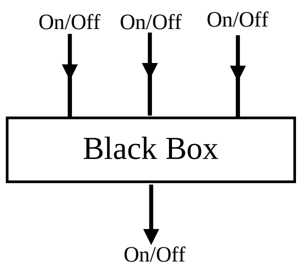
> *"raise the output variety to the power of the input variety."* (p. 45).

$$\text{That is: } V = (V\ output)^{V\ input}$$

The variety of inputs and outputs are calculated based on the configurations of their variety. For instance, the system in Figure 2-5 has three inputs and one output, each of them has two states (on/off). The input variety of this system is $2^3 = 8$ and the output variety is 2. Therefore, the black box's variety is $2^8 = 256$.

Nonetheless, the challenge of constraint that Ashby introduced is still valid in Beer's equation. While it might be easier to know the output and input variety in highly controlled systems, this mission can be extremely challenging, if possible at all, in social systems. Counting (or knowing) all the potential states of a staff, customer or even a manager's behaviour and reactions is still a question to be answered. The implications of this challenge on the way complexity should be classified and managed are discussed in section 2.6.

**Figure 2-5: A Black Box with Three Inputs and One Output**




In summary, the literature suggests that VSM's variety can be perceived to concern components, possibilities, information and the ways that information is communicated. It responds to the need to understand, in addition to what a system does at a specific moment and location, what a system might do. It is expressed with a calculated number that represents all the possible states (potentiality) of a system. This is discussed in detail in Section 2.5.

# 2.4. THE VIABLE SYSTEM MODEL FOR MANAGING COMPLEXITY

Discussing the VSM requires understanding six main elements to enable the reader to see through the same lens of the researcher. These elements are:

- The nature, importance, and the suitability of the VSM to this research.
- How the VSM defines a system.
- The VSM's definition of systems' viability.
- The notion of recursion and the fractal nature of viable systems.
- The notion of the environment and how the VSM understands and relate to what is beyond its boundaries.
- The structure and the functional and managerial characteristics of the VSM are explained.

## 2.4.1. Background and Suitability of the VSM

The Viable System Model (VSM) applies the cybernetics principle of control on management and organisational contexts. Stafford Beer introduced the cybernetics control function in the management literature in 1959 in his book *Cybernetics and Management* and later in his famous book *The Brain of the Firm*. In these books, Beer explains how the VSM's concept of control transcends the traditional meaning (centralised authority) to mean that the control function is spread across all levels of a system's structure. The VSM promotes that control is key for existence and ongoing functionality.

The VSM is known to be useful in diagnosing (Beer, 1985) and designing organisations (Rios, 2012). It offers a systemic way to observe institutions and other collectives in societies and improves organisational communication and resources allocation (Beer, 1979; Schwaninger, 2006b; Espejo and Reyes, 2011). Scholars have been successfully applying the VSM in many contexts. For instance, it is used to support communities' self-organisation and viability (Espinosa and Walker, 2013), in disasters (Reissberg, 2012) and analysing communication during disasters (Preece, Shaw and Hayashi, 2013, 2015), smart networks (Shaw *et al.*, 2004), and understanding and managing complexity (Espinosa and Porter, 2011; Awuzie and Mcdermott, 2013; Espinosa and Walker, 2013). Beer's claim that VSM maps the most viable system in nature (Beer, 1979) may explain the VSM's applicability to many contexts.

The VSM is suitable for the context of this research for many reasons. First, the response system is complex because it involves several agencies that are working together. It also faces a highly complex situation during emergencies. SVs make this situation more complex and unpredictable. Since complexity management is a key feature of the VSM, it is suitable to be used in this context.

Secondly, managing the emergency and SVs complexity may require a certain level of autonomy to enable making timely operational decisions. In emergencies, the timeframe for making decisions can be significantly shortened. Thus, making decisions on the operational level can be inevitable for survival. The VSM, contrary to hierarchal models, fosters autonomy on different structural levels (Espejo and Reyes, 2011).

Thirdly, communication is a major concern for responders during emergencies (Alexander, 1993, 2008; Coppola, 2011; Turoff *et al.*, 2013). Thus, introducing a new model that values effective communication as part of its design can help in understanding this aspect during emergencies. The VSM is acknowledged for diagnosing communication issues (Beer, 1985; Schwaninger, 2006b) among stakeholders during emergencies (Preece, Shaw and Hayashi, 2015) and allows a *"shared communication spaces for knowledge creation"* (Espejo and Reyes, 2011). It also embeds communicating with the external environment as part of its function. This is particularly important in the disasters context. Furthermore, VSM communication channels can help in making better and informed timely decisions as explained in the paragraph above.

Fourthly, the VSM is a recursive model, which means that the system has subsystems that share its structure and features and is contained in a larger system that shares the same features. This notion facilitates (1) understanding the multi-agency response system and (2) diagnosing the structural issues that may hinder an effective multi-agency response and generate performance problem and unintended outcomes (Espejo and Reyes, 2011).

Lastly, the VSM allows the author to assess the response system's viability and thus resilience against adversities. Besides the typical disaster response activities, the response system needs to be resilient when dealing with and managing SVs. Failing to meet the level of resilience and viability that are required to deal with disasters and its social aspects can threaten the response system reason of existence. Table 2-1 highlights the areas where the VSM meets the research needs.

**Table 2-1: The Suitability of VSM for the Research**

| | ***VSM's Merits*** | | | | |
|---|---|---|---|---|---|
| **Emergencies Characteristics** | *Complexity management* | *Autonomy* | *Communication diagnosis* | *Recursive structure* | *Maintaining viability* |
| Complex (Alexander, 1993) | **x** | | **x** | | |
| Multi-agency response (Coppola, 2011; Cabinet Office UK, 2013) | **x** | **x** | **x** | **x** | |
| Evolving response system (Zakour and Gillespie, 2013) | | | | **x** | |
| Challenging for survival and resilience (Alexander, 2011) | | | | | **x** |
| Timely decisions required (Kreps and Bosworth, 2007) | | **x** | **x** | | |

### *2.4.1.1. What is a System?*

The notion of systems dates back to the times of Aristotle and Plato (Jackson, 2003). Since then, the principles of systems have been adopted and developed by various disciplines such as biology, engineering, and sociology. It was only after the World War II that the notion of systems was used in management (Jackson, 2003). However, systems thinkers have managed to agree on the generic characteristics of a system. Beer (1979, p. 7) introduces a definition that explains the essential characteristics: *"A system consists of a group of elements dynamically related in time according to some coherent pattern"*. These elements are separated from the larger environment by a boundary that protects the system's elements. Thus, this boundary is key to recognise the system and its identity from external elements (Jackson, 2003; Espejo and Reyes, 2011). However, Pidd (2003, pp. 114–115) lists the key characteristics of a system as follows:

1. Boundaries: that separates the system from the environment. However, A system's boundary may not be obvious. For example, there is no agreement on

where the boundary of a human being is. Some might argue for the skin and others may include clothes.

2. Components: the elements that are contained within the boundary. A system must contain more than one element.
3. Internal organization: the elements are organised and are not chaotically aggregated.
4. Behaviour: the unique properties of the system. They are generated by the interaction between the components.

However, Beer (1979) extends the discussion and argues that the debatable characteristic of a system is its purpose. He explains that some systems declare their purpose such as hospitals and schools while others do not say what their purposes are (an animal). Hence, it is up to the observer to define an undeclared purpose, or to perceive a self-defined system differently. Jackson (2003) builds upon Beers' point and stresses that the systems that contain human being are purposeful. As such, organisations, as human systems, have multiple purposes, which are generated by their staff and managers. Beer (1979) emphasises that defining a system's purpose, elements and boundaries should be a matter of agreement. Nevertheless, he admits that the dilemma of the subjectivity of defining a system may not be solvable scientifically (Beer, 1979). The meaning of a system still resides in the eye of the beholder.

Proposed practical solutions to this dilemma were introduced by various system thinkers. Examples of these solution are the Soft Systems Methodology (Checkland, 1993) that facilitates discussions among the system's stakeholders to define the system and its purpose, and System Dynamics (Senge, 1990) that helps stakeholders to categorise and map the relationships among the system's elements, and the VSM that defines the system's purpose of what it does (Beer, 1985). What is common among these approaches is that they approach systems in a holistic manner that transcends the reductionist approach to systems analysis (Jackson, 2003).

#### *2.4.1.2. Viability for the VSM*

Systems' resilience is closely related to their viability. It can be argued that higher resilience contributes to systems survival and that viable systems should enjoy a high level of resilience. The VSM defines viability as the ability *"…to maintain a separate existence"* (Beer, 1979, p. 113) and *"a matter of preserving identity"* (p. 114) regardless of the surrounding circumstances. However, Beer (1985) clarifies that although individuals maintaining separate identities and existence does not mean isolation. Rather, individuals can only survive with the support of others. Individuals are part of families and societies with which they interact and share mutual benefits. Accordingly, Beer (1985) stresses that a system's viability is about the ability to survive in a certain environment.

Nonetheless, Schwaninger (2006) questions whether protecting identity is the organisations' ultimate goal. Survival while maintaining the exact same identity can be impractical in the current rapidly changing environment. Schwaninger argues that organisations should aim at viability "beyond survival" where the identity evolves to work in harmony with the whole and to respond to the external changes. Sticking to the narrow meaning of viability, i.e. maintaining identity, may result in what Beer (1979) calls the pathological autopoiesis. It happens when parts of the organisations form a separate entity and leave the system, which can lead to the disintegration of the whole.

Rigid structures and relationships often lead to organisational collapse (Holling, 2001). For organisations to continue to exist, they must change their structures and identities when these characteristics are no more valid. Cybernetically, change is needed when the identity and structure hinder the delivery of stakeholders' demands (Schwaninger, 2006b). The real world offers plenty of examples where organisation carried out a total transformation for survival. Nokia's phones company started as a sawmill and produced tyres; and WPP, a leading advertising company started as a wire and plastic producers (Schwaninger, 2006b). Mitsubishi has gone through many changes in structure and identity since its foundation in the 1860s to survive the Japanese authorities' pressures after World War two and to adapt to the economy's changes. The company worked in insurance, mining, electronics, and car industry just to name a few.

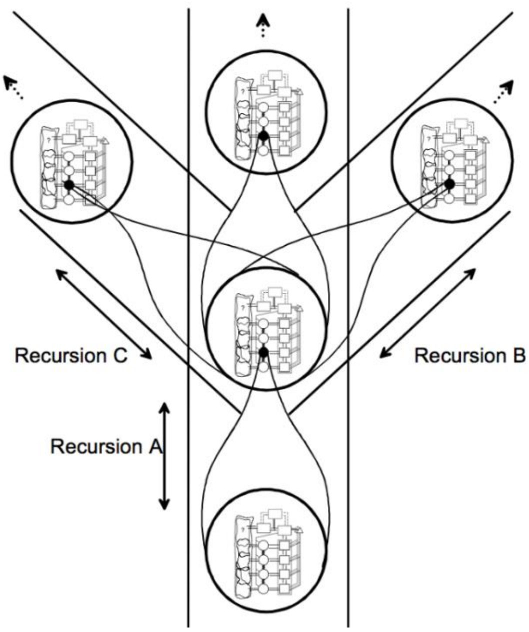
In conclusion, viability should be about maintaining an identity rather than maintaining the identity. An identity that makes an organisation or a system unique among other systems and that evolves continuously to respond to the surrounding changes to support organisational survival and its separate existence. Rios's (2012) note that an organisation's ability to achieve its purpose is an intrinsic part of its viability is a valid one.

### *2.4.1.3. Recursion*

The VSM's recursive system theorem states that *"in a recursive organizational structure, any viable system contains, and is contained in, a viable system"* (Beer, 1979, p. 118). Beer (1985) proposes that this recursion extends downwards to the level of a cell, and upwards to the global level. The notion of recursion was earlier observed as a characteristic of open systems in biology. In 1968, Von Bertalanffy generalised this notion to become a characteristic of systems in all disciplines and initiated what is known as the General System Theory (Jackson, 2003).

The concept of recursion may become deceptive if it is only interpreted in a two-dimensional space. In reality, systems exist in a multi-dimensional space. As such, a system may have more than one higher, or lower recursion levels (Beer, 1985; Schwaninger, 2006b) - see Figure 2-6. For instance, an ambulance team member is part of an ambulance local unit, which is part of a regional ambulance service unit, which is part of the health authorities, and, in turn, is part of the national health system (AACE, 2018). Similarly, the same person is part of a local emergency response system, which is part of a local emergency authority. Or, the person is part of a family, that is part of a certain society and so on. Considering all possibilities, one can imagine this person, as Beer (1985) describes it, in the centre of a sphere of all possible recursive dimensions.

**Figure 2-6: The Multidimensional Concept of Recursion**



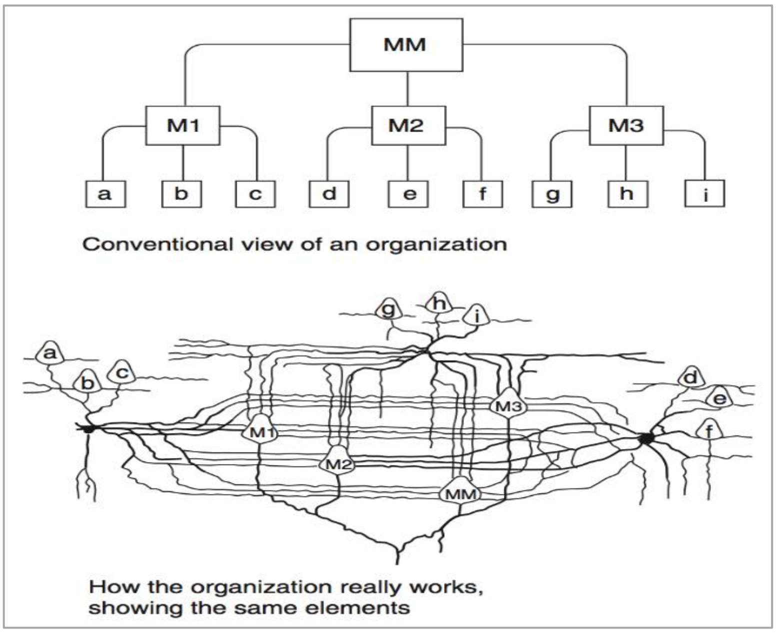

Source: (Schwaninger, 2006b, p. 87)

Christopher (2007) further explains that the multi-dimensional nature of recursion renders the conventional view of organisations as hierarchical entities absolute. He adds, in agreement with Beer, (1985), that perceiving an organisation as a neural network is more realistic. Figure 2-7 shows the differences between the hierarchical description of an organisation with how it really works.

Jackson (2002) approaches the notion of recursion from a conceptual managerial perspective. He elucidates that recursion is a way to adapt to and survive in complex and continuously changing environments. A recursive structure helps the system's management to devolve the responsibilities within the system to enhance the system's capability of managing problems. Christopher (2007) describes a recursive system as a web of active and interconnected systems that: has the functions and capabilities of viable systems: capable of self-organisation and capable of self-control.

Analysing the entire complex and multi-dimensional recursive network in organisations can be impractical. Thus, it is necessary to include only the relevant dimensions that best serve the analysis purpose (Beer, 1985; Hoverstadt, 2008; Espejo and Reyes, 2011; Rios, 2012). Beer (1985) suggests considering only three levels of recursion when analysing organisations: recursion level 1 is the organisation under analysis (or the system-in-focus), recursion level 0 that is the system that contains the system-in-focus, and recursion level 2 that is one level down.

**Figure 2-7: A Viable Business System as a Neural Network**




Source: (Christopher, 2007, p. 22)

### *2.4.1.4. Environment and Boundaries*

Systems exist in a space that is called environment. These systems separate themselves from the rest of the environmental elements by boundaries. Després (2016) explains that defining a System's boundary requires answering the questions: *"What are the limits of* *the query? … What is included and why? What is excluded and why? Who is involved and what are their perceptions about this query?"* (P. 80). While the 'what' questions seem to be descriptive, the 'why' questions, especially why to include and exclude, can be problematic. Indeed, the enquiry of boundary and its relationship with the environment is not simple. Systems and organisational scholars have been studying the implications of defining boundaries and their role in creating and managing conflicts.

Churchman (1970) argues that defining boundaries is crucial when trying to improve systems. The judgement of the success of this improvement depends on who these boundaries are drawn. Churchman explains that systems' boundaries are social and individual constructs. This perspective was a shift in the traditional way of understanding boundaries as *"given by the structure of reality"* (Midgley, Munlo and Brown, 1998, p. 468). Altering a system's boundary can exclude a legitimate stakeholder, which can influence the validity of the collected knowledge. On this note, Fuenmayor (1990) explains metaphorically that shedding the light on part of the environment by the means of boundaries will cast the rest of the environment in darkness. In cybernetics discussion, Arela (1986) points out that despite considering gut bacteria as external to the human body, it contributes to the human's immune system and forming its DNA.

Midgley (1992) introduces the notion of marginalisation. He explains that generally accepted organisational boundaries render elements in the environment marginalised. Although such elements might not be conceived as part of the system, this system needs them to function. He uses unemployed people in society as an example. These individuals are widely excluded from the system boundaries and hence analysis. However, they are stakeholders when forming recruitment policies and might potentially be part of the system at some point.

Midgley, Munlo and Brown (1998) agree and emphasise that setting boundaries has an ethical implication because *"…value and boundary judgements are intimately related"* (P. 469). Groups often use value systems to define their boundary. A disagreement between a group that has a narrow boundary definition and another that has a wider one can result in a conflict. The leads to marginalising the elements that do not fall within the narrower boundary, which leads to tension. Yolles (2001) notes that if the boundary conflict is not solved consensually, then the tension escalates and one of the boundaries will become dominant. Thus, Yolles concludes that boundaries are a political matter that concerns power. Power in the boundaries context is the ability to marginalise (Yolles, 2001, p. 40).

The boundary discussion is significantly relevant to this research and the conceptual model that is introduced in subsection 2.6.4. It is significantly important to define the boundaries of the response system, especially regarding SVs. If SVs are to be engaged in the response, then their identity in regard to the response system has to be clearly defined and communicated. Else, the conflicts and tension explained in this subsection can emerge which would marginalise an important stakeholder in the response process. In this research, the notion that holistically embraces systems and their environment is adopted. Further, the sacredness that might be given to boundaries is abandoned. The implications of this stand will manifest in the comprehensive conceptual model that is noted above.

### 2.4.2. The Functional Characteristics of the VSM

The VSM argues that organisations must enjoy certain characteristics to be viable. These characteristics are classified in this research into functional (structural) and managerial. The managerial characteristics will be discussed separately in subsection 2.4.3.The functional characteristics concern identifying the essential elements that an organisation must have. These elements are classified according to the function that they perform in the organisation. Although this classification is used to structure organisations (Hoverstadt, 2008; Espejo and Reyes, 2011), Beer (1979, 1985) prefers to *model* organisations as functions (or systems) to emphasise the equal distribution of power within viable organisations. On this note, Beer (1985) emphasises that models are not either true or false. Rather, a model is best judged based on its usefulness for the user.

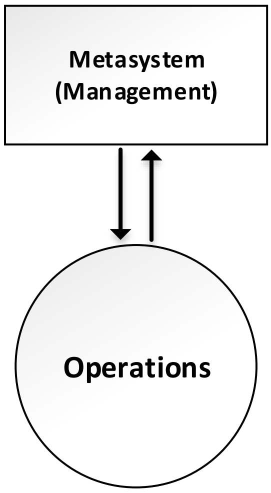
A viable organisation consists of operational units that produce products or services according to the system's purpose; and a metasystem that coordinates the activities of these units, ensures coherence, and assign strategies. In the VSM, operational units are usually expressed in a circular shape and the managerial functions are depicted in a rectangular shape. See Figure 2-8. These two main functions are explained below.

### *2.4.2.1. System One (S1): Operation*

It involves the primary activities that are intended to achieve the organisation's goals. In business terms, primary activities are what produce value for the organisation's customers. This function produces the products that represent the organisational identity (Espejo and Gill, 1997) and delivers them to the relevant environment.

The units within S1 are the only viable units in the organisation, and they enjoy a certain degree of autonomy (Beer, 1985). The units in other functions, although autonomous, are not capable of maintaining a separate existence. They only exist to support and regulate the S1function (Rios, 2012). That is, the rest of the functions lose their purpose of existence in the absence of S1. For example, the human resources department in a factory is meaningless without having shop floor staff. Beer (1985) stresses that the importance of S1 emerges from the fact that it produces the higher-level viable system, the system-in-focus that is under analysis.

**Figure 2-8: The Two Main VSM Functions**




For managers, these operational units are *muddy boxes*. Beer (1979) explains that managers have a partial understanding of what happens within the operational units. Thus, the term muddy means that the contents (complexity) of these units are not fully visible (transparent) to the management, yet they are not totally opaque to block all the information from arriving at the management.

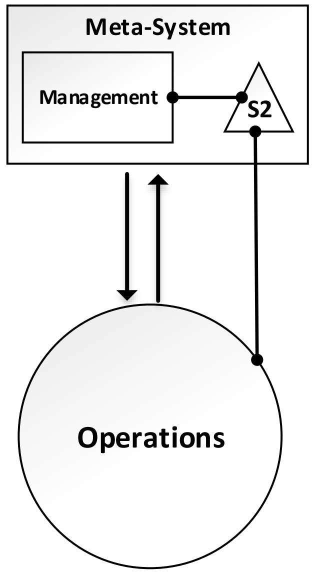
### *2.4.2.2. The Metasystem*

Stafford Beer built the VSM by developing Whitehead and Russell's notion of the metasystem that controls the system. The VSM was an epistemological contribution to the Viable System Theory (VST) that used the cybernetics principles to explain the survival mechanisms of social systems (Yolles, 2006). Beer (1985) recognised four functions that the metasystem needs to perform to maintain a system's viability. Those are explained below.

*Co-ordination (S2)*

Co-ordination in the VSM is the anti-oscillatory function for S1 units (Beer, 1985). It is a mechanism to ensure that the autonomous S1 units work in harmony and to reduce disruption to each other's operations (Hoverstadt, 2008). Examples of S2 activities are distributing tasks among operational units, arranging timetables (Espejo and Reyes, 2011), and guiding the interaction between the operational units and the external environment (Jackson, 2003). The latter activity prevents different teams from responding to a single customer, repeating jobs, competing in the same geographic area, or communicating contradicted information to the environment.

**Figure 2-9: The S2 Function Within the Metasystem**




Nevertheless, it is essential that the term coordination is not interpreted as a top-down approach. Rather, it is a mutual adjustment *"between support functions and between autonomous units"* (Espejo and Gill, 1997, p. 3). As such S2 is not part of the direct command channel between the control function and the S1 units (Rios, 2012), and thus has no authority on S1 units (Beer, 1979).

*Control (S3)*

This function monitors operations to maintain efficiency and internal stability. It is the management of the organisation's operational units that concerns the organisation's "here-and-now" (Beer, 1985). Beer (1985) explains that S3's duty is to ensure that S1 is working efficiently and delivering the right products to the relevant environment (e.g. customers). An example of the S3 role is a line manager who is responsible for several production processes.

However, control in the VSM does not refer to an authoritative, or hierarchical, relationship between management and operations, and is not about observing every detail within S1. Rather, the function depends on S3's ability to observe the S1 units as a whole and to create synergies among them (Rios, 2012).

S3 plays a key role in maintaining the organisation's identity (Beer, 1985). It interprets the organisational policy, communicates it to S1, and ensures that it is implemented. Therefore, S3 defines the cultural, legal, and environmental parameters according to which S1 has to function (Mingers and Rosenhead, 2001).

Negotiating and allocating resources to S1 units are S3's responsibility. The resources deal is an agreement between S1 and S3 on the degree of autonomy, performance expectations, the activities to perform, the resources required and how to monitor using them (Beer, 1985; Mingers and Rosenhead, 2001). S1 is accountable to S3 for delivering according to the deal and within the organisational parameters that are set by S3.

*Audit (S3*)*

This function supports S3. It is about obtaining regular and accurate information from S1 by looking directly into S1 activities (Beer, 1985). Such information may not be accessible by regular reporting (Rios, 2012). Hoverstadt (2008) points out that the audit function responds to the control dilemma of balancing control with integrity and trust. Obtaining information from the subordinates facilitates transparency with managers and helps in spotting issues early, which enhances trust that things are going as they are supposed to.

A good audit, that maintains a balance between performance reporting and monitoring, can *"reduce the need for performance measurement"* (Hoverstadt, 2008, p. 120). According to Hoverstadt (2008), a good audit system is:

- Sporadic: sampling everything is unrealistic given the scale of the activities. Also, regular or routine check on a department may create a negative impression among staff that they are picked on, or may make other staff feel neglected if not audited.
- Unannounced: predictable audits might create anxiety among staff which can disturb performance. It also can result in obtaining distorted impressions.
- Skips a level of management: audit function should be separated from the management function to ensure realistic view. Relying only on reports can make managers feel more comfortable, but it can have serious consequences.
- Done in depth: in-depth audit reveals the true nature of problems and enhances trust in the faults reports that managers receive from staff.

*Intelligence (S4)*

S4 Communicates with the external environment and predicts future (Beer, 1979). Rios (2012) points out that S4 can be considered a component of the organisation's adaptability system. As such, this function is key to help the organisation in maintain its identity and viability in the light of the environmental changes (Jackson, 2003; Espejo and Reyes, 2011); e.g. technological, economic, environmental, or legislative.

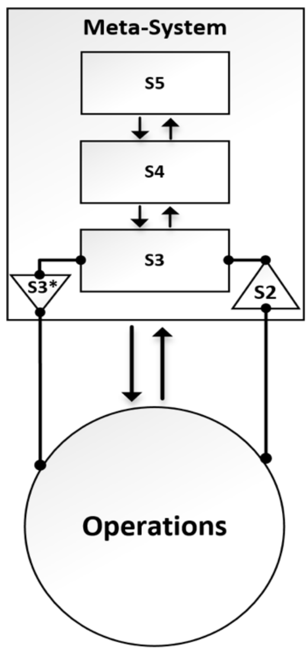
To function, S4 will need to have the necessary means to analyse the information received from the environment, assess its current state, and speculate about future scenarios. The information generated by S4 will allow the organisation to make more accurate operational and strategic plans.

*Policy (S5)*

This system is the optimum authority in the organisation. It has the capacity to resolve the issues between S3 and S4 that these two functions cannot resolve by themselves. S5 provides clarity of overall direction and assigns the system's values and goals. It also provides the conditions for overall effectiveness.

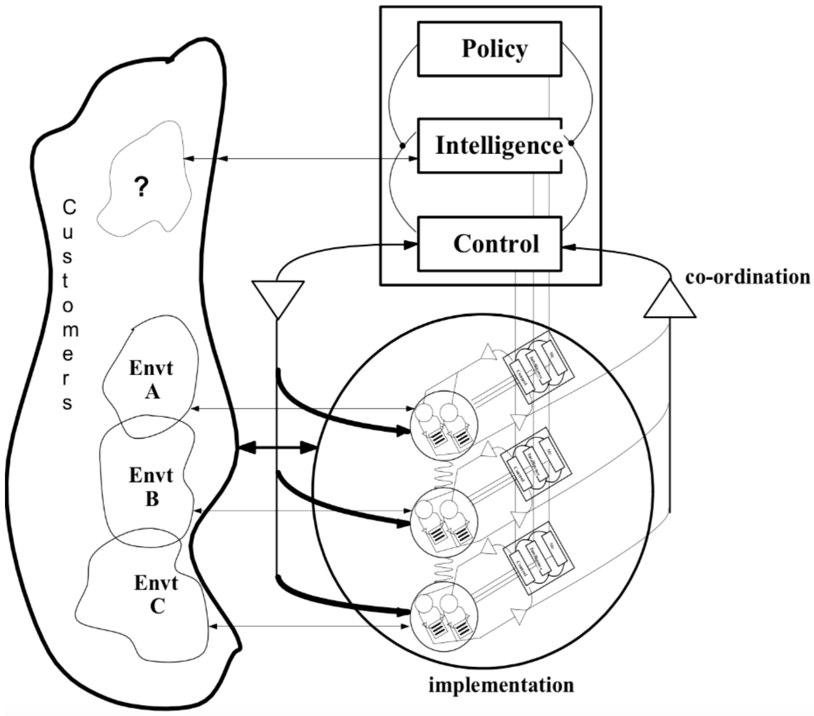
S5 can see the whole picture as it has the knowledge of the entire organisation and the environment. Naturally, S3 and S4 have conflicting missions. While S4 would push towards investing resources for more change and innovation, S3's priority is control to maintain a functional S1. Hence, it is a competition between outside and future on one side and the here-and-now on the other. Balancing future plans with the current internal needs is a major S5 responsibility. S5's decisions in this matter set up the organisational identity (Rios, 2012) beyond survival (Schwaninger, 2001). For instance, S5 decides what to produce, the level of change and its timeframe, the limitation of the organisation, and where they want to be in the future. In other words, S5 sets up the *"vision, mission and the strategic goals of the organisation"* (Rios, 2012, p. 46).

**Figure 2-10: VSM's Functions**



System 5 exercises a normative management which is different from the operational management exercised within S1 and strategic management exercised by S3 and S4 (Rios, 2012). Normative management takes a holistic view of the organisation and takes all stakeholders into account when making decisions. All stakeholders here means the existing and the potential stakeholders in the environmental domains, e.g. economic, ecological domains (Rios, 2012).

**Figure 2-11 The Viable System Model**




Source: (Espejo and Gill, 1997)

### 2.4.3. The Managerial Characteristics of the VSM

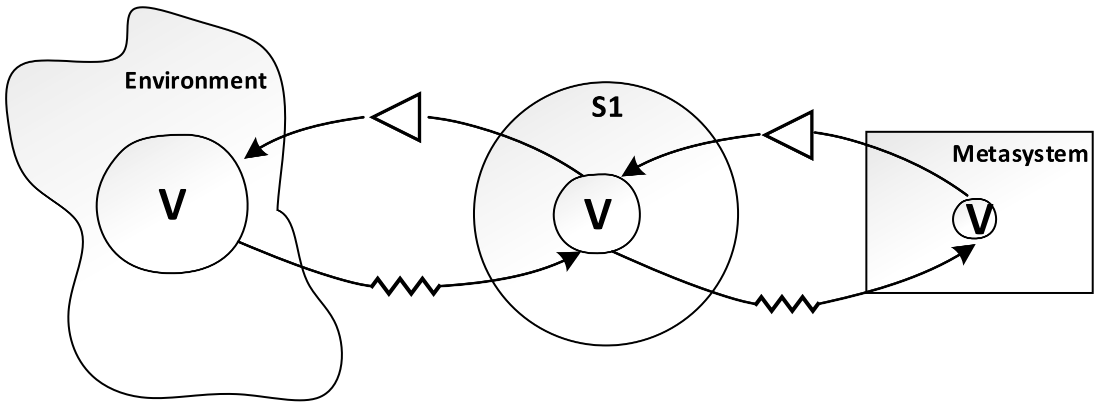
The managerial characteristics of the viable organisation involve the management style and the set of principles that govern decisions making. These involve complexity management and the notion of autonomy. Without ignoring the importance of the functional structure of viable systems, the managerial characteristics are of core importance for this research because they can help in analysing how the response system deals with SVs' complexity, how it perceives them and why it perceives them in a certain way (identity and boundary), and in highlighting the relationship between SVs and the response system as a way to solve the associated challenges.

### *2.4.3.1. Complexity Management (Variety Engineering)*

Variety engineering is a set of principles that the VSM uses to manage complexity and to guide decisions and operations in organisations. According to the VSM, variety should be regulated because it can be a threat to survival (viability). Regulation mainly concerns the flow of variety. A good regulator is the one that *"blocks the flow of variety from disturbances to essential variables"* (Ashby, 1957, p. 201). Essential variables are those that are important for a system's survival. Ashby (1956) distinguishes between two ways of regulating variety that natural systems use. The first is passive blocking, which is designed for simple systems that are not able to collect information. The second is skilled counteraction that involves collecting sufficient information about the disturbance, preparing for its arrival, and facing it with a defence that is as mobile and quick as the disturbance's. While the first is a characteristic of systems that are low on the evolution scale (a shell), the latter is suitable for complex systems that are able to collect a big amount of information.

Skilled counteraction is what modern organisations should do if they are aiming at viability. To achieve this task, the VSM uses Ashby's (1956) law of requisite variety as the base of its variety engineering procedures. Ashby's law states that only *"variety can destroy variety"* (Ashby, 1956, p. 207). As such, organisations need to ensure that they have the level of variety needed to encounter the high variety that is arriving at the system. Beer (1985) explains that this can be achievable in two ways: (1) reducing external variety and (2) increasing organisational variety. As such, he stresses that managers, as variety engineers, have two duties. The first is to attenuate (reduce) the variety that is flowing from the environment to the system and from the lower to the higher recursion levels. The second is to amplify (increase) the organisational variety (its capacity to deal with external perturbations). The final aim is to render the two varieties equal. In figures, the VSM uses the resistance symbol (from electronics) to refer to attenuation and a triangle shape to refer to amplification. As can be seen in Figure 2-12, the variety of the environment is larger than that of the operational unit, which in turn larger than the management's variety. For the management to be in control of the operations, they need to attenuate the incoming variety and amplify their own variety to stay in control. The same logic governs the relationship between operations and the environment. According to Beer (1979, p. 97), operating the arrangement in Figure 2-12 for a period of time will render the three varieties equal in size.

**Figure 2-12: Attenuation and Amplification According to Ashby's Law**




Source from (Beer, 1979, p. 96)

Espejo and Reyes (2011) introduce three systematic steps to manage complexity through variety engineering:

- Assigning a purpose to the situation.
- Selecting relevant CDs by establishing performance criteria.
- Designing and implementing pairs of attenuators and amplifiers.

The first step concerns agreeing on a shared purpose of tackling the situation. The organisational purpose is closely related to other notions such as boundaries and identity. The third step (complexity attenuation and amplification) is the core of the complexity management process (Beer, 1985; FLOOD and JACKSON, 1988; Espejo and Reyes, 2011). Thus, it will be discussed in more depth.

### *2.4.3.2. Designing Attenuators and Amplifiers*

Beer (1979, p. 97) stresses that attenuators and amplifiers do not happen by chance and they have to be *designed* by managers. However, for this point to be useful, guidance on what, when, and how to attenuate or amplify is needed. For the what question, Beer focuses on information as a source of variety and argues that the amount of information that is flowing should be regulated. Other cyberneticians (e.g. Jackson, 2003; Schwaninger, 2006b; Espejo, 2011) highlight the CDs that need to be addressed by the management (e.g. social, economic, cultural, and political). Most of these cybernetician use case studies in an attempt to exemplify and illustrate. Using case studies can be well justifiable because the matter of what to regulate can be case relative and subjective (Beer, 1979). On contrary to the what question, the VSM's answer to 'when' to attenuate and amplify is straightforward - always as part of the organisational design. While this guidance can be well received theoretically by managers, the task of applying the principle can still be complex and challenging.

Answering 'how' to regulate informs managers on the mechanisms and procedures that are needed to attenuate and amplify. Some scholars provide general guidance that ranges in its detail level. For instance, Schwaninger (2006) introduces 3 types of attenuators and amplifiers:

- *Structural*. This type aims at altering the environment's conceptual structure as a source of complexity so that it generates less complexity. Strategies to use this type are segmenting the market, decentralisations and autonomy, constraints (norms, rules and values).
- *Conversational/interactive*: This type reduces complexities by solving problems through approaches such as discussion among teams, and adopting a discursive approach to forming a strategy.
- *Cognitive*: It aims at influencing the sensory organs, perceptions and the information systems that filter the flow of activities and events.

These types are informative but they do not tell managers what to do. Espejo and Reyes (2011, pp.58–60) provide more operational, though general, guidance on how to regulate complexity. These are explained below with examples from the research context.

For amplification, it is necessary to find ways of:

- Strengthening the source variety to allow one-to-many interactions.
- Increasing the resolution of the source variety by using technological or human means to unfold the source variety in more detail.
- Creating new variety relevant to the regulatory situation by expanding the regulatory situation beyond the sources variety. The new variety should be aligned with the source variety. Otherwise, it is a source of disturbances.
- Maintaining, as far as possible, the relevance of source variety over time, that is, maintaining the amplification provided by the above mechanisms throughout the period of the situation. See Table 2-2 for examples from the disaster context.

**Table 2-2: An Example of How to Amplify Variety**

| ***Strengthen the source variety*** | ***Increase the resolution of the source variety*** | ***Create a new variety*** | ***Make variety time-independent*** |
|---|---|---|---|
| Establishing a social media page for the emergency control that allows one operator to communicate with several communities | The responder creates an online platform that receives and analyses the information that is provided by citizens. | Expands the existing radio system by providing staff with more radio units. | The responder establishes a hotline 24/7 that is dedicated only to receive citizens calls. |

For attenuation, Espejo and Reyes suggest that it is necessary to find ways of:

- Reducing, weakening, the source variety for the regulator.
- Reducing the resolution of the situational variety to develop an aggregated view of a situation. This complexity management strategy, similar to the first one, does not restrict the source variety, which can continue to grow.
- Selecting situational variety according to criteria defined by the regulator rather than the environment. This strategy has the effect of chopping-off aspects of the situational variety at the regulator's discretion.
- Making situational variety time-dependent to critical parts of the situation.

Table 2-3 shows examples of attenuating variety.

**Table 2-3: Examples of How to Attenuate Variety**

| ***Make weaker the situational variety*** | ***Reduce resolution of the situational variety*** | ***Select Criteria to reduce the situational variety*** | ***Make situational variety time-dependent*** |
|---|---|---|---|
| The responder selects random sets of data from the database to analyse. | The information in the database is clustered into themes and a summary is created. | The responder decides to service only the areas that have most priority. | The responder receives citizen calls during certain hours. |

There is an agreement among scholars that attenuators can sometimes be dysfunctional. For instance, while prejudice and ignorance are the strongest cognitive attenuators (Beer, 1979; Schwaninger, 2006b), their effect can be counterproductive. However, the VSM literature does not refer to dysfunctional amplifiers. It is maybe the assumption that, in principle, the management's capacity to control the system should be increased.

On another note, all the attenuators and amplifiers introduced above have to be arranged or approved by the organisation's management as rules, policies or procedures. Beer's emphasis that regulators are *designed* by managers highlights the fact that good attenuators are designed at the higher levels of the organisations. As such, it does not advise on whether such decisions can be made at the operational level. Schwaninger (2006) backs up the VSM's argument with his thesis that says *"It is less important to decide quickly than to recognize the need for decisions in good time"*. Indeed, not many can argue against making informed decisions and implementing strategic solutions. The *designed* set of attenuators and amplifiers can be considered as a management model although some managers might not be aware of it (Schwaninger, 2006b). Models belong to the past because they are usually built based on historical data. Beer (1979) emphasises that good and well-informed decisions require obtaining timely data and having the technological means to instantly process it. This can explain the years he invested in developing his dream project in cooperation with the Chilean government in the early 1970s. That project aimed at designing a system that can collect live information (big data), process it instantly, and use the results to timely regulate the social economy. Thus, one can strongly argue that the suitability and effectiveness of attenuators and amplifiers are relative to the designers' timely knowledge of the regulated situation.

### 2.4.4. Autonomy

Autonomy is another basic block of viability. Autonomy is the organisational term of freedom (Beer, 1979), mainly the freedom of choice (Gharajedaghi, 2011). For the VSM, the autonomy of the operational units is key for organisational viability. Beer argues that the metasystem is not able to sufficiently deal with the environmental complexity for two reasons. First, the metasystem will be busy with dealing with the internal organisational complexity and will not afford to add more complexity to the task list. Second, the metasystem may be unable to make the best decisions because it does not have a hands-on knowledge of the environment. Rather, it learns about the environment through the operational units that operate within that environment.

Espejo and Reyes (2011) defend the notion of operational autonomy by criticising the alternative hierarchal approach to managing complexity. They argue that the hierarchal strategy increases the residual complexity that managers have to consider, impairs creativity, and reduces staff's commitment. For these reasons, Schwaninger (2006) emphasises that autonomy is essential for viable systems because it is an effective strategy to absorb complexity and it *"encourages high levels of self-determination and intrinsic control"* (p. 31). It does so by distributing control and leadership over the whole organisation (Jackson, 2003) and frees the management resources to focus on strategic issues that concern the entire system's viability.

This autonomy is not absolute freedom. Rather, autonomy is the *"**freedom remaining** to the management on the horizontal axis to manage"* (Beer, 1985, p. 102). Horizontal management refers to the operational unit's management. Exercising total freedom might lead to conflicting interest among the S1 units, unhealthy competing for resources (Beer, 1979) or chaos (Gharajedaghi, 2011). To maintain the system intact and coherent, a form of constraints should be exercised on those units (Beer, 1979). Beer (1979) notes that the term 'constraints' does not mean oppression, which is the opposite of autonomy. Constraints in this context are rules that are directed to maintain the *minimum* cohesion of the system and are not necessarily oppressive. However, maintain cohesion does not mean forcing a system's element that has a conflicting purpose to remain part of the system – this is oppression. Constraints in the VSM are a service that people accept for their own interest that lies in keeping the organisation viable (Beer, 1979).

The autonomy-constraints balance is a paradox and a challenge for managers. Gharajedaghi (2011) discussed this challenge as a matter of generating and disseminating power, especially in multi-minded organisations. It is a question of concentration of power (centralisation), or the autonomy of the parts (decentralisation) that may lead to abdication of power. Gharajedaghi (2011) argues that the answer to this question lies in the fact that these two terms happen simultaneously. He further explains that disseminating power is not sharing and is not a zero-sum relationship. Thus, managers should perceive decentralisation as an empowerment and duplication of power. Gharajedaghi's argument is consistent with Beer's variety engineering principles. In cybernetics terms, autonomy and decentralisation are about amplifying management's power (variety) to manage the system. However, the appropriate degree and nature of autonomy is still context related and should be decided by the organisational management (Espejo and Reyes, 2011).

## 2.5. COMPLEXITY DYNAMICS DURING EMERGENCIES

This section aims at introducing SVs as a possible solution for helping the response system in managing the complexity of the environment. In particular, it connects the VSM and complexity literature to the context of this research.

Disasters are highly dynamic (Alexander, 1993). Hence, a single description of the evolvement of the complexity during a disaster is context related. However, this section introduces one of the possible scenarios of this evolvement for both, the response system and the environment. In this section, the complexity of the response system means the complexity that is available for the system to use in its operations (i.e. response personnel, equipment, and information). Likewise, the environment complexity means the complexity that the system needs to address. This implies that the system had already learned about this complexity.

### 2.5.1. The Environment's Complexity

When disasters strike, they bring about all kinds of changes to the stable environment. These sudden changes drive the environment's complexity to a peak magnitude in a very short period. This complexity is described in the disasters literature as an overwhelming flow of information, a sharp increase of the typical tasks that the system needs to perform, chaos in the environment, security and safety issues, or the emergence of new tasks (Alexander, 1993; Coppola, 2011). After a period of response, the system would have known much about the existing complexity. Hence, the environment complexity increasing rate starts to decrease. The slight increase of this complexity will be a result of a new observation or knowledge of the situation. It is only towards the end of the response when a significant decrease of the environment's complexity is observed.

The red line in Figure 2-13 resembles the environment's complexity. Please note that the shape of this line defines the complexity that is already being received and analysed by the organisation along the time axis. In other words, this line does not involve any distinction that is made later in time (e.g. after the event has finished). In cybernetics terms, this line expresses the distinctions that the response system has made in the environment. Therefore, the accuracy of this line, among other factors, depends on the effectiveness of the intelligence of the response system in gathering accurate information and passing it to the relevant subsystems.

### 2.5.2. Responders' Complexity

In normal conditions, the response system works on increasing its complexity as part of the preparedness for an emergency. The improvement is usually incremental and slow, as is the case in most organisational continuous improvement projects.

When a disaster impacts, the responder's goal becomes meeting the demand for its services (Alexander, 1993; Coppola, 2011), which is matching the environment's complexity (Beer, 1979). Often, responding to such events require a collaboration between a large number of organisations (Alexander, 2008) such as fire, ambulance and NGOs. This implies that the response organisation under discussion may need to modify their way of doing things to be able to coordinate with peer organisations (National Research Council, 2006; Alexander, 2008). The large number of stakeholders and the complex communication networks enhance the complexity of the response system. It is at this stage when the highest increase in the organisation's complexity happens. However, the response system would only manage to match the environment complexity only when the environment complexity decreases and the formal increase in resources is arranged. This does not usually happen in the early stages of the response in major disasters (Alexander, 1993; Fowler, Kling and Larson, 2007). See Figure 2-13.

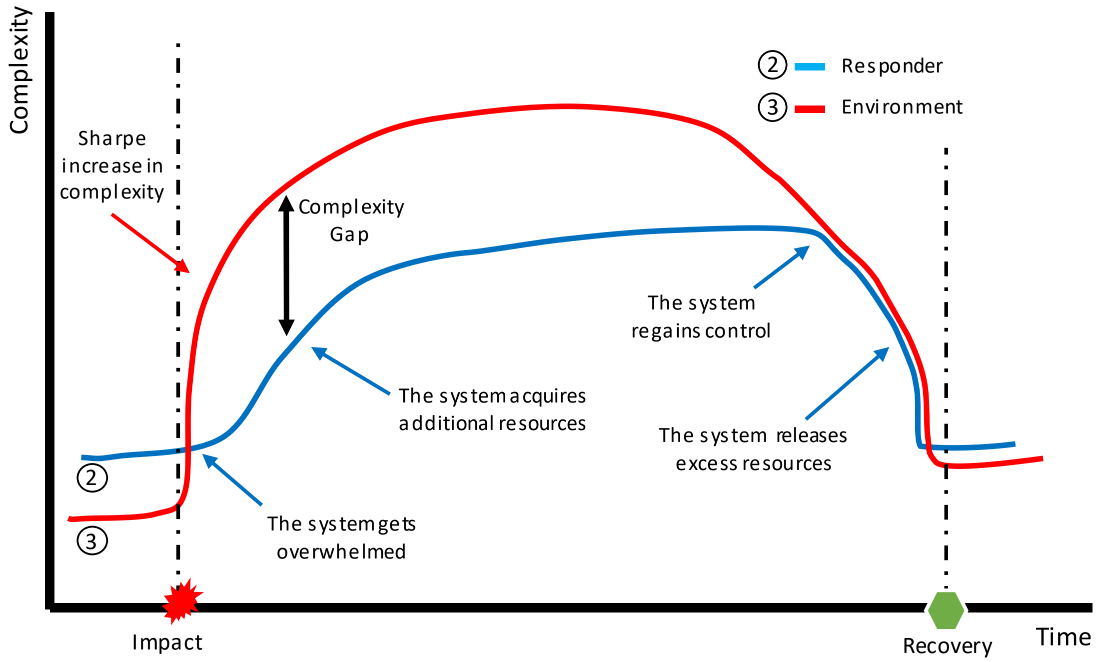
### 2.5.3. A Complexity Gap

The responder's inability to rapidly match the sharp increase in the environment's complexity creates a complexity gap. In cybernetics terms, the responder's viability is threatened because it is unable to control the situation (Ashby, 1957). The disasters scholars say that the response system is overwhelmed (Brassard, Howitt and Giles, 2015). From a resilience perspective, it can be argued that the responder is not resilient enough to boost its complexity quickly enough to adapt to the external changes. See Figure 2-13.

The above diagram could have been explained in terms of variety (i.e. the units of measuring complexity). However, this section and the graph aim at abstractly explain the shortages in resources that lead to overwhelmedness in terms of complexity.

Complexity gap exists regardless of whether this complexity is measured. The notion of variety, its practicality, and the distinction between complexity and variety during the response will be discussed in Section 2.6.

**Figure 2-13: A Complexity Gap During a Response to a Major Disaster**




The disasters literature contains explanations of responders' overwhelmedness. Examples are technological constraints (Furedi, 2007), human resources challenges (Quarantelli, 1982), organisational culture and legal issues (Zakour and Gillespie, 2013), and the unfeasibility of maintaining a huge amount of resources in preparation for an unpredictable event (Cox and Hamlen, 2015). This research classifies these notions as CDs. This is a contribution to the disasters literature that may facilitate an operational understanding, and hence solutions, for these problems.

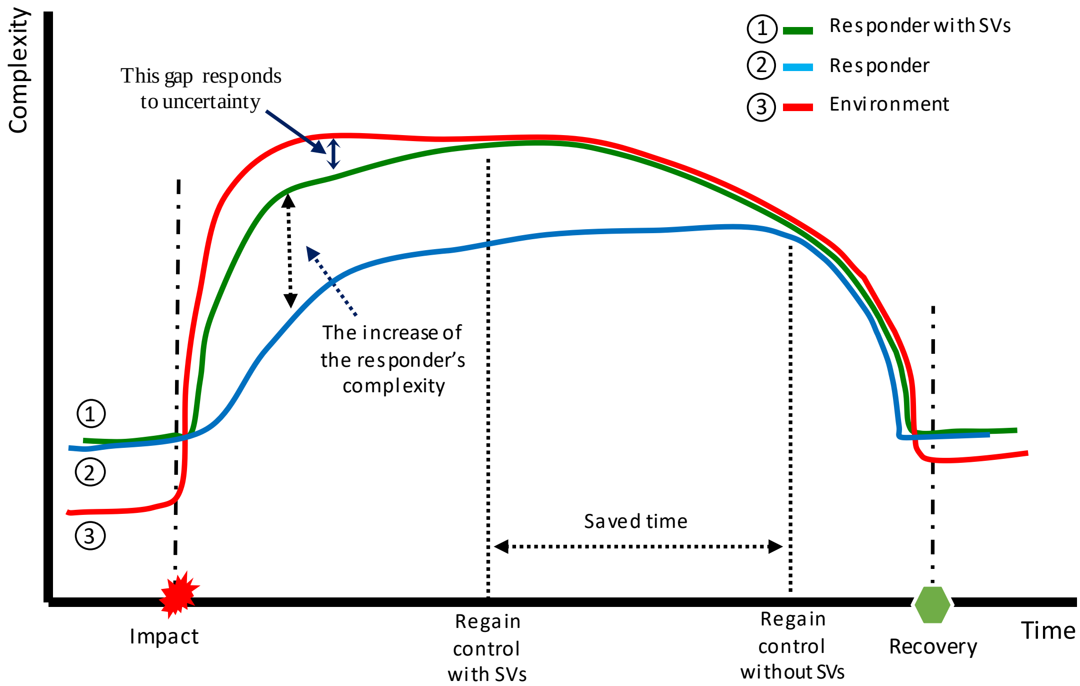
There is no straight answer in the disasters (or other inter-disciplinary) literature to how to solve the gap problem. This is understood because of the complexity of the subject. However, several voices have begun to argue the benefits of engaging communities in the disaster response efforts and helping them to self-respond (Orloff, 2011; Shaw *et al.*, 2015).

### 2.5.4. Embedding SVs' Complexity in the Response System

Figure 2-14 shows the scenario when the responder's complexity is enhanced by engaging SVs. SVs can offer human and physical resources. Adding these resources to the response organisation can significantly and rapidly increase its complexity. Rapidly because SVs often attend to the disaster scene before officials (Orloff, 2011). If integrated efficiently, this can reduce the time that the responder needs to enhance its complexity.

Ideally, the complexity gap that is illustrated in the figure should be closed. However, there will always be a complexity gap (expressed as a gap between the red and green lines) because of the uncertainty associated with emergencies and SVs. Therefore, a realistic aim should be minimising the complexity gap.

**Figure 2-14: A Conceptual Representation of the SVs Contribution to Closing the Complexity Gap**




However, many responders perceive SVs engagement, and community engagement in general, as a source of problematic complexity (Orloff, 2011; Barraket *et al.*, 2013; Zakour and Gillespie, 2013). The implication of adopting such perception is avoiding the engagement with SVs, or attempting to keep them outside the operations area (Barraket *et al.*, 2013; Harris *et al.*, 2017). Pushing SVs complexity outside the system will only enhance the environment's complexity even more and increase the complexity gap. Instead, as conceptualised in Figure 2-14, engaging SVs has the potential to significantly help the system in matching the environment's complexity and in saving time (dotted arrow in the figure), lives, and resources. In other words, it can enhance the responder's resilience and viability. It is no wonder that researchers (e.g. Osti and Miyake, 2011; Ainuddin and Routray, 2012) and international organisations (e.g. UNISDR) are encouraging governments and responders to invest more in engaging communities and volunteers during disasters.

# 2.6. DISCUSSION, GAPS AND CONCEPTUAL MODELS

## 2.6.1. Reconsiderations of the Notions of Complexity and Variety

As explained in subsection 2.3.4, most VSM scholars adopt the notion of variety as a measure of complexity (e.g. Beer, 1979; Jackson, 2003; Espejo and Reyes, 2011; Espinosa, Harnden and Walker, 2007). However, the analysis of the literature discusses some gaps in this understanding. This subsection argues that using variety might not be a practical or a representational measure of complexity, especially during disasters.

### *2.6.1.1. Defining the Gap*

Logically, if variety measures complexity then variety is a numerical expression of complexity. This is how variety is defined by the VSM (Beer, 1979). However, although Espejo and Reyes (2011) adopt Beers definition of variety, their explanation of complexity and variety can suggest that they are different. They state that a system's complexity is the distinguished variety. This means that variety is larger than or equals the states that an observer distinguishes. For instance, a surgeon cannot observe more parts in a human body than what it contains. This contradicts the adopted notion of variety as a measure of complexity. This points to a gap in the VSM literature and to the need to reconsider the existing definitions of the two notions.

Espejo (2000) strongly questions the practicality of managing variety. He argued that variety is usually huge (4.5 million million possible states for a group of 7), which makes it meaningless to consider because people cannot make sense of it. Espejo's argument becomes more relevant during disasters when systems face significantly complex and rapidly-changing situations. Hence, Espejo (2000) suggests that it is more practical to focus on the distinctions that people make to understand and manage complexity. There is no evidence in the cybernetics literature that Espejo's notes were considered.

Two attempts relate to this gap are observed in the VSM literature. The first is made by Espejo and Reyes (2011, p.36) by attempting to distinguish between the two notions. They stress that while variety measures a situation's potentiality, complexity measures its actuality. Initially, this statement separates the two notions clearly. However, it still does not explain how potentiality can measure actuality while, logically, potentiality is equal to or greater than actuality. In other words, it is not reasonable for a person to use the potential states of a system to measure the distinctions that they make. Thus, one can argue that this attempt to close the gap was not fully developed.

The second was made by Schwaninger (2006, p.11). Schwaninger suggests that complexity includes both actual and potential. He justifies the suggestion by stating that the distinctions that an observer makes can be made on the current and the potential states of a system. Nevertheless, this suggestion may not be helpful. First, it does not make a clear distinction between the two notions. Second, it can imply that both notions mean the same (all possible states). This can render the concept of variety, and thus the distinction unnecessary.

Hence, the VSM scholars' attempts to close the gap are not comprehensive, which maintains the confusion about these terms in the literature. The lack of clear definitions and a distinction between variety and complexity is still a major gap in the VSM. This gap can limit a wider application of the VSM.

#### *2.6.1.2. Discussion of the Gap and its Implications*

From the interpretive worldview of this research, the validity of variety as a scientific (real) term that can represent the absolute value (a number) of all possible states of a system is questioned. The VSM calculates variety by using the mathematical probability laws based on the number of elements in a system and the number of inputs and outputs of each element (Beer, 1979; Espejo and Reyes, 2011). Nevertheless, the VSM does not advise on how to overcome the challenge of subjectivity when obtaining these numbers. The challenge of subjectivity can be limited when dealing with machinery. However, the VSM does not discuss whether it is possible to accurately quantify the number of inputs and the possible outputs of a human brain in a given situation.

Cybernetically speaking, in principle, one can argue that changing the complexity of a system does not change its variety because the system's potentiality is not bound by what people know about it. This may be correct from a positivist perspective that believes in absolute reality (Creswell, 2012). However, the number of potential states (variety) is calculated based on what the observer knows about the situation and on their judgement on the relevant distinctions for the calculation. Both of the latter factors are subjective, which makes the value of variety dependant on the subjective complexity. Hence, what an observer thinks is a true value of variety may be relative to what they know about the situation. Consequently, any meaningful attempt to manage complexity during stressful times such as disasters may be better done by managing what is already distinguished rather than by calculating variety.

Closing this gap is important. This gap makes the usability of the notions of variety and complexity, and thus the VSM, questionable for two reasons. First, calculating and observing all the possible states of a system is an extremely difficult task (Espejo, 2000), and may be impossible in complex social systems. In these systems, it can be accepted that an observer's knowledge of a situation is always less than what there is. Hence, variety might not be helpful especially during a disaster response. This is discussed further in 2.6.2.

Second, the absence of clear definitions of the notions resulted in using them interchangeably. For instance, Rios (2012, p. 124) uses the terms complexity and variety interchangeable when he says: *"…the ideal situation would be for incidences resulting from these connections to resolve themselves within the actual relation rather than conveying variety (complexity) to the Meta-system"*. Similarly, Schwaninger (2006, p.14) uses the term *eigen-variety* to refer to the system's own *complexity* and the term *foreign variety* to mean the *complexity* of the environment. Interestingly, these terms and their meanings suggest that variety is a synonym of complexity. This may be a contradiction to Schwaninger's attempt to distinguish between the two notions.

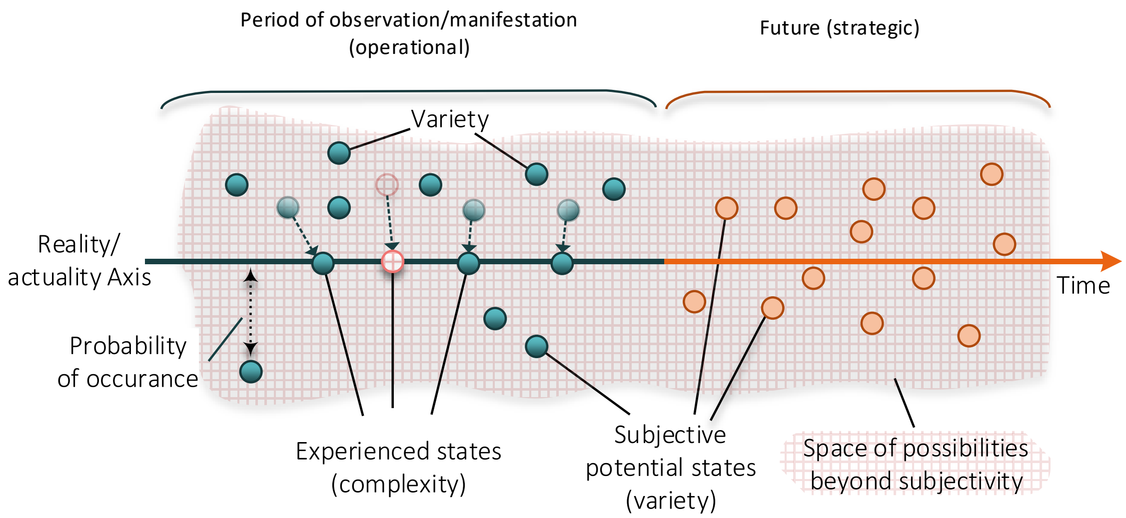
### *2.6.1.3. Closing the Gap – Redefining Complexity and Variety*

To put the previous discussion into perspective and to close the above gap and its correspondent issues, a novel conceptual proposition of the notions of variety and complexity is introduced. Abstractly, the proposition defines complexity as the manifested and the already-experienced states. For instance, a building that is collapsing or an SV who is taking risks to save a trapped person. On the other hand, it defines variety as all the possible (potential) states. These states can be of a system, environment, individual, group, and so forth. Hence, complexity is a sub-group of variety. However, the proposition acknowledges the subjectivity of both notions. This is particularly important for defining variety, which is still dependant on the observer's ability to distinguish, perceive, anticipate, and judge. Hence, variety in the proposition represents the subjective states rather than a number that represents what can exist in 'reality'. For instance, the discussion of disaster planners can suggest that there are six possible scenarios of SVs involvement in a future incident. These six possible states are considered variety.

Figure 2-15 represents the new definitions of variety and complexity. As shown, the figure has a time axis that differentiates between the period of observation (e.g. during a disaster response) and future. The figure shows that complexity does not exist in the future because it manifests in the present. Hence, only variety exists in the future and is used for planning purposes. On the other hand, during observation, some of the anticipated variety can become complexity. The green circles in the figure represent variety from the system's perspective during the observation period. The circles that do not settle on the reality axis maintain their variety status because they have not manifested and have not been experienced. Yet, these states had been *cognitively* distinguished and hence tagged as variety. The distance between the possibility and the axis defines its probability of occurrence. Variety and the probability of occurrence here are not necessarily numerical values. Rather, they can be an anticipated scenario by the system. In the disasters context, examples of this variety can be expecting the flooding of a road, expecting the arrival of a 100 SVs, and expecting volunteers to have certain skills.

Some of the potential states (variety) become complexity when they are manifested and experienced (the circles on the reality axis). A manifested state might be one of the already distinguished possibilities (variety). For instance, the disasters literature is abundant of scenarios of the potential development of a volcanic eruption (Alexander, 1993; Paton, Millar and Johnston, 2001). However, complexity might result from unrecognised possibilities. This is expressed in Figure 2-15 as an orange circle on the reality axis. This circle originates from the possibilities that exist beyond the limitations of subjectivity. These possibilities are presented as *space* of possibilities to stress the indefinite nature of the unknown. This recognition highlights the importance of having resilient systems during disasters to address the unexpected.

**Figure 2-15: Conceptual Model 1: Redefining the Notions of Complexity and Variety**




These proposed notions need to be modelled to be operationally useful. The next subsection considers these notions within the VSM structure and dynamics.

### *2.6.1.4. Conceptual Model 2: Complexity and Variety Dynamics*

Having established the definitions of variety and complexity, this subsection discusses the implications of these definitions on the VSM. In particular; where these notions are generated, communicated, and addressed within the VSM. Given that modelling is context and time related, the argument is made in this section for the disaster context when the system is addressing a rapidly changing environment – the focus of this thesis. This is also a main focus of the cybernetics when addressing complexity (Ashby, 1957).

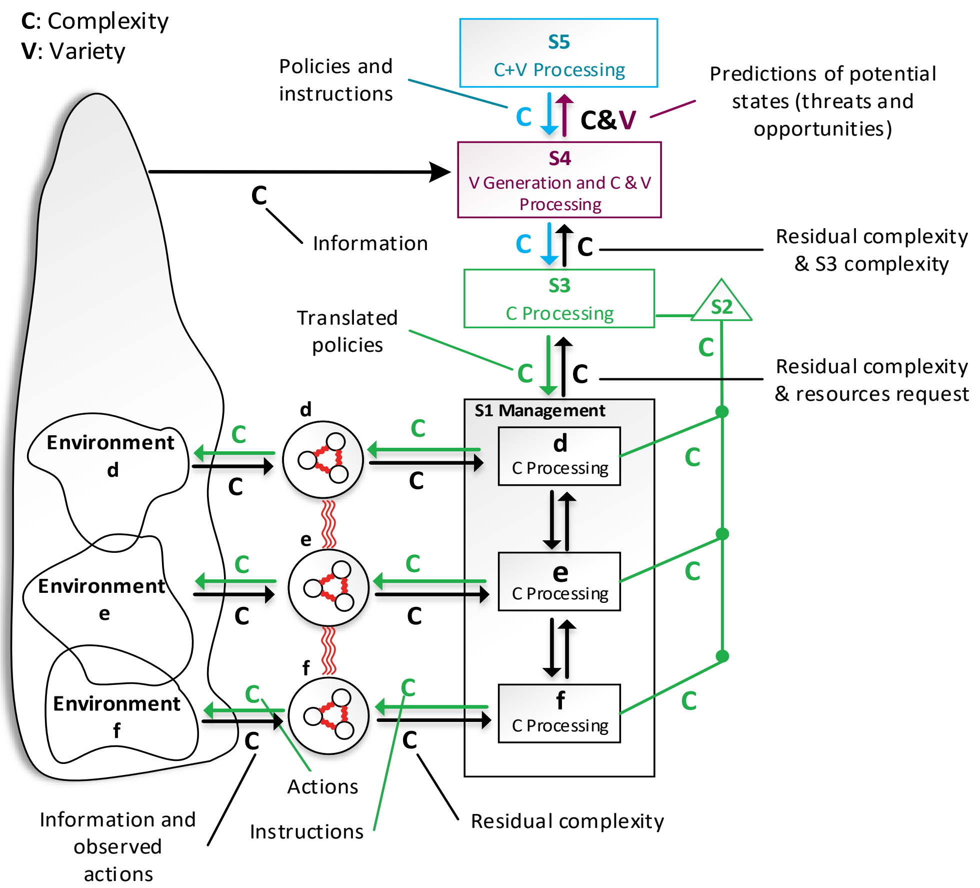
Variety and its probability of occurrence are outcomes of cognitive processing and analysis. Hence, it can be argued that variety is *generated* and processed by the brain of the system (S4 and S5 in the VSM). This variety (or part of it) can then be introduced by S5 to the system's functions, and maybe to the environment. This argument is consistent with the VSM's explanation of the roles of S4 and S5. Beer (1979) explains that a key role of S4 is to predict future opportunities and threats, and explains that S5 sets up the policy of the organisation based on the predictions that are presented by S4. The outcome of the variety analysis determines the system's strategy which is communicated down the recursive structure as policies and procedures. In the disasters context, this variety is found in formal guidance for carrying out a response (e.g. Cabinet Office UK, 2010), in predictions of natural disasters and their impact (QuakeWatch, 2017), the outcomes of disaster simulations (e.g. Albores and Shaw, 2008), and warnings that are sent to residents when disasters are expected (Alexander, 1993). However, the operational function of the response system may not generate variety during the response because (1) it is already overwhelmed with complexity (Brassard, Howitt and Giles, 2015) and (2) because this is not what the operation function is supposed to do according to the VSM (Beer, 1981; Espejo and Reyes, 2011).

On the other hand, complexity is *received*, *generated* and processed by the entire organisation (Beer, 1981; Espejo and Reyes, 2011). Complexity is received because it is generated in the environment and is imposed on the system (Ashby, 1957). SVs are an example of a complexity that is imposed on the response system during disasters. Also, complexity is generated by the system because it's a natural result of the operations within each function of the VSM (Beer, 1981). In disasters, the response personnel, managers, and decision makers generate complexity when they take actions. Lastly, complexity is processed by the entire organisation because each function has to deal with the inflowing complexity be it from the environment or from a different function in the system (Beer, 1985).

The conceptual discussion above needs to be modelled to be practically useful. Figure 2-16 shows where complexity and variety are generated and processed in the VSM. It also shows the channels through which each of the notion flow. Complexity flows from the environment. For instance, when SVs enter the operations area, they produce operational challenges for S1 and SV- related information for S4. The system receives and processes the environmental complexity (black arrows) through its S1 and S4 units (Beer, 1981). S1 would process some of this complexity and pass what is beyond its authority up to the management. This is called residual complexity (Beer, 1985). Residual complexity is then processed in S2 and S3. The escalated complexity to S5 is also residual complexity. Nevertheless, S4 processes the complexities that it receives from the environment (Beer, 1979). The complexity is passed to S5 and is also processed in S4. This is observed during disasters when the intelligence units collect and process information (Preece, Shaw and Hayashi, 2013) and pass it to the senior management. The result of processing this complexity is the variety that S4 generates in the form of predictions of opportunities and threats (variety). S4 passes the predictions to S5 (Beer, 1981). S5 would then process the information arriving from S3 and S4 and set up the system's strategy (Beer, 1985). The strategy is communicated down the recursion levels in the form of policies (Beer, 1985).

The complexity that is carried down and up the recursive structure and to the environment consists of policies, guidance, plans, schedules, resources, services or products. An example of this is the emergency response guidance (Cabinet Office UK, 2013) and the individual agencies response policies. Variety moves only in one direction (up) because it is generated by S4 and processed by S5 (Beer, 1979). The VSM does not suggest that intelligence information is passed to a different function (Beer, 1979, 1981; Espejo and Reyes, 2011; Schwaninger, 2015).

**Figure 2-16: Conceptual Model 2 - Complexity and Variety Dynamics -Flow and Processing Location**



### *2.6.1.5. Conclusion and Summative Conceptual Proposition*

Subsection 2.6.1 discussed the confusion about variety and complexity and identified the absence of clear distinct definitions of the notions as a gap in the VSM literature. It closed the gap by proposing new definitions and by embedding the newly defined notions within the VSM structure. Modelling the two-proposed notion in the VSM allows for conceptualising the features of the proposed two notions. These features are compared to what exists in the literature. Table 2-4 details the features. This conceptual proposition can offer a systematic and systemic attempt to address Espejo's concerns, close the identified gap, and to contribute to enhancing the VSM's resilience during disasters.

**Table 2-4: Conceptual Proposition 2 - A Proposed Characteristics of Variety and Complexity**

| | *The Literature* | | *A Proposed View* | |
|---|---|---|---|---|
| | **Variety** | **Complexity** | **Variety** | **Complexity** |
| ***Representation*** | Potentiality | Actuality (not agreed on) | Potential | Actual states |
| ***Type*** | A numerical measure of complexity | Occurrences/ distinctions | Potential occurrences | Manifested occurrences / distinctions |
| ***Distinguishability*** | A number, perceived, or experienced | Perceived by the observer | Conceptually perceived but not experienced | Experienced by the observer |
| ***Size*** | The largest | Not identified or similar to variety | The largest | Smaller in size (a subgroup of Variety) |
| ***Priority to address*** | Not identified | Not identified | Lower priority | Higher priority |
| ***Mutual influence*** | Not identified | Not identified | Possibility of influencing complexity | Changes in complexity lead to changes in variety |
| ***Impact on Organisations*** | Problematic if external and useful if internal | Problematic if external and useful if internal | May or may not have an impact on planning regardless its source and scale (Context related) | May or may not have an impact on operations and planning regardless its source and scale (Context related) |
| ***Epistemology*** | Objective | Subjective | Subjective | Subjective |
| ***Generated in*** | Inside and outside the system | Not identified | S4 and S5 inside the system | Inside and outside the system |
| ***Processed by*** | All functions in the system /not identified | Not identified | All functions in the system | All functions in the system |

This proposed view will be adopted in this research. Any reference to complexity or variety henceforth will refer to the distinctions that are made in this subsection.

## 2.6.2. Gaps in Variety Engineering

Given that this thesis focuses on the operational side of the disaster response, it argues that priority should be given to managing complexity. This subsection argues that existing variety engineering practices may be ineffective and inflexible when managing complexity, especially during disasters. Hence, it discusses gaps in variety engineering that may contribute to this ineffectiveness and inflexibility. Several gaps are identified. These are grouped under two interrelated themes. The first concerns how complexity is regulated (attenuated and amplified). The second is about how complexity is classified in the VSM literature.

### *2.6.2.1. Gaps in Complexity Regulation*

Managers often face instances when they need to make immediate decisions on what to attenuate. For instance, during emergencies, managers often encounter *new* situations that are (1) continuously changing (2) unknown or unpredictable, and (3) evolving in a very short period (Coppola, 2011). In such situations, the ability to prioritise and make immediate decisions may be necessary to maintain the system's effectiveness and maybe viability. Managers in the metasystem would not have the necessary real-time information and the adequate timeframe to design attenuators, disseminate them in a policy, and train staff to apply them. Further, the addressed complexity can often be rendered obsolete shortly after this policy is in place (Beer, 1979). It is common in many organisations that the operational units' authority to make an immediate decision is limited. In such cases, they would pass this type of complexity to the management as a residual complexity (Beer, 1979). During a disaster response, the amount of residual complexity can be larger than the management's capacity to handle it. Although the VSM suggests attenuating this complexity (Beer, 1985), practical solutions for this challenge are still not adequately addressed by the VSM. The VSM does not advise which complexity to attenuate and prioritise. This is a gap that can confuse S1 when making timely decisions.

A second gap in the variety engineering principle is not advising whether the regulation principle applies to the decisions (attenuation and amplification) that are based on personal initiatives. If complexity regulation applies to all staff's decisions, managers would face the dilemma of judging which decisions were ad-hoc and which were taken from a position of responsibility based on formal and designed procedures. This argument is particularly relevant for the operational level where a decision can be made on the ground. While the VSM suggests that operational autonomy can enhance viability (Beer, 1979), it does not advise on how to implement autonomy nor on whether this autonomy is governed by formal attenuators and amplifiers.

Thirdly, although the VSM says that some types of attenuators are counterproductive, e.g. ignorance (Beer, 1979), it does not provide the means to optimise the utilisation of inflowing complexity. The flow of external information is often misperceived. The statement *'knowledge is power'* is widely accepted as basic wisdom. Indeed, the more one knows about a situation the better decisions they can make to control it. Hence, it can be logically acceptable that more knowledge can facilitate more control. Ashby (1957, p. 61,62) emphasises the latter point by saying that a system's ability to control a situation determines its complexity. However, the only way to increase the system's knowledge of the environment is making more distinctions, which implies accepting inflowing complexity.

Thus, organisations should perceive external complexity as an opportunity rather than a challenge as suggested by the VSM (Beer, 1979; Espejo and Reyes, 2011). The system's overwhelmedness can be a result of internal complexity management issues rather than an intrinsic property of the incoming complexity. Some of the attenuated complexity that is not passed up to management can be very useful for making informed decisions and can support the organisation in achieving its purpose. Similarly, some of the attenuated complexity can potentially support S1' operations and resilience (e.g. SVs).

Lastly, the VSM suggests that managerial complexity should be amplified (Beer, 1985; Espejo and Reyes, 2011). However, it does not suggest exceptions to this rule or strategies to prevent undesired consequences of managerial amplification. In normal conditions, managers would have the time to collect information about certain challenges, discuss solutions with their peers, and test these solutions before disseminating them to the entire organisation. Hence, any undesired consequences of bad decisions can be mitigated and corrected. Nevertheless, disasters are dynamic and unpredictable. Thus, managers might feel the pressure to make decisions rapidly based on limited information (Alexander, 1993). Making decisions in such situations can significantly increase the possibility of making bad decisions. This case was observed in the volcanic eruption in Colombia in 1985 were poor decision-making led to the death of 22000 people (Alexander, 1993). Adopting the notion of managerial complexity amplification as a true principle can have serious consequences when bad decisions are applied widely in the organisation. It may be more logical for such decision to be delegated locally where live information is available. The operational units might face different forms of complexities simultaneously, which requires relevant and local decisions rather than a united amplified managerial decision (refer to the discussion of autonomy in subsection 2.4.4).

The potential gaps that are identified above in variety engineering principles might be related to gaps in theory regarding how complexity is perceived, measured, and classified. The first two were discussed earlier in the section. Complexity classification can be helpful to know how to prioritise, regulate, and respond to chaotic and rapidly-changing situations. Hence, gaps in complexity classification in the VSM are discussed next.

#### *2.6.2.2. Gaps in Complexity Classification*

The VSM's classification as introduced by Espejo and Reyes (2011) was discussed in detail in subsection 2.3.3. The usability of the introduced complexity types in the operational domain was questioned. It was argued that the classification process can be time-consuming and cognitively challenging, especially when detailed information is unavailable. It is unlikely that an operational individual will invest their energy and time to conceptualise whether a customer's behaviour is a result of individual, contextual or collective complexity when action is needed. Even if such quick conceptualisation was successful, it is unclear how it would be used operationally in dynamic situations. On contrary, enforcing such model on operations staff can negatively impact performance and hence the system's resilience. Thus, there is a need for a simple, dynamic and more operationally usable classification that can enable rapid decision-making and boost resilience.

This subsection closes this gap by introducing a novel complexity classification that can be used in the operational domain. It also facilitates a timely decision-making close to the complexity source.

*Internal and External Complexity*

Beer (1979) refers to a system's complexity as what is inside and now. However, organisational cyberneticians (e.g. Beer, 1985; Schwaninger, 2001; Jackson, 2003; Hoverstadt, 2008; Espejo and Reyes, 2011) interpret internal complexity as the outcome of the normal operations of the organisational elements. The need to study internal complexity emerges from the need to coordinate these operations and prevent (or limit) conflicts (Espejo and Reyes, 2011). Regulating internal complexity is a recognised management responsibility and is often planned as part of the organisational design. However, there is no clear guidance on managing internal operational complexity in the management and cybernetics literature. In particular, a classification that includes this type of complexity does not exist. Examples of internal complexity are personnel actions, systems breakdown, and staff communication.

Apart from attenuation, the VSM does not provide guidance on how to deal with internal complexity at different levels. It implicitly attributes autonomy for the five functions to deal with complexity. This is maybe because the VSM does not have a comprehensive definition of internal complexity. For instance, it is not clear from the VSM perspective whether SVs' complexity is internal complexity when they are engaged. Such complexities can be dominant and threatening to the organisation's viability during emergencies. Thus, a clearer definition of internal complexity is needed.

To conceptually close the above gap, internal complexity is defined in this research as *the complexity that is generated by CDs that are located within the system's boundaries or are operating under the system's management*. This definition addresses the elements that formally belong to the system and to those that are under the system's supervision and management. Examples of the former are staff, assets, purchased resources, and policies. For the latter, this can involve short-term contractors, spontaneous volunteers, and voluntary organisations staff who work under official staff's supervision during emergencies. This can also solve the dilemma of classifying SVs' complexity when they are engaged.

All the elements that exist outside the system's boundaries are perceived by the cybernetics as environmental disturbances (Beer, 1966) that can threaten a system's performance (Espejo and Reyes, 2011) and existence (Ashby, 1957). However, the VSM focuses mainly on identifying the environmental agents (CDs) that generate such complexity. Espejo and Reyes (2011) argue that the main complexity generating agents that exist beyond the system's boundaries are customers, suppliers, competitors and other intervenors (e.g. policy makers). Similar to the internal complexity case, these are higher-level CDs. In situations such as disasters, the environment would be abundant in complexity that is generated by low-level CDs (e.g. roads closures, evacuees, and local power failure). Hence, this research introduces a definition of external complexity to mean *the complexity that is generated by CDs that are located outside the system's boundaries or/and are not operating under the system's management*. This definition is more comprehensive because it includes special cases where some elements can officially belong to the system but not at the moment of operations (or observation). For instance, this definition classifies the complexity that is generated by a policeman who is independently volunteering as an SV during their holiday as external because it was not generated while the policeman is on duty.

These definitions are operational important. They explicitly define internal and external complexity and advise staff and decisionmakers of some cases when traditional boundaries are not sufficient to classify whether certain complexity belongs to the system. However, these definitions do not advise on the nature of complexity. Hence, this is discussed next.

*Supportive and Problematic Complexity*

The complexity and systems literature (Ashby, 1957; Beer, 1985; e.g. Espejo, 2000; Suh, 2005; Gharajedaghi, 2011; Awuzie and Mcdermott, 2013) provide plenty of examples on how complexity can disturb organisational performance. The Cybernetics literature suggests a solution for managers that emphasises the need to reduce that complexity arriving from the environment to the system or from the lower recursion levels (Beer, 1985; Espejo and Reyes, 2011). This may implicitly assume that this 'foreign' complexity is problematic or has a negative impact. It has been argued earlier in this section that such assumption can be counterproductive. Hence, this research proposes that complexity is problematic only when it *obstructs organisational operations,* *performance, or purpose regardless of any other systemic characteristics of this complexity* (e.g. what generates it and where it manifests).

On the other hand, the VSM suggested amplifying the complexity that is passed down the VSM structure to enhance the management's control of the lower recursion levels and the system's control of the environment (Beer, 1985; Espejo and Reyes, 2011). This implicitly assumes that the complexity that is created by the self (e.g. S5, S3 or S1) or the higher level (e.g. management) is a positive complexity. However, this assumption ignores the fact that management can create negative complexity. This happens when the management makes bad decisions. In such cases, the impact of complexity amplification can be disastrous as it may disseminate the damage to a wide area of the organisation. For instance, a bad management decision can put a response team in a life-threatening situation during a disaster. Such decision can have a wider impact if it was amplified to cover more response teams. Therefore, for this research, *complexity is positive only when it enhances organisational operations and facilitates achieving its purpose regardless of any other systemic characteristics of this complexity* (e.g. what generates it and where it manifests).

Neutral complexity is another type of complexity. Neutral complexity does not have any impact on the system. For instance, when a responder makes a distinction of a resident fixing their window. This does not disturb the responder's operations nor it does help them in achieving their operational goal. This type of complexity can only be relevant to a system if it was generated within that system because it can involve waste that needs to be eliminated. Thus, it will be of interest to continuous improvement and Lean experts, consultants, and managers who are in charge to reduce waste. Nonetheless, this might not be relevant to operations during disasters for two reasons. First, the system is usually overwhelmed by complexity. Hence, enhancing efficiency might not be a priority during the response. Second, it may not be in the system's interest to study environmental occurrences that do not influence the system during the response (directly or indirectly).

Categorising complexity into *problematic* and *supportive* is not explicitly present in the cybernetics and the VSM literature (e.g. Beer, 1979, 1981, 1985; Schwaninger, 2006b; Espejo and Reyes, 2011; Rios, 2012). Rather, this literature may have led the readers to generalise and interpret the implicit message as: the environmental complexity is problematic and organisational complexity (internal) is supportive. The cybernetics logic is that external complexity overwhelms the system and more organisational complexity is helpful to encounter the environment, and thus survive (Beer, 1985; Espejo and Reyes, 2011). However, this subsection argued that such generalisation can work against systems' resilience.

#### *2.6.2.3. Conceptual Proposition 2 – Complexity Classification*

Combining the previous novel complexity types results in the second conceptual proposition in this chapter. The Proposition suggests four main classifications of complexity: internal supportive, internal problematic, external supportive, and external problematic. Each of these types is defined by using the proposed definitions of each concept in the proposed classification in the subsections above. See Table 2-5.

**Table 2-5: Conceptual Proposition 2 -Complexity Classification**

| | ***Supportive*** | ***Problematic*** |
|---|---|---|
| ***Internal*** | The complexity that is generated by the system's elements or the external elements that are temporarily managed by the system. This complexity supports the system in achieving its purposes and facilitates its operations. | The complexity that is generated by the system's elements or the external elements that are temporarily managed by the system. This complexity disturbs the system's operations and can hinder achieving its purpose. |
| ***External*** | The complexity that is generated by the environment's elements. This complexity supports the system in achieving its purposes and facilitates its operations. | The complexity that is generated by any element that is not formally operating under the system's management. This complexity disturbs the system's operations and can hinder achieving its purpose. |

This proposition closes a gap in the cybernetics literature by explicitly defining four main types of complexity. These four typologies can provide a direct and quick guide to understanding the observed complexity. Hence, it can facilitate a rapid and timely decision-making regarding the response strategies. The novelty of the proposition comes from its ability to provide a more generic, simple, and functional guidance to defining complexity than what was presented by the VSM literature. However, this proposition is not rigid. It is receptive to new concepts should they serve a certain context. For instance, Espejo and Reyes' (2011) three types of complexity: individual, collective and situational can be added to the four categories if the observer finds the value of doing so. Theoretically, this proposition will be used in this thesis to develop conceptual, yet practical, models that can further enhance systems' resilience and their ability to timely address complexity.

### 2.6.3. Conceptual Model 3 - Complexity Drivers Classification

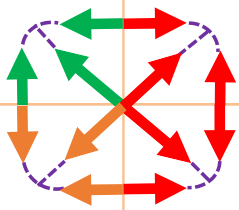
Managing complexity drivers (CDs) is a strategy for managing complexity. This strategy is based on breaking down the complex structure to facilitate understanding it (Beer, 1979; Hoverstadt, 2008). However, managing CDs can be argued to be a preventive measure or a proactive strategy for managing complexity. Organisations can avoid firefighting and save resources if they could establish strategies to deal with CDs in the first place. The focus of this discussion is to manage CDs in a way that enhances the system's resilience.

As is the case for complexity classification gap, the VSM literature (e.g. Beer, 1979, 1981, 1985; Schwaninger, 2006b; Espejo and Reyes, 2011; Rios, 2012) does not have an explicit classification of CDs in regard to their location or nature. Nonetheless, one can argue that the absence of such a classification is justifiable. Given their dynamic nature, it may be challenging to fit CDs in a generalisable model. Yet, the inability to classify CDs makes it challenging to manage them, especially when quick decisions are needed.

A solution for this gap is a dynamic model of CDs. A dynamic model allows CDs to move within the model boundaries and allows the observer to classify them in a timely manner. Table 2-6 shows the proposed dynamic model of CDs that builds on the conceptual proposition of complexity classification (Table 2-5). The model classifies CDs according to their location and the nature of the complexity they generate in relation to the observer's interest. Hence, a CD is internal supportive if it belongs to the system and if it generates the desired complexity that supports the operations and the system's purpose at the moment of observation. This CD may change its location for the observer within the four quadrants of the model. Table 2-6 shows an example of a volunteer (CD) according to their relationship with a charity (observer). The model shows how the charity classifies this volunteer according to the complexity he or she generates.

**Table 2-6: Conceptual Model 3 - Complexity Drivers Classification and Dynamics**

| **Complexity Drivers** | *Supportive* | *Problematic* | |
|---|---|---|---|
| *Internal* | An experienced volunteer contracts with a responder during a disaster:<br>• The charity needs his skills in rescue casualties<br>• He uses his own car during emergencies.<br>• He uses his social network to support the charity function<br><br>Green Zone: Ideal for Officials | The volunteer<br>• Is still contracted with the charity<br>• Start to ask for more autonomy doing the things his way<br>• Accepts help from friends in the disaster site, which might endanger the charity reputation.<br>• Makes a mistake that leads to putting some casualties' lives in risks.<br><br>Red Zones: CDs disturb operations or cause damage | Official Responsibility |
| *External* | Amber Zone: Accepted or encouraged by Officials<br><br>The volunteer:<br>• Cancels his contract with the charity<br>• Work independently to raise funds for the charity<br>• Form an experienced SVs group to communicate the charity messages to the affected communities. | The volunteer:<br>• Cancels his contract with the charity<br>• He and his SV group operate chaotically in the charity operations area.<br>• He accesses a dangerous building in the affected area.<br>• Contribute to convey exaggerated news about the disaster | No defined Responsibility |



In many cases, the user of the model might find it challenging to locate a CD in one quadrant. The CD might simultaneously generate the two types of complexity (supportive and problematic) during the observation period. Here, the observer would need to use an extra lens in addition to the time criteria or use a different lens when using the model. This can narrow down the criteria based on which complexity is judged. For instance, a department's lens can be used instead of the whole organisation's lens. An example of adding an additional lens can be adding a criterion to assess the complexity that the CD is generating (e.g. financial or social). This corresponds to the logic that Hoverstadt (2008) uses to choose a route to unfold the complexity of a system.

Three zones can be observed in the model. The first is a green zone in the first quadrant (internal-supportive). This zone is ideal for a system because CDs would be under its direct control and would be generating supportive complexity. Hence, no action is needed on these CDs. This is an inaction that is different from what Beer (1979, 1981, 1985) describes as ignorance. It comes from logic thinking that serves the system's interest. The VSM does not explicitly address this case (e.g. Beer, 1979, 1981, 1985; Schwaninger, 2006b; Espejo and Reyes, 2011; Rios, 2012).

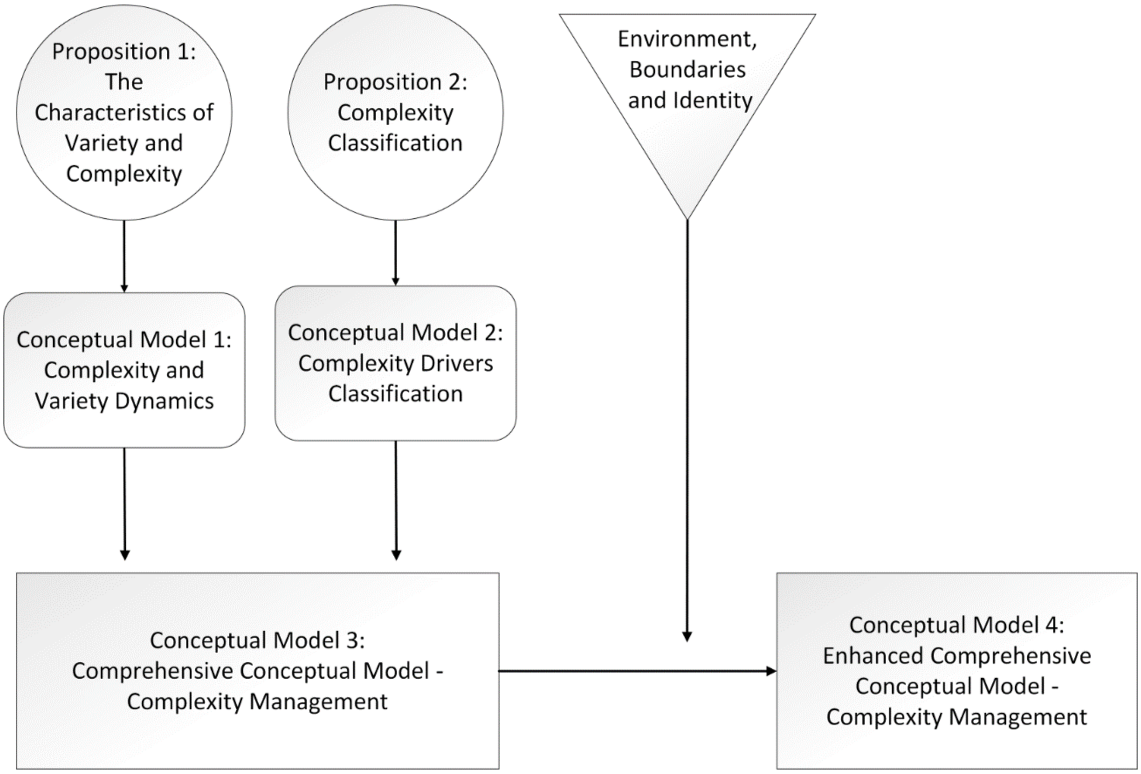
The second zone is an amber zone in the quadrant below. While CDs in this zone generate supportive complexity, they are not under the system's control. This can sometimes create uncoordinated operations. However, a system may allow these CDs to function freely as long as their complexity supports its purpose. This may require a closer monitoring than those CDs in the green zone. The third zone is red and includes the two quadrants in the right column. CDs in this zone generate disturbing complexity for the system. Thus, the system needs to take action to block CDs or influence them to move to the amber or green zones. Blocking and influencing complexity can be thought of as ways of attenuating complexity (Beer, 1979). However, influencing here involves changing the nature of the generated complexity. This was not explicitly discussed by the VSM. The quadrant on the right top is where CDs can be most damaging to the system because they cause damage from within the system. This implies that the system may be legally responsible for the consequences.

### 2.6.4. A Proposed Comprehensive Model

The proposed comprehensive model is built using the theoretical stands and the conceptual models that were proposed in this chapter (Figure 2-17). Although these models and theoretical propositions may be useful when used separately, their value can enhance significantly when they are put together in an operational model. The comprehensive model exercises the merit of these theoretical propositions holistically. It allows a user to enhance organisational resilience and provides operational guidance that is flexible enough to respond to sudden complexity efficiently and effectively. The ability to embrace, influence and manage the complexity that the model can grant to systems means that the system can be more effective during disasters. It can also be effective in helping the system to manage the dynamic complexity of SVs.

The following concepts and models were used to build this model. First, the proposed distinctions and definitions that were made between variety and complexity. These can be found in subsection 2.6.1 and Table 2-4. Second, the proposed model that explained how variety and complexity flow in a viable organisation and where each is managed and generated (subsection 2.6.1.4 and Figure 2-16). Third, the proposed model that classifies complexity according to its impact and location (subsection 2.6.2.3 and Table 2-5). Fourth, the proposed CD model that classifies CDs according to the complexity they are generating in a given time (subsection 2.6.3 and Table 2-6). Lastly, the model uses the learning from the discussion on boundaries and identity in 2.4.1.4. These concepts and models evolved to form each other and to build the final model as shown in Figure 2-17.

**Figure 2-17: The Process of Building the Proposed Comprehensive Model**




The comprehensive model is shown in Figure 2-18. The model in the figure depicts two recursion levels. The first level represents the multi-agency response system on the ground (in black outline). The higher recursion level in blue outline represents the containing system (e.g. SCG). The emergency area of the environment contains different CDs. The relevant ones in this model are SVs as individuals and SVs who organise themselves in groups. Typically, these two CDs are a source of disruption, confusion for the operational units on the ground.

The flowchart inside the S1 unit proposes a scenario where operational staff can actively deal with CDs. When an S1 unit (a team or an individual) distinguishes a CD, it uses the

CD model to classify the CD in one of the quadrants. Three decisions can be quickly made as follows:

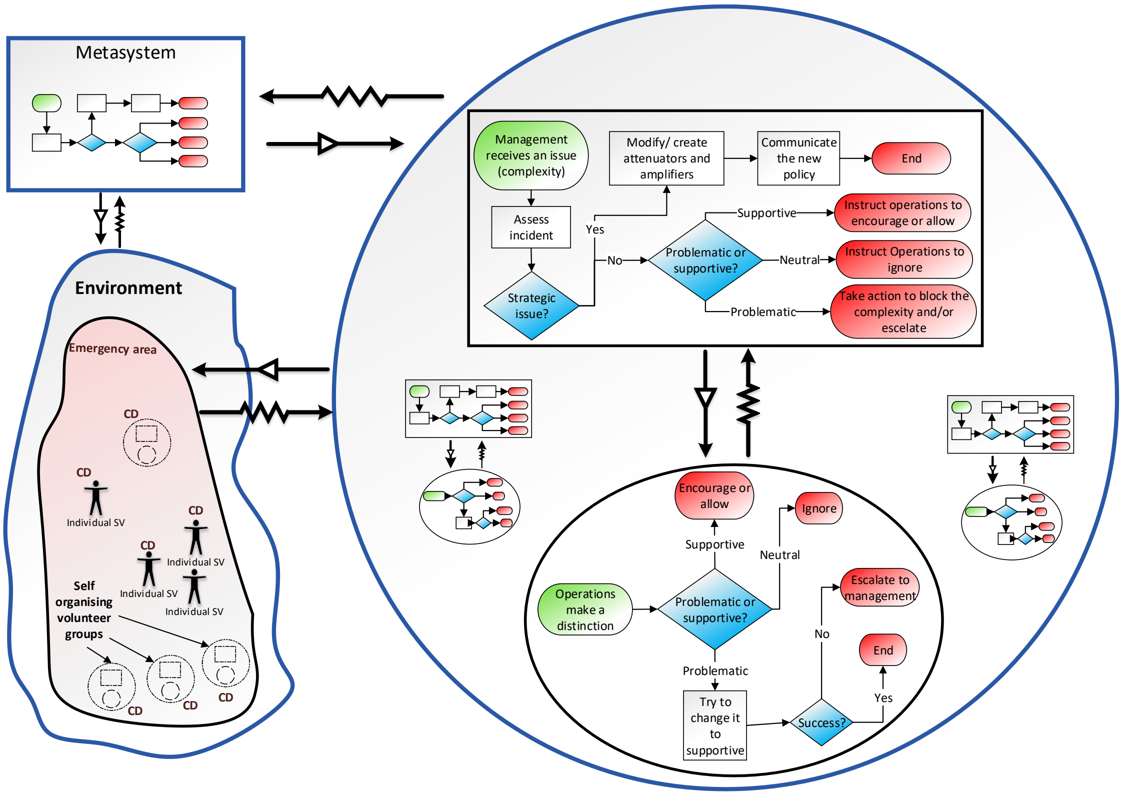
- Ignore if the complexity that they CD is generating is neutral.
- Allow or encourage the CD to generate complexity if it is supportive.
- Take action to influence the CD if it is generating problematic complexity. If this is not possible, the issue is escalated to management.

Granting the authority to S1 to use this logic will address a large amount of complexity that was usually ignored or escalated as residual complexity to the management. The model allows S1 to filter CDs on the spot, take advantage of the supportive CDs to enhance the resilience of the system, reduce the complexity that needs action, and convert some problematic CDs to support the system. It is only the remaining CDs that do not pass the comprehensive process that can be a matter of concern. However, the S1 flowchart in Figure 2-18 can be developed further using the proposed conceptual models in this chapter. For instance, S1 can be guided to directly escalate problematic internal CDs without trying to influence them. It is important to note that changes in the model are informed and supported by the philosophical underpinnings that were used to build it. The modifiable nature of the model is not a criticism of validity. Rather it is a sign of viability and resilience to achieve the same outcomes in different contexts.

Similarly, the management can use the same logic when it receives complexity form S1 (residual complexity). The flowchart shows management-related filters, yet they use the same CD model. The first filter that the management uses to assess a CD is whether it can impose strategic consequences. Strategic consequences are those that have a large impact and are likely to reoccur. If they are strategic, then the management would carefully assess the CD and design policies that guide S1 on the attenuators and amplifiers to use with this type of CD. Designing the policy can be done in the S1's local management or can be escalated to the higher recursion level (depicted in blue outline in Figure 2-18).

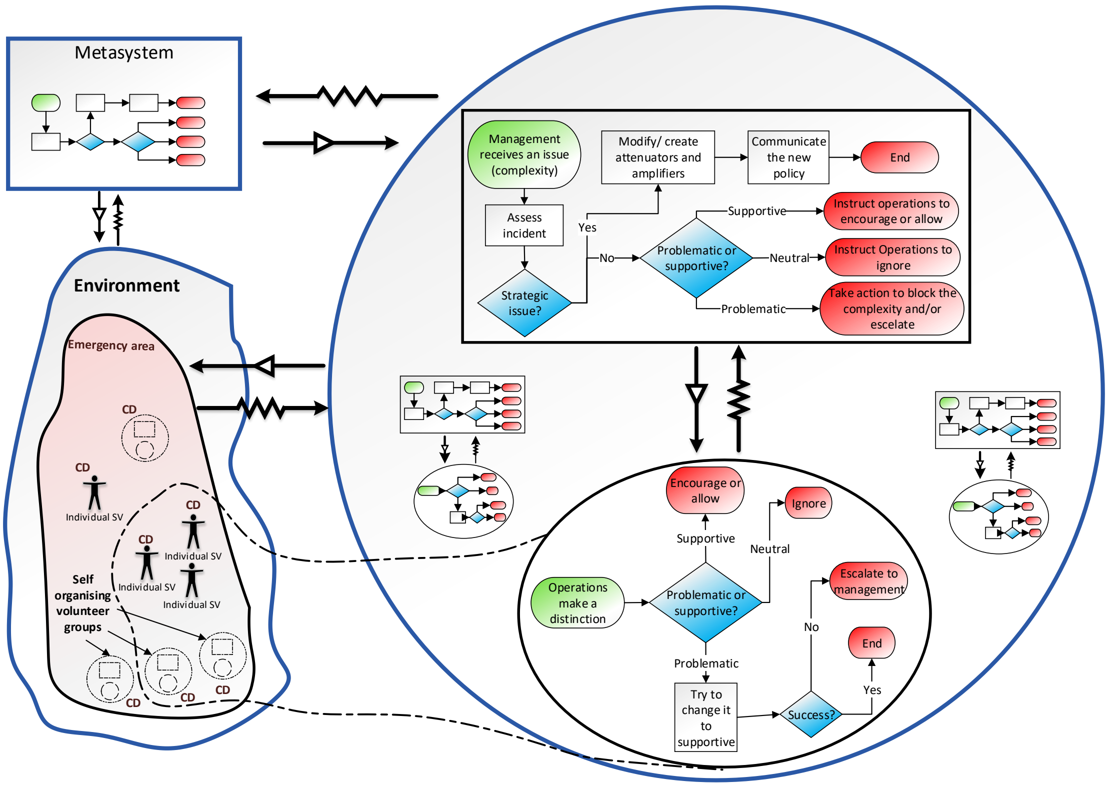
The higher *guided* autonomy that S1 enjoys in this model brings two enhanced benefits for resilience and viability. The first contributes to answering the control/autonomy balance dilemma. The second is enhancing the effectiveness and efficiency of the VSM's complexity regulation significantly. It facilitates handling the largest amount of complexity on the ground, which considerably reduces the flow of complexity to management. It also makes use of all the potential resources of supportive complexity in the environment, which can multiply the outcomes of amplification. The difference from the traditional complexity management is amplifying all supportive complexity rather only the outflowing complexity, and attenuating all problematic complexity rather than aiming at reducing the incoming complexity.

**Figure 2-18: Conceptual Model 3 - A Proposed Comprehensive Model**




The theoretical notions that were not demonstrated in the figure above are the notions of boundaries, identity and the system-environment relationship. The system's management can enhance the comprehensiveness of the model by incorporating the theorem in its policies. Figure 2-19 shows a conceptual scenario where S1 changes the location of CDs. In this example, the response system's S1 decides to engage experienced SV groups within its team and supervise them. This will grant the system further resources (human and physical) that will reduce the emerged complexity gap. Also, the S1 teams encountered problematic SVs who were acting chaotically in the area. They managed to convince them to work under the official's supervision to perform tasks that are suitable for their skills. Thus, SVs moved from the external problematic quadrant in the CD model to become internal supportive. The dashed extended boundary of S1 shows the temporary inclusion of the targeted SVs and SV groups.

**Figure 2-19: Conceptual Model 4 - An Enhanced Comprehensive Model that Merges with the Environment**




Including the notion of environmental inclusiveness in the model enhances the magnitude of complexity regulation. Figure 2-19 shows how this approach reduces the uncontrolled environmental elements. This attenuates the unpredictable complexity that S1 and S4 must deal with. This also attenuates variety that is generated by S4 and processed by S5. On the other hand, the model increases the complexity that is deployed and coordinated by the system (S1 and S3). According to traditional VSM, SVs are likely to be considered problematic CDs because they increase the uncontrolled elements in the situation and may cause health and safety issues (Osti and Miyake, 2011; Barraket *et al.*, 2013).

Nonetheless, some systemic considerations related to systems' characteristics (Checkland, 1993) need to be considered when using the previous model. These are:

- The system's boundary, particularly the operational unit, has changed and should be redefined accordingly.

- The SVs and SV groups are 'new' elements for the system. They do not necessarily have the same skills, training, culture, and understanding of the system as the system's components.
- The system should redefine the relationships between the system's elements and the new elements.
- Embodying environmental elements within the system's boundary will change the environmental characteristics. The system should redefine the relationship with its environment based on the new change.

Evidence to study the above points will be sought after during the data collection and analysis and will be presented in the findings, mainly in chapter 4.

The models above have been explained in a simple manner, with simple and limited examples to ease understanding. In reality, CDs can be more complex and more dynamic. Thus, this proposed model should be tested and developed further to increase its reliability. The data collection and analysis process will focus on identifying key CDs that are associated with community engagement. Then, the response system will be modelled and its response to these drivers will be examined. The multi-agency response systems, the case studies of this research, are complex enough to test the initial validity of the proposed concepts and models in this chapter.

## 2.7. SUMMARY OF THE CHAPTER

This chapter started by discussing the notion of resilience and how to enhance it to achieve viability. It identified the effective and efficient management of complexity as a major strategy to enhance resilience and viability. The VSM was identified as a suitable and effective systemic approach to manage complexity. Hence, complexity, its generators, classification and management were reviewed from the VSM's perspective. These subjects were discussed in sections 2.2 - 2.4.

Section 2.6 critically discusses key notions that are relevant to complexity management and identifies gaps that can hinder achieving higher resilience during disasters. Further, it introduces conceptual propositions and models that can help in closing these gaps.

Subsection 2.6.1 discusses two overarching gaps. The first is the unsuitability of the notion of variety as a measure of complexity and its impracticality of managing complexity, especially for operations during disasters. Variety is introduced as all possible states of the system. Such concept can be operationally overwhelming and unrepresentative of the observed complexity. It may be illogical to use the potential value to measure the actual value of a situation or a system. The source of this problem might be the second identified gap. This is the absence of clear definitions and distinction between variety and complexity in the VSM literature. This gap can confuse the VSM user and hence render the concept impractical.

These gaps were closed through two conceptual models. The first redefines the notions of complexity and variety and clearly distinguishes between them. It states that variety concern all the potential states of the system while complexity is only the manifested and observed states. Hence, variety (the potential and larger) is not an appropriate measure of complexity (the actual and smaller). The proposition can enable the VSM user to systemically prioritise when rapid decision-making is needed. See Figure 2-15. The second model embeds the new definitions within the VSM structure. It shows where these notions are generated within this structure, and how they are communicated and processed. This contributes to the VSM by enabling the user to define responsibilities, understand the source and the nature of the distinctions they are making, and make decisions on how to respond to them. See Figure 2-16. Lastly, subsection 2.6.1.5 combines all the proposed notions in a table that details the theoretical and practical features of the notions of variety and complexity and compares it to what exists in the VSM literature. See Table 2-4.

Section 2.6.2 discussed gaps in VSM's variety engineering. Two overarching gaps were identified. The first concerns the way the VSM regulates complexity. It is argued that the VSM's guidance of attenuating external complexity and amplifying internal complexity can be counterproductive and can limit resilience. The implication of strict application of such regulation is losing opportunities, knowledge and resources that may support systems' resilience. Although Beer (1979) highlights ignorance as a dangerous strategy to attenuate complexity, the VSM does not suggest a strategy that can be used to make informed decisions in stressful and rapidly-changing situations.

The second gap was proposed as a possible cause of the regulation gap above. It is the absence of an operationally useful complexity classification in the VSM. The implication of keeping such classification implicit is overlooking important opportunities or risks during decision-making and when policies are designed. Further, it may lead to a radical implementation of the notion of attenuation against external complexity – hence ignorance. As such, S1's ability to make rapid decision-making in chaotic and dynamic situations can be significantly reduced.

To close the latter gap, and hence the former, a novel conceptual proposition to classify complexity is introduced. The proposition argues that there are four types of complexity that were not explicitly categorised in the VSM literature. These are internal, external, supportive and problematic. Detailed definitions of these types were introduced. These definitions are derived from the proposed complexity definition and proposed definitions of internal or external elements that can enhance organisational resilience. See Table 2-5.

Another conceptual model was introduced to further enhance S1's agility and hence the system's resilience. The novel model classifies CDs using the same criteria that are used to classify complexity (internal, external, supportive and problematic). The need for this model comes from the fact that actions can only be made on CDs, not on complexity itself. Complexity is past occurrence once it is observed. Hence, the model comes to assist operations in acting on complexity generators as a proactive approach to managing complexity. The model recognises that CDs are dynamic in nature because their complexity is time and context related. See Table 2-6.

Lastly, a conceptual comprehensive model is proposed. This model is a representation of the disasters response system using the VSM structure. It shows examples of the decisions that can be made in the systems management and operations units using the above conceptual models and their underlying propositions.

These novel concepts and models will change the research's approach to data analysis. Instead of following the pure thematic analysis that is common in qualitative research, a VSM-based analysis will be performed. The aim is to test the validity of the conceptual propositions and the models that were discussed in this chapter. For instance, the structure of the response will be analysed for viability according to the VSM. The relationship between the system and its environment (e.g. SVs) will also be analysed. Furthermore, evidence of the different types of complexity and complexity drivers will be sought after. Lastly, the complexity regulation practices will be analysed to examine their impact on resilience. Hence, this chapter validated the research questions that were identified in Chapter 1. These were:

1. How does the multi-agency emergency response system evolve during a response to a disaster?
2. What are the systemic and viable characteristics of the emergency response system that contribute to its resilience?
3. How does this system systemically relate to and regulate SVs' complexity during the response?
   d) What generates the SVs' complexity?
   e) What are the types of the generated complexity?
   f) Where and how is this complexity processed?

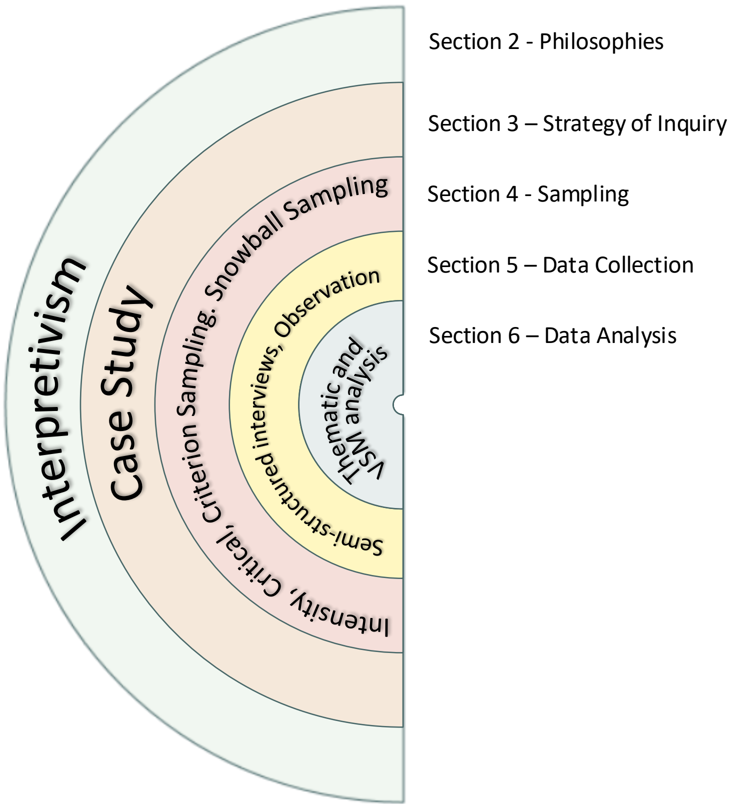
# CHAPTER 3

# METHODOLOGY

## 3.1. INTRODUCTION

This chapter discusses the methodology that is used to answer the research questions. Section 3.2 discusses and justifies the philosophies that govern this research. The epistemological and the ontological considerations are discussed in detail. Section 3.3 moves on to explain the strategy that is used to conduct the research and enquire data. Sections 4-6 justify and explain in detail the sampling, data collection, and data analysis procedures that were followed in this research. Figure 3-1 shows the structure of the chapter and summarises the choices made in this research.

**Figure 3-1: The Chapter Structure and Research Design**



## 3.2. RESEARCH PHILOSOPHIES

It is well established among methodologists (Bryman, 1989; Creswell, 2009; e.g. Yin, 2011; Myers, 2013) that philosophical assumptions are the foundation of research. These assumptions can alter the way in which the researcher understands the research questions (Saunders, Thornhill and Lewis, 2007). Researchers need to justify their choices of the methods and tools used in research in the light of their understanding of how the world functions around them. This justification can determine the value of the research (Crotty, 1998) and whether it can be completed successfully (Creswell, 2009).

Philosophers are in a continuous endeavour to answer questions on what qualifies as knowledge, reality, and what can be considered true. While some philosophers adopted extremely opposed positions when answering these questions, a spectrum of positions evolved in between these extremes (Fleetwood and Ackroyd, 2004). Saunders and colleagues (2012) stress that research philosophies are multidimensional in regards to answering the questions noted above as shown in Table 3-1. The field that discusses the first question in the table (what is the nature of reality?) is called ontology and the field that covers the second question (what is acceptable knowledge?) is called epistemology.

**Table 3-1: Research Philosophies as a Multidimensional Set of Continua**

| Question (dimension) | Continua | | |
|---|---|---|---|
| • What is the **nature of reality**? | external | ⇔ | socially constructed |
| | objective | ⇔ | subjective |
| • What is considered **acceptable knowledge**? | observable phenomena | ⇔ | subjective meanings |
| | law-like generalisations | ⇔ | details of specifics |
| • What is the **role of values**? | value free | ⇔ | value bound |

Source: (Saunders, Lewis and Thornhill, 2012, p. 129)

Saunders et al. (2012) identify four major research philosophies in business and social research: Positivism, Realism, Interpretivism, and Pragmatism. Pragmatism will not be discussed as it simply means that the researcher is free to select and match from the available main philosophical paradigms to achieve their research goals (Saunders, Lewis and Thornhill, 2012). Rather, this section starts with discussing the key epistemological and ontological assumptions of positivism as positivism is the most familiar and dominant epistemological orientation in the West (Johnson and Duberley, 2000), and because it is generally established that other philosophical positions evolved by critiquing positivism (Johnson and Duberley, 2000). The criticisms of positivism and interpretivism are used to justify the paradigm adopted by this research. Critical realism is then briefly introduced as it was considered a potential philosophy of this research. Lastly, the author concludes with a justification of the selection of the philosophical positioning of this research.

### 3.2.1. Positivism

Bryman and Bell (2015) claim that positivism is a doctrine that is difficult to precisely define because researchers use it in numerous ways. For instance, some researchers use it as a philosophy while others use it as a term to describe superficial data collection. In agreement, Creswell (2009) points out that different scholars refer to positivism as the scientific method, positivist research, postpositivism, or empirical science.

Positivism was developed in the 19th century when philosophers who previously rejected generalisation, that is a characteristic of positivist thinking, started to accept that the scientific method is what leads to knowledge. Phillips and Burbules (2000) claim that the origin of positivism was established by the French philosopher Auguste Comte (1798 – 1857) who strongly defended the notion of ignoring the search for the hidden causes of phenomena and replacing it with using observation and strict reasoning to learn about the phenomena. Comte with others from the empiricist tradition (e.g. Mill and Durkheim) proposed and defended the emergent notion of using the physical science methodologies in social research (Phillips and Burbules, 2000). Smith (1983) highlights the justification of this notion by referring to Comte's classification of social science as part of the hierarchical development of science: *"mathematics through astronomy, physics and down to sociology*" (p.7).

The positivist epistemologically believes that social structures can be predictable because they are governed by laws. A justification of this stand can be found in Berger and Luckmann (1966) where they claim that habitualisation is what rules human activity. Habitualisation refers to the repeated actions that form a pattern. They state that *"Habitualization further implies that the action in question may be performed again in the future in the same manner and with the same economical effort. This is true of non-social as well as of social activity."* (Berger and Luckmann, 1966, p. 71). One can then conclude that understanding these laws (or regularities) requires a researcher to objectively observe social phenomena and search for causal (i.e. cause and effect) relationships. Burell and Morgan (1979) explain that this approach to social science is rooted in the natural science where researchers seek to confirm or refute hypothesised regularities by adequate experiments. The verified insights are continuously added to the already established knowledge in a cumulative process.

The deterministic position of positivists believes that every outcome is *caused* by (or determined by) factors or variables. This position is described as reductionistic because it seeks explanations by *reducing* (or dividing) the studied phenomenon into a smaller set of ideas, or variables, to test (Creswell, 2009). These variables are carefully isolated and observed in a laboratory-like environment seeking to reach an objective knowledge that can be generalised. Usually, the observation uses numeric measures when studying human behaviour to seek objectivity (Creswell, 2009). These two characteristics (deterministic and reductionistic) are among the several base foundations of positivism.

Talking about objectivity introduces the ontological position of positivism. Positivists believe that there is a reality that exists external to and separate from social actors. As such, it assumes that "*human behaviour is determined by external stimuli"* (Singh, 2007, p. 407). Thus, positivist researchers assume that management is identical in all organisations as it is based on a structure and rules already determined. Thus, changing the manager in an organisation would not result in changing the management function as it is governed by formal hierarchies and reporting systems (Saunders, Lewis and Thornhill, 2012). The ontological explanation of this assumption is that management is real and is independent of who plays the manager's role.

Bryman and Bell (2015, p.28) summarise the most widely accepted principles of positivism as follows:

1. Only phenomena and hence knowledge confirmed by senses can genuinely be warranted as knowledge (phenomenalism).
2. The purpose of theory is to generate hypotheses that can be tested and that will allow explanations of laws to be assessed (deductivism).
3. Knowledge is arrived at by gathering facts that provide the basis for laws (inductivism).
4. Science must (and can) be conducted in a way that is value free (objectivism).

5. There is a clear distinction between scientific statements and normative statements and the former are the true domain of the scientist.

Building on their objective ontology, positivists believe that they can obtain knowledge that is independent of them if a rigorous methodology is followed, where this knowledge is maintained uncontaminated by the observation and the knowing of the observer (Johnson and Duberley, 2000).

However, in the second half of the 20th century, several scholars such as Berger and Luckmann (1966) argued against the use of the natural science principles in sociology. This led to the emergence of the interpretive paradigm, which is sometimes referred to as qualitative (Bryman, 1989), social constructivism (Creswell, 2009), or constructivist (Bryman, 1988). Those criticisms will be highlighted to introduce and discuss interpretivism.

### 3.2.2. Interpretivism

Johnson and Duberley (2000) refer to a fundamental problem, which is the positivists' exclusion of metaphysical form of knowledge; this resulted in breaking with positivism and in the re-emergence of subjectivism. Johnson and Duberley (2000) point out that this exclusion is self-contradictory because it ignores the metaphysical knowledge of the relationship between the subject and the object, which is the foundation of any epistemology including positivism. The importance of metaphysics here is that it can explain the role of *"human subjectivity in explaining human behaviour"* (Johnson and Duberley, 2000, p. 33).

The advocates of interpretivism take a contrasting epistemology to positivists (Bryman and Bell, 2015) and accuse them of misunderstanding how humans should be researched (Bryman, 1989). Studying people and their institutions require a totally different logic because they are fundamentally different from natural order (Bryman and Bell, 2015). Social phenomena cannot be objectively observed because observation is value and theory-laden (Burell and Morgan, 1979), which leads to the epistemological dismissal of the existence of neutral knowledge.

Interpretivists also reject the causality, replication and the generalisability when studying sociology. They argue that social structures are very complex to be summarised in a law or a theory. Thus, any attempt to understand this complexity in a reductionist approach will result in losing the richness of this complexity (Saunders, Lewis and Thornhill, 2012).

For interpretivists, humans are different from the objects that exist in nature because they are purposive and conscious actors (Robson and McCartan, 2016) in the play of life. Individuals' interpretations of the experiences and the things around them are subjective, varied, and multiple (Creswell, 2007) because they assign meanings to the world around them. These diverse interpretations and perceptions influence their roles and shape their actions (Saunders, Lewis and Thornhill, 2012). Using different metaphors (e.g. mechanical, religious, or biological) to explain a phenomenon can result in different understandings. Similarly, using different language can influence the way people perceive a phenomenon. Thus, social phenomena exist in people's minds and do not have a separate existence 'out there'. In other words, reality is *created* in the human mind and not *perceived* by it as advocated by positivism; and therefore, there is no one reality or one truth (Robson and McCartan, 2016).

Interpretivism takes an orthodox positioning regarding subjectivity. As such, it rejects the claims of moderate post-positivists who although reject the notion of universal truth, they tend to accept *"the possibility of specific, local, personal, and community forms of truth"* (Kvale, 1995, p. 21).

An ontological outcome of this discussion is the notion of social constructionism. Saunders et al. (2012) explain that social constructionism assumes that reality is socially constructed by social actors who collectively make up a reality based on their interpretations of the situations they encounter. This reality is people-relative because it is based on the interaction within a group of people who might agree on an interpretation of a phenomenon different from another group's interpretation; e.g. employees vs customers (Saunders, Lewis and Thornhill, 2012, p. 132). Social reality is also context-relative because the interpretation can change when changing the geography or the time of the interpretation. Lincoln and Guba's (2013, p.39) strongly accentuate this relativity as the presupposition of constructionism and state that *"Change the individuals and you change the reality. Or change the context and you change the reality. Or change both the individuals and the context and thoroughly change the reality this reality"*.

Hence, the role of the interpretivist researcher is to access the socially constructed reality through capturing the language, consciousness and meaning that people assign to the studied phenomenon (Myers and Avison, 2002). Myers and his colleague add that the aim is to generate an understanding of a phenomenon by considering its context and the process by which it influences and is influenced by the studied phenomenon. However, accepting the ontological stand that acknowledges the existence of multiple realities has epistemological implications; that the researcher is not discovering knowledge but co-creating it in the time and space in which it is generated. Lincoln and Guba (2013) explain this point by saying that the transaction between the subject and the researcher is subjective and is influenced by the researcher's race, gender, experience, knowledge, class, values, and by his or her interpretation of the context. Lincoln and Guba (2013) argue that the existence of subjectivity does not mean that a research project should be brought closer to objectivity as it is advocated by positivists. Rather, they explain, the searcher should uncover and make transparent his or her and the participants' value system and the intrinsic values of the context because the researcher's subjectivity and the co-creation of reality may be inevitable.

Nevertheless, interpretivism's tendency to epistemologically distance itself from positivism did not protect it from criticism. For example, Johnson and Duberley (2000) claim that interpretivism shares the *"warranted knowledge in observation"* with positivism. They further explain that interpretivists' observation process is considered epistemologically privileged when it is not influenced by the observation process conducted by the observer. This implies that interpretivism admits that objective truth can be obtained by using the *"…observer's passive sensory registration the facts that constitute external reality…"* (Johnson and Duberley, 2000, p. 35).

### 3.2.3. Critical Realism

Realism is a philosophical notion that is located between the "naïve positivism" and structuralism (Denzin and Lincoln, 2005). It is a blend of the epistemological assumptions of interpretivism and the ontological assumptions of positivism (Barbour, 2014); a blend that is recently advocated and recommended by Maxwell (2012). Its ontological stand is based on the existence of an observable reality that is independent of the human mind. However, epistemologically, knowledge for critical realism is constructed by social actors. Therefore, the feelings, thinking, and the interpretations of people must be studied (Denzin and Lincoln, 2005).

Critical realism is popular in the management research (Saunders, Lewis and Thornhill, 2012). Its popularity comes from recognising the necessity to go beyond the limitations of scientific methods, and concurrently observe the structure of the social world that represents the management and business domain. Yet, Maxwell (2012) argues that despite the support given to critical realism, its influence is still limited for qualitative researchers and is even unnoticed by most of them. Denzin and Lincoln (2005) further explain that when qualitative researchers notice critical realism, they see it as a different presentation of the positivist approach. Maxwell (2012) strongly argue against this perception and state that critical realism differs from positivism in many grounds and implications. He adds that a key difference that makes critical realism suitable for qualitative research is its belief that *"mental states and attributes (including meanings and intentions), although not directly observable are part of the real world…"* (Maxwell, 2012, p. 8). However, Maxwell (2012) review of methodologists' works reveals that scholars have not reached an agreement about attributing some of the epistemological and ontological assumptions of critical realism to either positivism or interpretivism.

### 3.2.4. Justification of Philosophical Choice

This study followed the interpretivist paradigm. The research treated participants as black boxes (Beer, 1985). The aim was to use the participants' perspectives (the output of the black box) to design a model within which the appropriate inputs (decisions) can be available for managers. The research built on the complexity principles that acknowledged uncertainty and relativity and sought to address them effectively. Although the proposed conceptual model in Chapter 2 categorised complexity to facilitate decision making, it acknowledged that managers' decisions could in many cases be subjective especially in rapidly changing situations such as emergencies. The premise of this research is that classifying an incident as problematic or supportive is relative to context (e.g. the decision maker, location, and/or time – the emergency response phase).

Epistemologically, the context of this research implies that the subjective meanings that different stakeholders hold should be accepted as valid knowledge (Saunders, Lewis and Thornhill, 2012). That is, to accept the perspectives of volunteers and officials as versions of reality. Ontologically, there is evidence in the disasters literature that the volunteerism phenomenon is socially constructed. For instance, volunteers' behaviours and practices are influenced by their culture and social class (Zakour and Gillespie, 2013). Therefore, an interpretive research was most suitable for this context.

The interpretive nature of data collection and analysis did not contradict the VSM principles. The VSM can implicitly acknowledge subjectivity as evident in Beer's (1979) comment that an S3 manager needs to change his role when he or she contributes to the strategic planning meetings of S5.

The critical realism paradigm was excluded in this research. The research did not believe in, or sought to understand, a proposed independent reality of the studied social structure. That is, it did not aim to understand the laws that govern the participants' actions nor to understand the economic and situational conditions that can result in habitualisation. Habitualisation is having *repeated* actions that can be *predicted* (Berger and Luckmann, 1966).

The researcher perceived the problematic situation as dynamic and unpredictable. SVs could be local, national, international, speak different languages, belong to different age groups, have different skills, and could be volunteering for different motives. Thus, every emergency could have had a unique emerging social structure (SV community). This social structure might be prone to changes over the emergency lifetime as a result of the continuous entrance and exit of SVs from this social structure. Building a law-like model that describes a proposed reality based on the stakeholders' perceptions, whether these perceptions are real or not, was not the main concern for this research.

## 3.3. STRATEGY OF INQUIRY

Grounded theory, action research and case study were considered for this research because of their wide popularity in similar qualitative research (Saunders, Lewis and Thornhill, 2012). The grounded theory strategy (Charmaz, 2006, 2008) was abandoned after careful consideration. The research did not aim at establishing a theory from the data alone nor it aimed at studying SVs and emergency systems as a phenomenon. Rather, the goal was to obtain an in-depth understanding to build a more robust operational model that can improve an existing system, overcome the challenges it faced, and enhance its resilience.

Action research was also excluded. Action research requires the researcher to influence change and to achieve tangible improvement in the context (Saunders, Lewis and Thornhill, 2012). The timeframe and the financial constraints of a PhD project rendered action research a risky choice. For instance, it was considered that facilitating change requires the researcher to select a team of officials, SVs, voluntary organisations, and influential stakeholders. It also requires an official commitment from participating organisations to participants to meet at certain times and to implement any obtained solutions. The initial analysis showed that diverse political, logistical, and admin factors can get in the way of the project. Hence, action research was excluded.

The remaining choice was using case study as the strategy for inquiry. The researcher aimed at an in-depth understanding of the emergency system and the operational challenges of the SV phenomenon. A case study strategy was suitable here because it can facilitate learning about different stakeholders' perspectives (or realities). Lincoln and Guba (2013, p.79) strongly support using case studies in interpretive research and state that *"The report of a constructivist inquiry is most usefully made in the case study format...as a re-presentation of the multiple constructed realities..."*. They explain that using case studies gives a sufficient scope of the studied setting circumstances, especially the *"physical, social, economic, and cultural elements"* (p.80).

One aspect of the complexity of the enquiry of this research was the influence that different stakeholders had on the emergency response system. The communities' support of this system contributed to an equilibrium that made the existence and stability of this system possible. Lincoln and Guba (2013) argue that case studies may be the only approach that can help in identifying the voices that can influence such equilibrium and in maintaining the aims of the enquiry concurrently. While this study's goal was not to report on these influences, any operational solutions would be defective without understanding the influence of different stakeholders on the studied system.

Engaging volunteers in the emergency response system was still in the recommendation stage when this research was commenced (Cabinet Office UK, 2012). A case study strategy was suitable to explore the features of this new topic (Myers, 2013) in the existing systems and processes (Creswell, 2003). Using case studies gave the researcher the flexibility to choose from several data collection methods (Creswell, 2009) to gather detailed information and explore the subject in depth.

Stake (2005) argues that case study is not a researcher's methodological choice but it simply expresses what is being studied. However, many methodologists accept case study enquiry as a strategy (e.g. Eisenhardt, 1989; Hartley, 2004; Saunders, Lewis and Thornhill, 2012) or as a methodological approach (e.g. Berg, 2001; Myers and Avison, 2002). Yin (2011) avoids explicit arguments about the classification of the case study enquiry and introduces it as a variation of qualitative research, which implicitly suggests the methodological nature of this enquiry system. This suggests an existing confusion about qualitative research, case studies, and inductive research (Eisenhardt, 1989).

A criticism of case studies can be the limited generalisability of results. However, Lincoln and Guba (2013) stress that case studies promote transferability of results that are based on a rich and in-depth enquiry of a certain context rather than generalisability that is a characteristic of positivist enquiry. They continue to emphasise that only potential users, not the researcher, are able to decide of transferring the results to their own context. The responsibility of the researcher is *"…to provide sufficient detail about the context, actors (participants), context-embedded (community and program) values, and context processes…"* (Lincoln and Guba, 2013) to make it possible for the potential users to decide its suitability for their context.

Lack of generalisability does not restrict the possibility of building theories from case studies. Eisenhardt (1989) introduced a full model to build theories from case studies. She was motivated by the work of grounded theorists such as Strauss (1987) and from scholars who promoted the possibility of building theories from case studies such as Gersick (1988) and Harris and Sutton (1986). This model is a systematic enquiry that results in a hypothesis. Generating hypotheses from the rich understanding that case studies offer is still advocated by methodologists such as Lincoln and Guba (2013).Conceptual frameworks and process (operational) models are also considered theoretical outcomes of case studies (Eisenhardt, 1989).

## 3.4. SAMPLING

The high complexity of emergency response (explained in the literature review) influenced the selection of the methods used for sampling in this research. Yin (2011) suggests that defining the data collection units (as major components of the study's structure) and their relationship with the research subject can clarify the complexity associated with sampling. A data collection unit here can be a case study, an interviewee, a focus group, or a policy (Yin, 2011, p. 82). Yin (2011) explains that qualitative research tends to have more than one level of data collection units; broader levels such as an organisation or a society and narrower levels such as an individual (interviewee). Defining those levels in early stages and their consistencies with the research topic can help the researcher in improving the coherence by tightening those relationships. For instance, a researcher can discover a mismatch between the research topic and the emerging findings. Such discrepancy can happen when these emerging findings come from a level that did not have a clear relationship with the research topic. Applying this concept to this research resulted in two data collection units' levels as illustrated in Table 3-2.

**Table 3-2: Two Levels of Data Collection Units**

| Topic | Data collection units | |
|---|---|---|
| | Broader level | Narrower level |
| Engaging spontaneous volunteers in the official response system | Two case studies (the response systems and their communities) | CAT1 members, organised voluntary organisations' members, and spontaneous volunteers |

Having identified the units, the next stage according to Yin (2011) is to select the specific units (sampling) in both levels and their numbers.

### 3.4.1. Sampling in Qualitative Research

Sampling can differentiate between qualitative and quantitative methods (Patton, 1990). This research adopted the purposeful sampling for selecting data collection units. This method is accepted by most qualitative scholars (Charmaz, 2006; Creswell, 2007; e.g. Yin, 2011; Myers, 2013; Corbin and Strauss, 2015). Purposeful sampling involves choosing the samples deliberately by the researcher in contrast to the random selection that is the main feature of quantitative research (Yin, 2011). Patton (1990) lists 15 purposeful sampling strategies that can assist the researcher in making the selection decisions. Given the purpose and the limited size of this section, the strategies that were considered are listed below. Patton's (1990) full list of strategies can be found in Figure 3-2.

1. *Extreme or deviant case sampling*: This approach aims at obtaining rich information from special cases, that are unusual or unique. These cases are unique because of a significant success or failure, from which valuable lessons can be learned.
2. *Intensity sampling:* Involves information-rich cases as it is the case of the extreme case sampling but it emphasises the intensity of the studied phenomenon rather than the extremes. This strategy goal is to avoid the unusual experiences that might distort the understanding of the studied phenomenon.
3. *Typical case sampling*: This strategy is used when the researcher aims to describe a system or a programme to an audience not familiar with this system. For this, the researcher uses typical cases with the aid of participants who can define what is typical for their system. However, this strategy does not lead to generalisation and does not address specific problems, deviations or extremes.
4. *Critical case sampling*: Critical cases can illustrate a theme dramatically or they are of special importance for the studied subject. Critical cases can be identified by the existence of statements such as "*if it happens there, it will happen anywhere*" or "*if that group is having problems, then we can be sure all the groups are having problems"* (p. 174). This strategy is useful when the research budget is limited, and the aim is to pick the case study that provides the maximum information and contributes to generating knowledge.
5. *Snowball or chain sampling*: This strategy is based on asking well-informed people and participants to recommend other participants who know much about the subject. The researcher can then choose the data collection units that are repeatedly mentioned. This process functions as a snowball that grows with progress.
6. *Criterion sampling*: Only case studies that meet specific criteria are selected. Examples of a criterion are age, experience, or location. Critical incidents can generate criteria to be used in this strategy.
7. *Opportunistic sampling*: The cases are selected because they emerge during the study as an opportunity to collect useful data. The selection decision can be made on-the-spot to ensure that such opportunities are not missed.

### 3.4.2. Selecting Case Studies

Two response systems in two different UK counties were selected as the broader level data collection units. Given the complexity of the subject matter, the choice of the counties was based on a combination of purposeful sampling strategies. The researcher has to consider two factors. First, selecting the data collection units required a flexible strategy that allows triangulation and responds to different perspectives (Patton, 1990). Second, engaging spontaneous volunteers formally in official organisations was still in its early stages in the UK (Cabinet Office UK, 2013). This factor raised the question of whether different organisations have the adequate knowledge and experience in the subject to provide extensive and reliable data.  From this research’s perspective, an information-poor response system is the one that did not encounter any forms of SVs engagement during emergencies. Therefore, an ideal case study would have had its members in contact with SVs and experienced the operational challenges associated with SVs’ involvement in a formal response.

**Figure 3-2: Sampling Strategies**

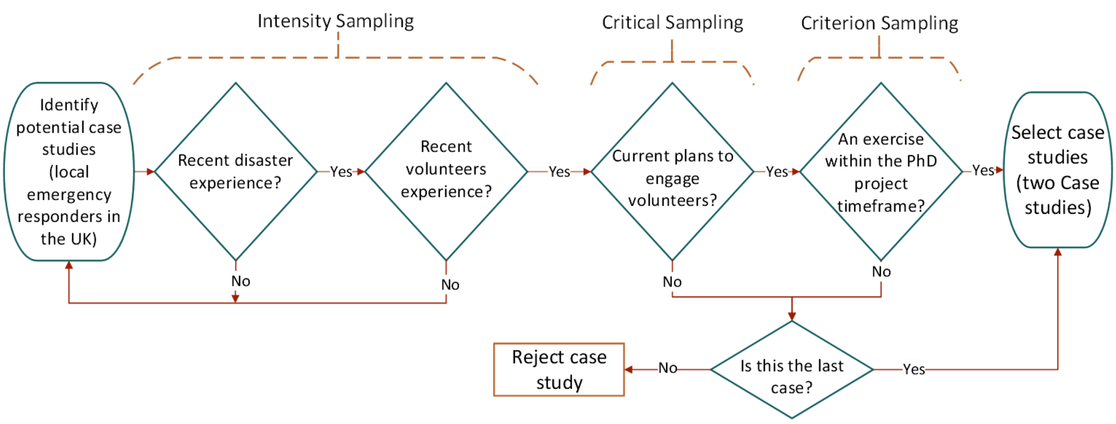
| *Type* | *Purpose* |
|---|---|
| A. Random probability sampling | Representativeness: Sample size a function of population size and desired confidence level. |
| 1. simple random sample | Permits generalization from sample to the population it represents. |
| 2. stratified random and cluster samples | Increases confidence in making generalizations to particular subgroups or areas. |
| B. Purposeful sampling | Selects information-rich cases for in-depth study. Size and specific cases depend on study purpose. |
| 1. extreme or deviant case sampling | Learning from highly unusual manifestations of the phenomenon of interest, such as outstanding successes/ notable failures, top of the class/ dropouts, exotic events, crises. |
| 2. intensity sampling | Information-rich cases that manifest the phenomenon intensely, but not extremely, such as good students/ poor students, above average/below average. |
| 3. maximum variation sampling-purposefully picking a wide range of variation on dimensions of interest | Documents unique or diverse variations that have emerged in adapting to different conditions. Identifies important common patterns that cut across variations. |
| 4. homogeneous sampling | Focuses, reduces variation, simplifies analysis, facilitates group interviewing. |
| 5. typical case sampling | Illustrates or highlights what is typical, normal, average. |
| 6. stratified purposeful sampling | Illustrates characteristics of particular subgroups of interest; facilitates comparisons. |
| 7. critical case sampling | Permits logical generalization and maximum application of information to other cases because if it's true of this one case it's likely to be true of all other cases. |
| 8. snowball or chain sampling | Identifies cases of interest from people who know people who know people who know what cases are information rich, that is, good examples for study, good interview subjects. |
| 9. criterion sampling | Picking all cases that meet some criterion, such as all children abused in a treatment facility. Quality assurance. |
| 10. theory-based or operational construct sampling | Finding manifestations of a theoretical construct of interest so as to elaborate and examine the construct. |
| 11. confirming and disconfirming cases | Elaborating and deepening initial analysis, seeking exceptions, testing variation. |
| 12. opportunistic sampling | Following new leads during fieldwork, taking advantage of the unexpected, flexibility. |
| 13. random purposeful sampling (still small sample size) | Adds credibility to sample when potential purposeful sample is larger than one can handle. Reduces judgment within a purposeful category. (Not for generalizations or representativeness.) |
| 14. sampling politically important cases | Attracts attention to the study (or avoids attracting undesired attention by purposefully eliminating from the sample politically sensitive cases). |
| 15. convenience sampling | Saves time, money, and effort. Poorest rationale; lowest credibility. Yields information-poor cases. |
| 16. combination or mixed purposeful sampling | Triangulation, flexibility, meets multiple interests and needs. |

Source: (Patton, 1990, p. 183)

Three strategies were used in the selection process: intensity sampling, criterion sampling and critical case sampling (Figure 3-3). These strategies were applied in sequence as follows. First, intensity sampling was used to shortlist case studies that could richly inform the study. For this, the case study should have responded to a recent emergency where SVs were actively involved in the response activities. Recent experience would allow the researcher to obtain more accurate observations rather than a retrospective information (Yin, 2011). Second, the critical case sampling was used to select the cases that were of special importance for the research. Critical cases are those that allowed a logical generalisation and transferability of the results into other case studies (Patton, 1990). From this research's perspective, the operational side of managing SVs is key. Therefore, the critical case studies should have had plans to engage SVs formally in their operations. Three case studies were shortlisted at the end of this stage.

The final selection stage was criterion sampling. The researcher needed to ensure that the selected case studies were running their SV projects within the lifetime of this research. The researcher selected case studies that planned to write their SVs policies and test them in a live exercise within the first two years of this research. Live exercises are live simulations of disaster responses, which can be an opportunity to observe the responders in operation. Hence, this allowed the researcher to (1) collect empirical data and (2) to have the necessary time to analyse the collected data and write up the thesis within the time limits of the PhD project. Only two case studies met this criterion and therefore they were selected as the broader level of data collection units.

**Figure 3-3: Case Studies Selection Process**




The advantage of selecting this multi-strategy approach in selecting case studies was giving the researcher the room to gradually increase the criteria that could result in a richer data collection experience. Concurrently, it gave the researcher the flexibility to stop the selection process at any point if all the potential case studies did not pass the filtration process. Fortunately, the full selection steps were completed and there were two case studies that met all the conditions.

Although this particular process was not adopted from literature, it is consistent with Creswell's (2012, p. 207) statement that *"In some studies, it may be necessary to use several different sampling strategies…"* to select *"individuals, groups, or entire organizations and sites"*.

The researcher considered other sampling strategies but those were abandoned. For instance, the extreme case sampling (Creswell, 2012) was considered because it might have provided data from unique cases where the official-volunteers relationship was very successful or very unsuccessful. However, using this strategy could have risked the transferability of results to other case studies and provided results that were not necessarily general features of the phenomenon. This could have damaged the value of the research. In contrast, a typical case sampling might have provided average data (Patton, 1990) that would not have allowed an in-depth analysis of the operational challenges associated with engaging SVs.

### 3.4.3. Selecting Participants

Similar to case studies, the participants (the lower level data collection units) were selected purposefully according to a mixed sampling strategy (Patton, 1990). The selecting process was done in two stages. Firstly, intensity sampling was used to select the most information-rich participants in each case study. The managers of the emergency planning units in the local county councils were selected in this stage. Management tends to be the linking point where all information from different operational units arrive (Beer, 1981). Secondly, snowball sampling (Creswell, 2012) was used to select the rest of participants in each case study. The researcher decided to use this approach because of the scarcity of information about who holds the most information about the subject among the key stakeholders. In this instance, the only way that enabled the researcher to identify the relevant emergency planners in the local council was the managers of the emergency planning units. Similarly, the managers and the key emergency planners were the reliable individuals to identify other official responders' representatives for this project (e.g. police, fire, and ambulance), and the community representatives who were SVs and were also playing a part in planning for the exercise. However, the researcher used the snowball sampling purposefully and not based on convenience (Creswell, 2012). Yin (2011) emphasises that purposeful snowball approach is only accepted in qualitative research if used purposefully. The researcher reviewed the suggested interviewees to make sure that they could provide new information or new perspectives that could enrich the collected data.

During the exercise, an opportunistic approach (Creswell, 2012) was used where diverse SV players and official responders were available on the ground. The researcher took advantage of this opportunity to listen to selected people's feedback on the exercise and asked them about the challenges they faced and the areas of improvement they could identify. Snowballing was also used in some cases during the exercise when the researcher could not identify the players who can provide specific information. For instance, the researcher asked the British Red Cross (BRC) representative in the forward command post (FCP) -sometimes called the incident control point- on who could best reflect on the challenges that the BRC had faced in the exercise. The representative identified members of his team who could provide the richest information because of their role and location during the exercise. The researcher then purposefully selected one member to interview in regard to the degree of involvement with SVs.

Participants were selected from (1) the official and organised voluntary responders to understand the operations of the response system and the challenges they face when they encounter SVs during emergencies and (2) citizens and volunteers to learn their perspectives about the existing response system and their experience with the responders when they attempted to help. Details on the conducted interviews are provided in section 3.5.

### 3.4.4. The Number of Data Collection Units

There is not a desired number of data collection units in qualitative research (Yin, 2011; Baker and Edwards, 2012). However, Yin (2011) explains that a general rule of thumb is that the more units the better because they can create better confidence in the research's findings. Still, such rule is bounded by practical considerations such as the nature of the research's subject, and the budget and time limits.

For the broader level (case studies), Yin (2011) claims that most qualitative research studies involve a single case study when researchers aim at testing a hypothesis through selecting extreme, intense, typical case studies; or a critical case study. Nevertheless, Yin (2011) stresses that two case studies are better because they yield greater confidence in the results especially if the results from one case study contrast the results from the other in a predictable way. Two case studies were selected representing two emergency response systems in two counties in the UK to ensure greater confidence in the research's findings, especially regarding the validation of the proposed conceptual model.

On the narrower level (participants), Yin (2011) suggests that the number of qualitative research participants can fall in the range 25-50. Again, this is relative to the scope of the research. Although the rule of the larger the better still apply, the researcher still needs to consider the complexity of the study (Yin, 2011) and whether more participants will result in more information. The confidence in the research can also be generated by representing different perspectives and mitigating for bias when collecting data rather than depending only on increasing participant's numbers (Yin, 2011).

For the stage 1 in data collection (explained in section 3.5.1.2), 13 participants were selected from the first case study representing the response agencies and the community group that is involved in planning for the exercise. During and after the exercise, it was difficult to determine the number of participants because the researcher could not predetermine who would provide the richest information. Rather, he kept the possibility open to interviewing unknown participants whose contributions emerge as important during the exercise. In the final stage of data collection (section 3.5.1.5), additional interviews were conducted with participants who were identified as information-rich during the exercise. The data collection stopped whenever saturation was reached.

The same selection strategy was used in both case studies. However, the number of participants deviated over the data collection stages. This was mainly because of the differences in the case studies' characters (size, number of organisations involved in the exercise planning, and the SV strategy). In general, three factors were taken into consideration when reviewing the participants' numbers: the size of the organisation and the community, whether interviewing more people resulted in new information (saturation) and the time available to obtain an in-depth understanding of the situation

(Creswell, 2003; Myers, 2013). Details on the number of the conducted interviews will be explained in section 3.5.

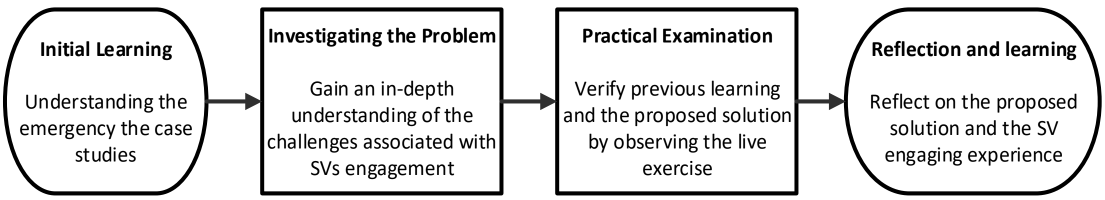
# 3.5. DATA COLLECTION

## 3.5.1. Data Collection Stages

The research conducted data collection in both case studies successively. The researcher built his knowledge base in the first case study by collecting a large amount of data. The ability to collect a large amount of data in a short time was aided by the contribution of two other researchers (two research supervisors) in the data collection process. The data collection activities in the second case study started after one month of finishing the data collection process in the first case study. This approach allowed the researcher to be more focused in the second case study after he had reflected on the lessons learned from the first case study. The logic of collecting data in several stages is illustrated in Figure 3-4.

The data was collected from each case study over several stages to ensure that the data was collected rigorously, with consideration of the relative political factors, and in a manner that requested only, but richly, the relevant data for this research. However, these stages were slightly amended when used in the second case study to reflect the case uniqueness and the learning that the researcher had accumulated from the first case study. The subsections below cover the data collection stages. The differences between the data collection in the two case studies and their impact on the data collection will be discussed in section 3.5.2.

**Figure 3-4: The Data Collection Logic**



### *3.5.1.1. Understanding the Organisation*

Before any intensive engagement with the clients, the researcher had to understand the organisations' background, scope, and plans. The investigation started by studying the literature and official publications and websites to learn about the response agencies' roles and responsibilities, how these agencies coordinated during emergencies, the phases of response, the response system's structure and the relevant emergency response policies. Furthermore, the researcher learned about the case studies' current plans, the history of emergency response in their areas and the challenges that their collective response system faced - particularly, the challenges associated with SV engagement. The researcher was also keen to understand the UK government's perspective on engaging SVs and communities during disasters. This was key to understanding such a major political factor that can significantly influence the prospective national SV engagement projects. The researcher used different resources such as the UK government cabinet office website, the DEFRA website, social media, news agencies, online disaster databases, emergencies literature and the county councils' emergency plan documents.

Although the resources above helped the researcher to theoretically understand the UK response system and some of the issues regarding the SVs engagement, they were not enough to properly understand the response system and the operational challenges as they occur in reality. Since the researcher did not have previous experience with the UK emergency system, it was important to learn about the response system and the SVs challenges directly from the case study members and its key stakeholders. Thus, the researcher, joined by his supervisor, attended a workshop that was organised by the county council in the first case study to discuss the SV involvement project.

The presence of key stakeholders enriched the discussion with diverse perspectives and experiences. The workshop participants included CAT1 representatives (e.g. police, fire and rescue, ambulance, local county council), the organised voluntary sector (e.g. BRC) and the community group whose members were planned to be involved in the exercise. The diverse perspectives enhanced the researcher's comprehension of the complexity of the project. Further, accessing primary data (feedback from participants, the researcher's informal chats with participants, and presentations) assisted the researcher in verifying (or dismissing) what had been learned through the readings and added new information that was not available in the published formal documents. It also provided information about the scope of the SV project, its background and what could be politically acceptable in this case study.

The collected data at this stage was mainly notes taken from presentations, participant's contributions, the researcher's observations, and informal chats with diverse participants. After the end of the workshop, the researcher and his supervisor compared and discussed their notes, which resulted in major themes that can be used to design the interview questions for Stage 1. Having two researchers with different experience levels and backgrounds during collecting data enhanced the research's reliability and validity because it mitigated against possible bias and limiting the research to the researcher's expertise and background (Lincoln and Guba, 1985; Duffy, 1987). More on Triangulation is discussed in subsection 3.6.3.

#### *3.5.1.2. Stage 1*

The aim of this stage was to obtain an in-depth understanding of the case study, the expectations of both officials and volunteers, the nature of the exercise, and the suitability of the theoretical framework. Methodologically, this stage was important to prepare for the stage 2 of data collection (the exercise) by understanding the key areas to observe during the exercise. Therefore, this stage was designed to obtain an in-depth data about the challenges associated with SVs engagement from different participants who represent different stakeholders.

In the first case study, 13 semi-structured interviews (45-60 minutes each) were conducted with participants from emergency planning in the county council, blue light members, BRC, and volunteers. The researcher also obtained the SV policy document draft, which was a formal statement of the official intentions, objectives and plan in regard to engaging SVs. The thirteen interviews were planned to be conducted on one day when all participants were present in one location for the SV exercise planning meeting. Therefore, three researchers were involved in conducting the interviews (three interviews were conducted simultaneously). This facilitated interviewing the participants face-to-face in their own setting when they have freshly discussed the SVs issues. Having three researchers enabled investigators triangulation as will be discussed in subsection 3.6.3.

In the second case study, the researcher conducted the interviews alone. He conducted five interviews in person in the participants' offices. Given logistical and time restrictions some participants were not able to attend to the county council on the same day. Further, the researcher was not able to travel frequently to the case study because of the long distance and the limited budget. Hence, five interviews were conducted on the phone. In total, 10 interviews were conducted in stage 1 of the second case study.

Semi-structured interviews are popular in qualitative research (Berg, 2001; Glaser and Strauss, 2006; Myers, 2013). They were used in this research for their flexibility, which allows expanding on important points to achieve deeper understanding (Creswell, 2003). Using semi-structured interviews allowed the researcher to use a mix of open-ended and closed-ended questions. Creswell (2012) stresses that using both kinds of question is advantageous. While closed-ended questions can help the researcher to filter the information that can verify the conceptual model, open-ended questions were used to seek explanations, perspectives, concerns, and suggestions; and to explore further comments that the participants could have (Creswell, 2012). The questions focused on the main themes that had been derived from the literature and from the previous learning that the researcher had accumulated. However, the researcher also expanded on the questions to cover important and emergent themes (Yin, 2011).

Since semi-structured interviews do not strict the researcher to a certain behaviour (Yin, 2011), the researcher could conduct the interviews in a conversational form, which made the interviews more comfortable by promoting an individualised social relationship between the interviewer and the interviewees (Yin, 2011). Yet, participants were given the priority to express their ideas and the researcher only maintained the minimum speaking time possible. Furthermore, the researcher made sure not be directive when asking questions and allowed participants to list their priorities according to their world experience (Yin, 2011), which maintained a rapport between the researcher and the participants.

Structured interviews were not compatible with this research. Yin (2011) stresses that structured interviews script the interaction between the interviewer and the interviewee. This means that all the questions to be asked are pre-determined and asked formally by the researcher who should maintain a consistent behaviour during the interview. Saunders and colleagues (2007) agree with Yin and add that in structured interviews, the researcher has to read the questions exactly as scripted and in the same voice tone to all participants. These reasons might have led Yin (2011, p. 133) to exclude studies that use structured interviews from the qualitative category and to classify them as surveys or polls. However, some scholars such as Berg (2001) and Stake (2010) still count structured interviews within the qualitative methodology. Yet, Berg (2001, p. 69) notes that researchers who use structured interviews "*assume that the questions scheduled in their interview instruments are sufficiently comprehensive to elicit from subjects all (or nearly all) information relevant to the study's topic(s)*".

The unstructured interviews approach was also excluded. Unstructured interviews do not use scheduled questions (Berg, 2001) and are non-directive (Saunders, Thornhill and Lewis, 2007) because they grant participants the right to talk freely and informally about events, perspectives and behaviours. Berg (2001) emphasises that researchers use this approach because they cannot determine what questions to ask and assume that different participants use different vocabulary and terms. This was not the case in this research and therefore this approach was not suitable.

In the first case study, the interviews were conducted face-to-face in the local county offices. For the emergency planning participants, this was their real-world setting while other participants attended to this office for meetings. However, the participants were comfortable because the emergency local unit was the place where all participants regularly meet and coordinate emergencies response. In the second case study, some of the interviews were conducted over the phone because the participants were located in a distant geographical area. The researcher was aware of the main drawback of using telephone interviews. Phone interviews can reduce the interviewer ability to capture the participant's perception because of the limited communication means (only vocal) compared to the face-to-face interviews (Creswell, 2012).

The interviews were tape recorded after securing the participants' consent. Recording interviews mitigated missing information especially when the researcher had to engage with the participant (e.g. keep eye contact) while important information was being expressed. Semi-structured interviews require the researcher to be more engaged (Campbell, 2011; Creswell, 2012; Myers, 2013). Notes of key ideas and themes were also taken to be used in the hot analysis shortly after all interviews were completed. The interviews conducted in stage 1 are shown in Table 3-3.

**Table 3-3: Interviews Conducted in Stage 1**

| Case Study 1 | | | | Case Study 2 | | | |
|---|---|---|---|---|---|---|---|
| **Participant** | **Organisation** | **Method** | **Length /m** | **Participant** | **Organisation** | **Method** | **Length /m** |
| 1 | Emergency Planning | In Person | 38 | 1 | Emergency Planning | In Person | 67 |
| 2 | Emergency Planning | In Person | 50 | 2 | Emergency Planning | In Person | 67 |
| 3 | Emergency Planning | In Person | 40 | 3 | Emergency Planning | In Person | 34 |
| 4 | Ambulance Services | In Person | 45 | 4 | Emergency Planning | In Person | 36 |
| 5 | Local Police | In Person | 26 | 5 | Local Police | Phone | 31 |
| 6 | Community Group 1 | In Person | 37 | 6 | Fire & Rescue | Phone | 53 |
| 7 | Community Group 1 | In Person | 45 | 7 | Local Resilience Forum | Phone | 45 |
| 8 | Community Group 1 | In Person | 60 | 8 | Rotary | Phone | 54 |
| 9 | Community Group 2 | In Person | 39 | 9 | Community Voluntary | Phone | 38 |
| 10 | Community Group 3 | In Person | 50 | 10 | British Red Cross | In Person | 40 |
| 11 | British Red Cross | In Person | 38 | | | | |
| 12 | District Council | In Person | 27 | | | | |
| 13 | Community Group 3 | In Person | 43 | | | | |
| **Total** | | | **538** | | | | **465** |

### *3.5.1.3. Follow-up Interviews*

These interviews were conducted on the day preceding the exercise and had two aims. First, they aimed at obtaining a feedback on the exercise plan (e.g. any changes in roles, exercise objectives, the location of responders, and the level of community engagement). And second, they aimed at helping the researchers (explained in subsection 3.5.1.4) to decide where they would be best located in the exercise venues to collect the richest data for this research. Eight phone semi-structured interviews (15-20 min each) were conducted with six emergency planners and two volunteers. Phone interviews were selected because participants were geographically spread and it was difficult to arrange them to attend to one location (Creswell, 2012). The interviews were an opportunity for understanding the participants' expectation for the exercise after all preparation activities had finished. Examples of the questions asked at this stage were "*Have there been any changes to the planning for the exercise since we last talked?*", "*Have there* *been any changes to the planning for the exercise since we last talked?*", "*How do you think that the actual event will differ to this ideal?"* and "*Do you have any other expectations for the exercise?*"

These Follow-up interviews were conducted only in the first case study. The lessons learned from conducting these interviews in the first case study (discussed in Subsection 3.5.2) rendered this stage unnecessary for the second case study.

**Table 3-4: Follow-up Interviews**

| Case Study 1 | | |
|---|---|---|
| **Participant** | **Organisation** | **Method** |
| 1 | Emergency Planning | In person |
| 2 | Emergency Planning | In person |
| 3 | Emergency Planning | In person |
| 4 | Community Group 2 | Phone |
| 5 | Community Group 3 | Phone |
| 6 | Emergency planning | In person |
| 7 | Emergency Planning | In person |
| 8 | Emergency Planning | In person |

### *3.5.1.4. Stage 2*

The data was collected at this stage using the observation and interviews methods. Observation is a legitimate qualitative data collection method (Myers, 2013) and can be invaluable because the researcher can observe with his or her own senses what others might have not voluntarily expressed to the researcher (Creswell, 2009; Yin, 2011).

Three researchers observed the exercises (the author and his supervisors) to mitigate what Yin (2011) calls fluidity in a complex setting. Yin (2011) defines fluidity as the inability to be at all places and times, which prevents a researcher from observing everything. Involving several researchers also aimed at reducing the bias that can result from lack of representativeness (Yin, 2011) of different participants, locations, and events. The rationale for choosing the researchers' locations will be explained when the exercises are explained.

Emergencies are complex situations that offer a large number of potential subjects to be observed. Among what scholars (Berg, 2001; Silverman, 2011; e.g. Yin, 2011; Myers, 2013) suggest observing, the researcher decided to observe actions (whether of participants or other events such as receiving a 999 call), the interactions between people, and participants' behaviours including verbal and nonverbal behaviours. These aspects are relevant to the exercise, and to the research questions and the research's conceptual model.

To enhance the validly, the researcher applied the notion of reflexivity during this stage. He was keen to stay aware of how his assumptions, beliefs, values and experience could affect the constructed knowledge (epistemological considerations). Bryman and Bell (2015) emphasise that reflexivity critiques the notion that the researcher extracts knowledge from observation and transmits it to the audience. Rather, the researcher participates in the construction of knowledge through using his or her assumptions lens to observe and the way he or she transmits the results through a text. Ontologically, the researcher considered Johnson and Duberley's (2003) forms of reflexology during his observation role:

- Methodological: Advocated by objectivists. It claims that social phenomena are independent of social actors. It requests the researcher to keep phenomena unaffected when he makes the observation. This form is closely related to the positivist epistemology that believes in a single reality. This form was excluded as it is not compatible with the worldview adopted by this research.
- Epistemic: Although it stems from the constructionist view, it requests for more engagement of the researcher in the studied phenomenon. It encourages a participatory approach where the researcher co-construct knowledge with other actors. This form is closely related to critical realism because it hopes to achieve some form of truth by reaching a consensus among actors when they engage in the research subject.
- Deconstructive: It comes from the constructionist ontological perspective. This perspective assumes that social phenomena are constructed by the relations and interaction among social actors. Further, this form is associated with the interpretive epistemology, which stresses that studying actors' interpretation of the situation is necessary to understand their behaviour. In this form, the researcher should recognise himself or herself as a privileged voice, and therefore should question his or her beliefs and acknowledge that there are other valid interpretations of the research subject.

The deconstructive form of reflexivity was the most compatible with the interpretive assumptions of this research. The community group members who participated in the exercise used to be SVs in previous disasters. Therefore, the researcher stayed critical to his own interpretation of what he had observed and acknowledged that participants' interpretations can be more valid when reflecting on their practical experience (Johnson and Duberley, 2003). For instance, the community group members' behaviours as observed by the researcher were more accepting of supervision and orders from officials. Some participants expressed that they understand the need to coordinate with officials because officials know more than them. However, one of the researcher's interpretations was that the community group needed to show more cooperation to secure their engagement in future official plans. The epistemic form of observation was excluded because the researcher did not plan to be closely involved with participants to co-create a new reality (Johnson and Duberley, 2003). Yet, he acknowledged his potential influence on shaping participants' reality (Bryman and Bell, 2015)when he collected data and contributed to writing exercise evaluation reports for the county council.

The researchers had decided to play changing observational roles (Creswell, 2012), which added richness to the collected data. The researchers alternated between the participant and nonparticipant roles to adapt to different phases of the exercises and to the emerging situation to capture the richest information and experience. In their participant roles, the researchers were engaged in the exercise activities; while in the nonparticipant roles, they were taking notes and making observations from a distance without interfering in the exercise (Creswell, 2012).

*Exercise 1*

The aim of this exercise, as stated in the exercise planning documents, was to test a community-led response represented by recognised community groups and to test the collaboration and communication channels between official responders and these community groups. The exercise started at 8:00 am and finished at 4 pm. The morning part was dedicated to testing the community group initial response and their collaboration with official responders when they arrive, while the afternoon part tested the SV registration process. Members of the community, the voluntary sector and university students volunteered to role play for the exercise as SVs, residents, and victims. Some roles were meant to be challenging to test the community group's response and the effectiveness of the SV registration process in real-life situations. This exercise ran in three locations simultaneously. Two of these locations were table-top indoor simulations of an emergency of finding a bomb in a residential area and covered only the morning part of the exercise. The third location involved a live exercise responding to the same scenario. Live exercises involve simulating responding to a disaster with real players such as police teams and fire acting on the ground. The choice was to only observe the live exercise because it provides the richest experience for the researchers. See Table 3-5.

The exercise started early in the morning when the existence of a bomb in the village was announced. The community group in the village activated its response plan and evacuated residents to the village hall before the arrival of officials. After, all CAT1 responders arrived and established the Forward Command Post (FCP) and took control of the situation, coordinated the response and managed the community group. The FCP was formed by members of fire and rescue, police, army, and the BRC.

In the morning session, it was a response simulation, a researcher located himself in the FCP, another shadowed the community group leader, and the third researcher was mobile in the area to observe the response operations and the tasks implementation. These locations were selected based on the participants' recommendations and the researchers' assessment. The researchers interviewed participants who were identified on the spot as information-rich units. In total, 24 short interviews (2-7 min) were conducted after a key event had been observed or at the end of the main exercise phases. For instance, the community group leader was interviewed after he had completed a meeting with his team members to initiate their plan and response. Police and fire officers in the FCP were interviewed after they had tasked community groups. And different participants were interviewed after they had gone through a challenging event (such as having a problem in accessing some areas or reporting a missing person). Otherwise, the researchers maintained a minimum visibility and mitigated being mixed with participants by wearing different reflective vests that marked them as observers.

In the afternoon part, the researchers observed the SV registration process and took notes of the effectiveness and the efficiency of processing SVs. The notes included hard aspects, such as the throughput time, and soft aspects such as the way the staff handled challenging behaviours. Further, the researchers played the role of SVs after taking permission and went through the registration process to get the closest experience from an SV perspective (Creswell, 2012). SVs were also interviewed when they had gone through the SV registration process to ask for their reflection. The recordings including the interviews conducted in this stage are summarised in Table 3-6.

In the next morning, the researchers attended a hot debrief that was held at the county council office. This meeting involved the emergency planning staff who planned and executed the exercise. Notes were taken and the meeting was recorded fully with the consent of the meeting participants.

*Exercise 2*

The second case study arranged its exercise differently. The local authorities developed a policy to manage SVs based on the lessons learned from the recent floods. The exercise mainly examined the process of registering, training, deploying and supervising SVs. The organisers chose a sports club in the county as the Volunteer Reception Centre (VRC) to receive and process SVs. This process was played over the whole life of the exercise (8:00 am-4:30 pm). The VRC consisted of 3 separate rooms allocated for welcoming and interviewing, training, and deployment. The staff consisted of an exercise director, a VRC manager, a deputy manager, interviewers, deployment staff, SVs supervisors, observers and evaluators. The exercise director and managers were county emergency planning staff while the other staff were volunteers from community groups and NGOs such as the Red Cross, the Salvation Army and the 4x4 group. SVs were deployed to different sites in the county where they performed their allocated tasks (e.g. filling in sandbags and giving flyers to residents) under supervision. A hot debrief was held at the end of the exercise where a quick feedback was provided by participants. See Table 3-5.

**Table 3-5: The Case Studies Exercises**

| | **Exercise 1** | **Exercise 2** |
|---|---|---|
| **Description and Focus** | A simulation of a response to a bomb explosion in a rural area in the UK. The focus is to operationally test the SV policy by engaging volunteers in the official response system. | A simulation of a response to a flood incident in a UK county. The exercise focus is to test the SVs registration and deployment policy. |
| **Morning Session** | Simulation of a response where a community group initiates a response before the officials arrival and engages in the operations of response system after the officials arrival. | SVs registration and deployment |
| **Afternoon Session** | SVs registration | Comprehensive SVs registration and deployment |

Three researchers took part of the data collection activities to ensure richness of the collected information and to cover all aspects of the SV management process. The researchers used several data collection methods in an iterative manner during the exercise. First, similar to the first exercise, the same changing observational roles (Creswell, 2009) were used. As participants, the researchers played the SV role and went through the process from start to finish. For more rigour, the researchers went through this process three times. Each time, the researchers changed their roleplay to reflect diverse SV characters. Those roles were exercised at different times of the day, which allowed the researchers to reflect on the consistency of the process, validate and compare the experience in each time, and collect updated information if improvements were made to the process. In their non-participant role, they observed SVs running through the process and took notes such as their impressions, the processing times, the space, and dealing with challenging SVs.

The second method was short interviews (3-8 minutes) with SVs in different stages of the process; e.g. when they were interviewed, trained, and while being deployed. In total, 10 SVs interviews and one interview with a BRC member were conducted. One of these interviews was conducted with a group of 5 SVs as an informal chat while waiting in the deployment room. This informal group chat allowed the participants to speak freely, reflect openly on their experience during the process, and validate or deny each other's experiences. Lastly, a survey was conducted among SVs participants to learn about SVs reflection on different aspects of the process. The survey consisted of multi-choice questions to rate the satisfaction on every aspect of the process and some open questions where SVs could provide qualitative notes on their observations. At the end of the exercise, 33 surveys were obtained – see Table 3-6 for the data collected in stage 2.

At the end of the exercise, a 30-minute hot debrief was held. The researchers took notes of the key observations and reflections made by participants.

**Table 3-6: The Data Collected in Stage 2**

| Case Study 1 | | | Case Study 2 | | |
|---|---|---|---|---|---|
| **Type** | **Organisation** | **Count** | **Type** | **Organisation** | **Count** |
| Interview | 4x4 | 2 | Interview | British Red Cross | 1 |
| Interview | Ambulance Services | 1 | Interview | SVs | 9 |
| Interview | Community Group 1 | 5 | Interview | Group of SVs | 1 |
| Interview | British Red Cross | 4 | Survey | SVs | 33 |
| Interview | Fire and Rescue | 3 | | | |
| Interview | Emergency Planning | 3 | | | |
| Interview | Local Police | 2 | | | |
| Interview | Raynet | 1 | | | |
| Interview | SV | 2 | | | |
| Interview | Community Group 2 | 1 | | | |
| Event recording | Multiple | 18 | | | |
| Observation note | Researchers | 26 | | | |
| **Total** | | **66** | | | **44** |

### *3.5.1.5. Stage 3*

The aim of this stage was to learn about the organisers and participants' reflections on the exercise couple of weeks after it had finished. This period allowed participants to sufficiently reflect on their very recent experience. In the first case study, the author obtained a full recording of the debrief that was held two weeks after the exercise. This debrief involved the official organisers and planners of the exercise in addition to key community groups members. Furthermore, the researcher interviewed the exercise facilitator and some participants who played the SV role during the afternoon part of the exercise. In total, the researcher conducted 5 interviews that lasted 15-40 minutes.

In the second case study, the researcher attended the debrief workshop. The attendance included stakeholders representing CAT1 responders, NGOs, community groups, and other exercise players. A professional facilitator led the debrief and seated participants in groups of 6-8. The groups were asked to reflect on selected aspects of the SVs management process, and their notes were recorded on post-it notes and presented to the other groups. The researcher joined one of the groups who included the emergency planning manager who was involved in planning the exercise, Fire and Rescue Officer who was involved in planning the exercise, and members from the Red Cross and some community groups. The researcher took notes of the group-level discussions and the reflections of the other groups when shared.

### 3.5.2. Data Collection Deviation Between the Case Studies

The researcher intended to use the same data collection strategy for the second organisation. However, the initial investigation revealed that this organisation had approached the exercise differently. The first difference was the focus of the exercise. The first organisation's exercise had two aims; (1) to test the possibility of engaging CGs as a first emergency responder before the arrival of official responders, and (2) to test the SV registration process. In contrast, the second organisation's exercise was entirely about testing the SVs registration and deployment process. The second difference was the role that they assigned to community groups. In the first exercise, a community group was engaged in the initial emergency response tasks and had no role in managing SVs. However, in the second organisation, CGs were not deployed but were mainly involved in processing SVs as staff in the SV reception centre.

Follow-up interviews were skipped from the data collection in the second case study for two reasons. First, stage 2 interviews in the first case study did not result in new information that is related to the research questions. The data that was collected in Stag1 was sufficient to learn about the exercise. It was unlikely that any relevant additional information would be obtainable from such interviews in the second case study.  Second, the researcher attended all the planning meeting in the case study, which kept him informed of information that is needed to observe the exercise effectively. Stage 3 was also different in the second study. The debrief that was conducted in the second case study was information-rich as it involved a large number of participants representing all the exercise's stakeholders. Therefore, there was no need to conduct stage 3 interviews as stakeholders' representations and saturation were already reached.

### 3.5.3. Data Collection Issues

The research methods literature is rich with examples of what can go wrong during data collection. One challenge is securing the access to case study sites (Creswell, 2012). This particular aspect was arranged in advance by the researcher's supervisor who is involved in working in a wider project on SVs in the UK. However, these sites were located in a far travelling distance from where the researcher is located. Further, many of the targeted participants scattered in rural areas in the counties. Within a limited budget and time, it was not possible to travel for each data collection activity in both of the case studies. Instead, most of the stage 1 interviews were arranged in a single or two consecutive days in the county councils offices. Conducting these interviews in person was important to build rapport and to understand the case study closely. The participants who could not attend to the office or are located in other areas were interviewed on the phone. For the planning meetings, the researcher managed to attend all those meetings, which helped him to obtain an in-depth understanding of the case study and the SV-related issues from different stakeholders' perspectives.

Another challenge was to identify participants who represent the SVs' perspective. Identifying people who volunteer as SVs was not an easy job. As explained in subsection 3.4.3, this challenge was mitigated by adopting a snowball strategy of selecting participants. However, using snowball approach had its risks as well. Although the researcher was provided with contact details for SVs and the exercise participants, it was anticipated that many of these participants may not respond. Therefore, the researcher ensured to contact more participants than planned in order to mitigate this challenge.

Lastly, the researcher considered anticipated risks that may face him during interviews and observe the exercises. For interviews, Creswell (2012) and Myers' (2013) recommendations on how to conduct interviews were considered. Examples of these recommendations are awareness of the researcher's body languages, icebreaking, and not expressing the researcher's opinion. Further. information of interview times, type of questions, and the anticipated duration were sent to participants one or two days in advance for them to feel more comfortable responding and arranging their time (Creswell, 2012). Spare batteries were also kept with the researcher to mitigate any technical issues.

The scale of the exercises was very large. Therefore, it was challenging for the researcher to observe all important aspects of the exercises. This was mitigated by having three researchers observing the exercises. This arrangement was negotiated with the exercise organisers in advance and all the exercise participants were informed about the observational role of the researchers. The researcher was aware of the disadvantages associated with observation such as deception by participants, distraction, or feeling an outsider without the support from within the setting (Creswell, 2012). This was mitigated by playing the changing observational role. This gave the researcher the flexibility and the ability to (1) change preference to access as much quality data as possible and (2) timely record (taking notes) collected data to avoid depending on memory to remember a large amount of data (Creswell, 2012).

## 3.6. DATA ANALYSIS AND INTERPRETATION

Analysing qualitative data is the process of making sense of recordings, texts, images and notes, bringing order to data (Reichertz, 2014), or as Flick (2014) defines it *"the move from data to meanings or representations"* (p.5). The latter definition implies that the analysis process can have several goals. Flick (2014) introduces three general goals of qualitative analysis:

- To describe a phenomenon.
- To compare several cases (individuals or groups).
- To develop a theory from the analysis of the empirical data.

This research adopts the last goal – to develop and test a theory. The SVs phenomenon and emergency response systems have been described in the disasters literature. Confirming or refuting those descriptions is not the goal here. Also, the research does not aim at comparing the UK context with other contexts discussed in the literature, nor it aims at comparing the response system and the SV experience in two UK counties. Instead, the research is developing a conceptual model that can facilitate managing SVs and enhancing the resilience of emergency response systems by building on empirical data from two case studies. The core of this model is the theoretical principles of viable systems and system thinking.

This analysis in this project is inductive; that it starts from the smaller piece of information to build broader categories. Although it begins with dividing data into smaller chunks, the final goal is to consolidate a large picture (Strauss, 1987; Creswell, 2012). Saunders et al. (2012, p.549) provide a useful guidance and state that the inductive approach is appropriate when:

- [the researcher does] not commence a study with a clearly defined theoretical framework;

- Instead [the researcher] identifies relationships between [his or her] data and develops questions and hypotheses or propositions to test these;
- Theory emerges from the process of data collection and analysis.

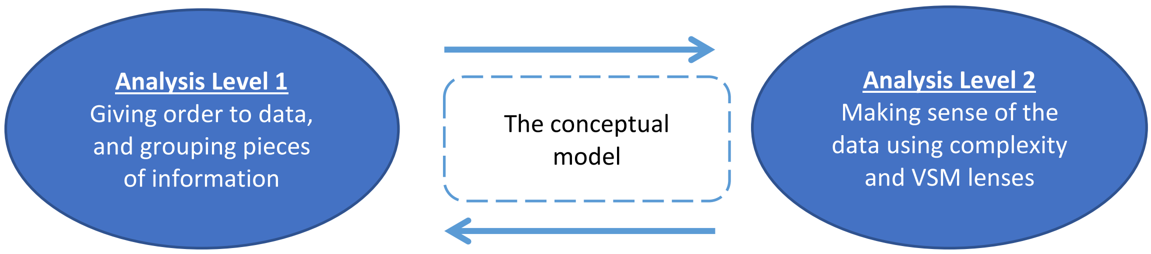
Many scholars claim that qualitative research is mostly inductive as it can be seen in (Creswell, 2012). However, Saunders et al. (2012) offer the qualitative researcher the choice to analyse his or her data inductively or deductively. Nonetheless, they point out that, even if the analysis is inductive, it is likely to have deductive elements when a conceptual model is being developed and data is used to test it. This point was observed earlier by Bechhofer (1974, p.73) when he emphasised that *"The research process…. is a messy interaction between the conceptual and empirical world, [where] deduction and induction occurring at the same time".* The American pragmatist Charles Peirce tried to systemise this combination by introducing the concept of abduction (Strauss, 1987), which uses both the inductive and the deductive features. Recent methodologists introduce the new approach in their publications as an acceptable approach for doing research (Saunders, Lewis and Thornhill, 2012; Klag and Langley, 2013; e.g. Reichertz, 2014). Yet, abduction does not seem to be a popular approach as it is still not referenced in leading methodologist publications such as Creswell (2012), Yin (2011), Berg (2001) and Myers (2013).

Reichertz (2014) simplifies the inductive-deductive discussion and claims that the deductive and inductive choice depends on how a variety of data relates to theories; that is, whether theories are *"...pre-existing or still to be discovered"* (p.125). This, in particular, is related to Saunders and colleagues' point above that inductive analysis is conducted without a defined theoretical framework. It also justifies the inductive nature of data analysis in this research because the proposed conceptual model was developed over the entire period of the research.

Qualitative data analysis is not a distinct research phase as it is the case for quantitative research (Bryman and Burgess, 1994). Rather, qualitative researchers suggest that it is part of the continuous and simultaneous of a research process (Glaser and Strauss, 2006; Creswell, 2009; Denzin and Lincoln, 2011) that is not *"...a clear cut sequence of procedures following a neat pattern"* (Bechhofer, 1974, p. 73). Nevertheless, Bryman and Burgess (1994) claim that many qualitative researchers exaggerate *"...the extent to which data analysis is a separate phase in qualitative research…"* (p.217). Therefore, it may not be surprising that methodologists did not agree on a single accepted data analysis approach (Creswell, 2012) and many of them are reluctant to state the analysis procedures (Bryman and Burgess, 1994). Flick (2014) emphasises this point further and states that the field of qualitative data analysis is *"growing and becoming less structured"* (p.3). Yet, the procedures advocated by scholars such as Dey (1993), Miles and Huberman (1994), and Charmaz (2006) are still referenced and recommended by recent qualitative publications such as those of Creswell (2012), Yin (2011) and Saunders et al. (2012).

The structure of data analysis in this research consists of two broad levels – see Figure 3-5. The first level aims at organising and tidying up the chaotic data that were collected, identify relevant pieces of information and group them in themes. The second level of analysis is a VSM and complexity focused analysis. This level aims at making sense of the collected data and structuring the identified pieces of information in the first level of analysis by using the under-development complexity model and the VSM principles. These two levels were conducted iteratively as is explained in the remainder of the section.

**Figure 3-5: Data Analysis Levels**




## 3.6.1. Level 1 Analysis

This level started very early during the first visit to the first case study and was divided into two stages. The first stage was an early analysis. The benefits of early analysis are acknowledged and recommended by qualitative researchers (e.g. Charmaz, 2006; Creswell, 2007). The researchers collectively discussed and analysed their notes and observations during the exercise and immediately after they had left the site. This facilitated a rich discussion while the researchers' experiences were still fresh (Creswell, 2012). Potential themes were identified and notes were made of them. The early analysis was used during all stages of data collection – after interviews in the first case study and during and after the exercises. This allowed the researchers to timely improve the ongoing data collection (Creswell, 2012). However, in the second case study, the author conducted the interviews and attended the planning meetings alone. Therefore, this stage was carried out merely by the researcher as an early reflection of the collected data and potential themes were identified and recorded.

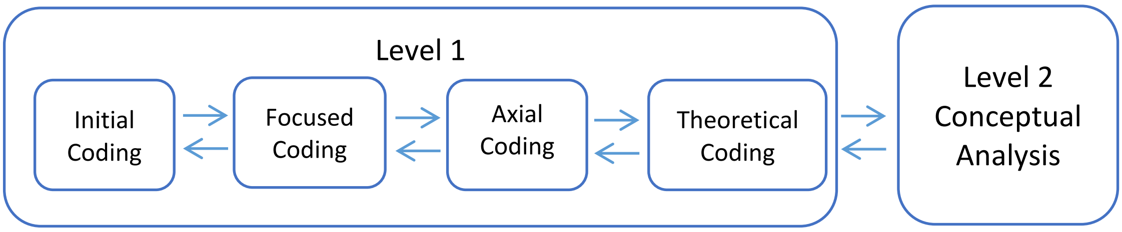
The collected data (recordings and notes) were then organised and stored in a secure and autonomous manner in accordance with the qualitative researchers' suggestions (Charmaz, 2006; e.g. Creswell, 2012; Bryman and Bell, 2015). Audio recordings were saved in electronic folders on the computer, which were named according to the data collection stage. The files were coded to hide the participants' identities (Creswell, 2009). Another copy of these files was saved in a separate electronic storing device to mitigate any technological issues. The access to these folders was restricted to the researcher. The documents that were collected in paper forms were kept in categorised folders in the researcher's office in a secure locker. A database of the collected files with their detailed storage information was created in MS Excel. This file was stored securely in the researcher's computer.

The researcher transcribed the stage 1 interviews of the first case study verbatim; that is word by word exactly as participants said them. Stage 1 interviews were of a maximum importance for the study. Given that these were the first main data collection activity, the researchers expanded on questions to understand the whole context in-depth (sometimes beyond the focus of the research questions). The learning that was gained from analysing these comprehensive interviews informed, and was the foundation for, the succeeding data collection and analysis stages. The researcher followed the general transcription guidance such as including nonverbal information (e.g. [pause], [interruption], [laugh]) and highlighting the questions and the notes made by the interviewer (Creswell, 2012). The rest of the interviews were not transcribed because of time and funds limitations. The researcher had to consider interpreting the data of the first case study and improve the conceptual model before starting the data collection in the second case study (within 3 months). Financially, data collection in both case studies was expensive because it involved a long and frequent travel. Therefore, the assigned budget for this project did not allow outsourcing the transcription task. However, Creswell (2012, p.239) notes that the researcher can transcribe only a few interviews and listen to the rest of the recordings, especially when time and funds are limited. The second stage of the level 1 analysis is coding, which will be discussed in detail next.

### *3.6.1.1. Coding*

Coding is the most common qualitative analysis procedure (Bazeley and Jackson, 2013) and the most difficult to understand and master (Strauss, 1987). Coding involves identifying segments of data, words, phrases, and incidents (Charmaz, 2006). However, although methodologists' coding approaches show similarities, the coding steps can slightly vary. This research considered the coding steps suggested by leading grounded theorists, mainly Strauss (1987) and Charmaz (2006). Nonetheless, aspects of these steps were amended to meet the research's objectives and to respond to its uniqueness while maintaining the advantages of Grounded Theory. The acquired advantage of using a grounded theory approach to coding was that it permitted extracting the codes openly and obtaining the richest information possible, which enhanced the development of the conceptual model. Nevertheless, it may worth emphasising that this research did not adopt the goal of grounded theory analysis; that is to find a theory that is grounded in the collected data. Rather, it aimed at understanding the complexity that is associated with SVs engagement in emergencies from different stakeholders' perspectives; and to use this understanding to develop the conceptual model. Charmaz (2006) coding steps were conducted as follows – see Figure 3-6.

**Figure 3-6: Level of Analysis and the Coding Process**




<u>*Initial Coding*</u>

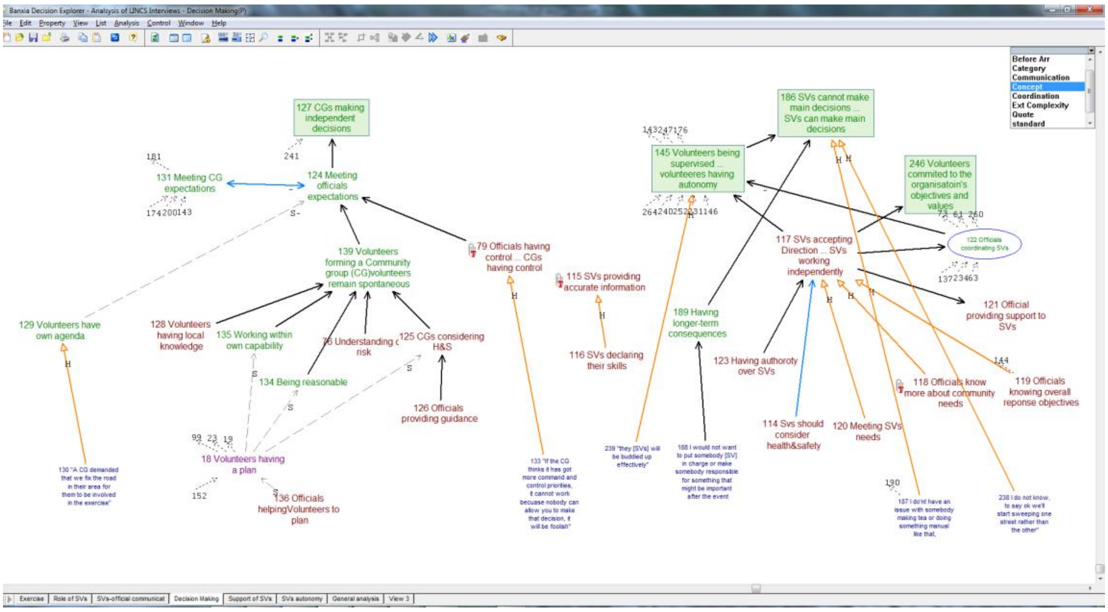
This was a foundational step to prepare for more in-depth analysis. The researcher started with reading the transcripts and listening to the recordings openly to identify any actions, comments, events, and incidents related to volunteering during emergencies. Openly here means that the researcher included any factor that was considered directly or indirectly a subject-related complexity. Charmaz (2006) emphasises the importance of such openness at this stage. The instances were coded as actions whenever possible (e.g. *"meeting officials expectations"* and *"Providing local knowledge"*) to give the codes a conceptual leap to be used in later stages (Charmaz, 2006). The researcher did not use any pre-existed codes (e.g. from the conceptual model or the literature). Rather, the codes were generated during the coding process to keep the closest relationship with the data, protect the open nature of initial coding, and to maintain an open mind to extract as much information as possible. Failing to do so would have compromised the benefits for which a grounded theory coding approach was chosen. A major benefit that was important for the author was gaining the ability to think of the data in new ways that may differ from the participants' interpretations; and therefore, having the possibility to make some hidden assumptions and fundamental process explicit (Charmaz, 2006, p. 55).

Charmaz's (2006) suggests three ways of initial coding: word-by-word, line-by-line, and incident-by-incident. Word-by-word coding asks the researcher to move through the data word by word while the line-by-line requires the researcher to assign a code to each line of the text. However, our choice was to use the incident-by-incident approach. Charmaz's (2006) claims that our choice is common among grounded theorists and highlights that it can be applied to different types of data (e.g. observational, recorded and textual). Using a line-by-line approach could have hindered capturing *"concrete, behavioristic descriptions of people's mundane actions…"* (Charmaz, 2006, p. 53). However, Charmaz's (2006) stresses that the selection of these coding methods depends on the type of the collected data, its level of abstraction and the purpose of coding. For instance, the word-by-word method is mostly useful for analysing textual data such as internet pages.

The software that was used to facilitate the coding process is Decision Explorer® (DE). DE was designed by academics from the universities of Bath and Strathclyde and now by Banxia Software to manage qualitative and complex data. It is used in 45 countries worldwide in the academic and the commercial sectors. It can be used to arrange concepts, structure them in maps and to connect these concepts using different kinds of relationships. Further, the concepts can be assigned to different categories distinguished by visual formatting (e.g. colour and font). The main reason for choosing this software, rather than the popular ones such as NVivo 11, is that the researcher could obtain a rich and cohesive visual representation of the concepts and their relationships without compromising the main required features required for qualitative analysis.

A sample of analysing our data with DE can be seen in Figure 3-7. The colours and boxes styles are used to distinguish codes, quotes and higher-level categories. For instance, the text in blue is verbatim quotes taken from the interviews. The arrows colours were used to define the type of the relationship between the concepts (e.g. leads to or depends on). Every concept was automatically allocated a number to facilitate the concept search function.

**Figure 3-7: Analysing the Data with Decision Explorer**




## *Focused Coding*

This step is more "selective, directed and conceptual" than initial coding (Glaser, 1978). In the grounded theory practice, these concepts are obtained from the first initial coding step. The researcher maintained the principles of focused coding but expanded its application to include concepts from the conceptual model. He used the most significant codes that were identified in the previous stage (Charmaz, 2006) in addition to conceptual codes, such as internal complexity and problematic complexity, to code larger sections of the data. Among the codes obtained from initial coding, significant codes were identified by their frequency, their relevance to the research questions and the conceptual model, and/or the importance that participants assigned to the code. In this stage, themes such as communication, expectations, skills, health and safety, and supervision were proven to be important to the participants from the authorities, the voluntary sector and SVs. Identifying these allowed the researcher to pay specific attention to the aspects that can be crucially important to understanding the context's complexity and to developing the conceptual model.

*Axial Coding*

Traditionally, this stage focuses on finding the relationships between the generated major categories (Strauss, 1987) even those in early stages of development (Charmaz, 2006). The researcher used this step to consolidate the data that was disassembled in the open coding step (Creswell, 2007) into a coherent whole (Corbin and Strauss, 2015). The step started by linking categories with subcategories and investigating the nature of the relationship among them (Charmaz, 2006). Strauss and Corbin's (1998) scientific guidance was used to identify those relationships. For instance, the researcher considered the conditions that governed officials and volunteers comments, attitudes and decisions; assessed whether the coded actions and incidents (e.g. a Policeman prevents an SV from performing a task) are part of participants' routine, planned strategic responses, or it is an unplanned response; and the outcomes of the actions and the interactions among officials and volunteers (e.g. frustrated and unsupervised SV). Strauss and Corbin's (1998) call these methods conditions, actions/interactions, and consequences respectively. However, the researcher did not limit himself to these terms and remained flexible to investigate for emergent relationships of a different kind.

*Theoretical Coding*

The research deviated from the traditional application of this step. This step is used in grounded theory to search for emerging theories form the data (Charmaz, 2006). This was not the aim of this research. Rather, the research aimed at using the outcomes of the analysis in the previous stages to validate the conceptual models. Hence, instead of finding theoretical relationships between the substantive themes generated in focused coding (Charmaz, 2006), these codes were used to validate the under-development conceptual models. To be valid, the model should accommodate the categories and explain their dynamic manifestation during the exercises. Further, the model should provide conceptual guidance on how to deal with these dynamic complexities to enhance the response system's resilience and viability. For instance, an SV's action can be problematic at some point and supportive at another. The model should systemically and systematically accommodate actions, explain the dynamics, and guide a manager to evaluate the organisational status of this SV accordingly.

As noted earlier, there were differences in the two case studies. The implication of these differences was that the data collected deviated between two relatively different types of volunteers: the recognised ones represented by community groups and the entirely spontaneous volunteers. Consequently, it was not possible to collectively use the entire data in the initial coding stage of the data analysis. Alternatively, the researcher analysed the data collected in the first organisation to obtain the key codes (or themes) and then analysed the data from the second organisation using the already generated codes to confirm the results. However, the researcher stayed open to validate any emerging themes during the analysis of the second organisation.

### 3.6.2. Level 2 Analysis - VSM Analysis

This level is conducted concurrently with and was impeded in the level 1 analysis. Using the term level 2 does not suggest any hierarchical meaning or a separate stage. Rather, it refers to the different nature of this analysis, which may require an explanation different from that of coding. The concepts that were used for the analysis in this level are those of the VSM and of the evolving conceptual model. The conceptual model was explained in the literature review chapter and will also be discussed in the findings and the discussion chapters. However, for the purpose of this chapter, it may be methodologically important to highlight the VSM’s analytic procedures that were used in the data analysis.

The VSM is advocated by many academics and practitioners to be very useful for diagnosing organisations and complex situations (Beer, 1981; Flood and Zambuni, 1990; Preece, Shaw and Hayashi, 2013). While Beer (1985) explains how to use the VSM as an analytic tool, Flood and Jackson (1991) claim that using VSM is often complicated. To simplify this analytic tool, they introduce the Viable System Diagnosis (VSD) as a structured and systematic set of procedures to use the VSM for analysis. The VSD consists of two major activities: system identification and system diagnosis.

### *3.6.2.1. System Identification*

This step involved the following:

- Identify the system-in-focus
- Identify one recursion level down (System 1 components)
- Identify one recursion level up (the system that contains the system-in-focus)

The system-in-focus was identified in the early stages of the research as the local emergency response system. However, identifying the elements that make up this system started as a matter of discussion and was then informed by the findings of the data analysis process. According to the VSM, System1 defines the purpose of the whole system (Beer, 1979). Therefore, the VSD requests the analyst to identify the parts that form System 1. The data suggested that many volunteers shared the purpose of the emergency response system, that is to save lives. Therefore, our VSM analysis of System 1 considered that some community groups and selected volunteers as part of System 1. This was discussed in the literature review and will be covered in the finding and discussion chapters. Another analytical benefit of studying the system's purpose was to examine if all the parts of System 1 (e.g. Police and BRC) really shared the same purpose. Having a shared purpose can be essential for a coordinated and coherent response.

Lastly, the researcher identified the viable system that contained the system-in-focus (one recursive level up) and the environment of the system-in-focus (Flood and Jackson, 1991). The higher-level system was identified as the national emergency response system that is led by the LRF or the SCG. The environment of system 1 was identified as the area of operation, communities and its different stakeholders.

### *3.6.2.2. System Diagnosis*

According to Flood and Jackson (1991), this activity involves:

- Identifying the viable system functions (S1-S5).
- Define the environment for each of these functions.
- Studying if each function is meeting its duties as suggested by the VSM.

Identifying the functions of the system-in-focus was conducted during the focused coding step. The researcher coded each incident in the data according to the where it belongs in the VSM functions. For instance, if an unsupervised SV took a risk and saved a victim, the researcher would code this as S1 function. However, if another volunteer contributed by providing the responders with local knowledge, this would be coded as S4 (intelligence). Similarly, if an official responder on the ground decided to coordinate with and supervise SVs then this would be coded as S2 function. Other official staff may have chosen to exercise the S3 function by using their authority on SVs.

The analysis also identified the incidents that related to complexity. The incidents were coded as supportive or problematic complexity. Analysing the (S1-S4), the complexity, and the emergent codes and comparing them to different data sources and in different scenarios and timeframes have richly informed our conceptual model.

### 3.6.3. Validity of Analysis

The researcher was aware of the potential problems of qualitative analysis. Coding a certain incident can be subjective, which can increase the analysis vulnerability to bias (Yin, 2011). Charmaz (2006) agrees and strongly emphasises the necessity to force one's perception of the data. To mitigate this problem, the researcher kept in mind the rich knowledge that he gathered during the fieldwork - including understanding the participants. He always questioned whether the code represented the participant's perspective and whether the researcher's background had an impact on the interpretation (Charmaz, 2006). When in doubt, the researcher returned to the interview recording and listened again to capture any nonverbal signs that accompanied the code (e.g. tone of voice, feelings and pauses). To ensure consistency, a note was written on those concepts. Furthermore, the researcher continuously compared the coded materials to look for similarities that may lead to what Yin (2011) refers to as negative patterns (Yin, 2011). Such patterns could refer to a bias that should be examined. Lastly, the researcher was very careful not to be influenced by the participants' status, education level and position. Miles et al. (2014) call this phenomenon the *"elite bias"*. The participants in this research came from different backgrounds, age, experience, educational, and social status. The sought-after operational cohesion between official and communities requires an equal representation of all stakeholders' perspectives.

Another major measure that was taken to validate the analysis and the resulting findings was triangulation. Miles and colleagues (2014, p.299) define triangulation as supporting the findings by *"...showing that at least three independent measures of it agree with it or, at least, do not contradict it"*. In this research, the researcher followed the classic types of triangulation that were suggested by Denzin (2001). Accordingly, the researcher continuously compared the codes that were taken from the data collected in different case studies, and different data collection stages, and different participants (data source); from observations, interviews, and documents (method), and the data collected by the three researchers who were involved in the data collection (by researcher). However, the latter type did not involve the researchers in the analysis process. The benefits of using investigator (or researcher) triangulation are subject to criticism in the literature. For instance, Kimchi and colleagues (1991) stress that bias is not measurable. Duffy (1987) and claim that having more than one investigator can amplify the bias. Furthermore, investigator triangulation can be problematic if each researcher strictly adheres to his or her epistemological beliefs (Nolan and Behi, 1995). However, there were other practical considerations that dismissed the investigator triangulation option in the analysis. Analysing such large amount of data can be a full-time job. In the conditions of limited budget and time, it was unlikely to find the suitable and agreeable researcher.

### 3.6.4. Conceptual Implications on the Analysis

The conceptual model that was explained in the literature review had an implication on using the VSM as an analytical tool. According to the model, during emergencies, the system-in-focus shares the amoeba shape that Beer suggested for the environment, which means that the system-in-focus cannot be precisely determined before the analysis as requested by the VSD. During the focused coding, segments of the data were to be coded as part of the system or external (that it belongs to the environment). However, the conceptual model and the data suggested that some elements were dynamic and cannot simply be permanently pinned down to one VSM category. For instance, the model suggests that the supervision action is what makes any volunteer part of the system, and not having a contractor formally working for the organisation. Therefore, categorising an SV (or a community group) to be part of the response system or the environment is relative to his actions, the phase of the response, the timely officer's decision to engage him or her, and many other perceivable or unperceivable factors. Therefore, the coding process was conducted with an open mindset that accepted the undetermined shape and size of this system. Traditionally, it is possible to draw a line between what belongs to an organisation and the external players. Therefore, the early stages of the analysis were challenging given this line can indeed be dynamic during the short observation period.

## 3.7. ETHICAL CONSIDERATIONS

Direct and transparent communication was maintained with participants regarding the study, their role, and the researcher's role to mitigate any possible deception or misunderstanding. The goals of the research were explained in detail to all participants in advance, and the data were collected only after obtaining their consent. The participants were also informed of their right to withdraw from the research at any time. The researcher provided the participants with his contact details should they need to inquire about how their data being used in the future or to withdraw from the research.

The participants were also informed of the researchers' presence and roles during the exercises. The research was aware of the criticisms of covert observation (Patton, 2002) and the scepticism that many organisations have about them (Creswell, 2012).

A formal ethical declaration application was made to the University of Manchester before the field work. The data collection process began after the application had been approved.

CHAPTER 4

# THE EVOLVEMENT OF THE RESPONSE SYSTEM

## 4.1. INTRODUCTION

The systems and VSM lenses were used to analyse and to model the emergency response system. The focus of this chapter is the systemic analysis of the response system as observed during the response simulations in the live exercises. Further, some complexity (and its drivers) that is relevant to SVs and to the system's functions is also identified. A more in-depth analysis of the SVs' complexity and the validation of the proposed conceptual propositions are addressed in Chapter 5. Hence, this chapter addresses the following research questions:

1. How does the multi-agency emergency response system evolve during a response to a disaster?
2. What are the systemic and viable characteristics of the emergency response system that contribute to its resilience?
3. How does this system systemically relate to and regulate SVs' complexity during the response?

The term evolvement was used instead of evolution to express the rapid and impermanent increase in the system's complexity to respond to stress. Also, it is used to differentiate this process from the slow and gradual natural development for which the term evolution is commonly used. To ease the analysis, the evolvement of the observed system was divided into stages according to key milestones. The milestones were chosen because they influenced changes in the system's characteristics. The analysis resulted in the following evolvement stages:

- Before the officials arrival
    - Before the activation of the CG response.

  - After the activation of the CG response.
- After the officials arrival
  - One official responder in charge.
  - Multi-agency response.
  - The system-in-focus that is fully evolved.

These stages are analysed in detail in Sections 4.2 and 4.3.

### 4.1.1. Key Findings in This Chapter

The findings in this chapter in regard to the above research questions are:

F1. The response system evolved over the response period in terms of structure and function. The duration and the way this evolvement occurred was not precisely predetermined. The evolvement process was determined by the accessibility that different agencies and individuals had to the incident site, the order in which these agencies arrived at the site and the relative authority that these players had.

F2. Three systemic characteristics were found to be dynamic. These are boundary, elements, and identity. The changes in the system's boundary was a result of adopting a collaborative and embodying relationship with the environment (SVs). These characteristics changed in every evolvement sage to respond to external and internal complexity and to maintain resilience and viability.

F3. The emergency system was recursive during all its evolvement stages. However, the agencies that formed the system changed their recursion and viable function (e.g. S1-S5) with every evolvement stage.  In general, agencies moved in one direction - down the recursion structure with every step of increasing the system's structural complexity. However, recursive issues were identified in the system-in-focus. These issues may potentially hinder the system's efficiency, resilience, and potentially viability. Finally, the analysis showed that each complexity regulation function was observed operating in both directions of the communication channel. Although this case is not covered by or maybe contradicts the VSM, it was positive and supported the system's resilience and viability.

F4. The system was not able to address the complexity of random SVs during its evolvement stages. SVs were only addressed when the system-in-focus was fully formed. Furthermore, the SVs management function in the system-in-focus was not able to fully process 100% of SVs given the autonomy that these SVs might have. However, the issue of addressing autonomous SVs by S1 was still not addressed by the system.

### 4.1.2. The Structure of the Chapter

Three approaches are used to reduce the complexity, enrich the analysis, and ease the experience of reading the presented analysis in this chapter. These are: Combining data, presenting the findings as a narrative of the system evolvement in a chronological order, and coding the case studies, exercises and participants.

#### *4.1.2.1. Chronological Narrative and Analysis*

Given the complexity and dynamicity of the observed system, this chapter will narrate and analyse the formation of the system in a chronological order. However, it is important to note that this chapter is not a mere case description because it does not describe the cases' normal settings and historic performance. The cases and exercises were explained in Chapter 3. The narrative in this chapter is about analysing the performance and evolvement of the response system during a simulation of a disaster response in light of the new SV policies.

Section 4.2 describes and analyses how the system evolves from the moment of the impact until the system is fully formed (the system-in-focus). The system's characteristics in every evolvement stage are analysed. The characteristics involve the system's elements, its recursion levels, and its communication channels. It also analyses the observed complexity management approach in each stage. It is in this section where the most structural changes to the system happen. The analysis in this period of the system's development will show that the elements that composed this system were not predetermined as is the case in typical organisations. Rather, the structure and elements were unpredictable, evolving, and continuously changing. The system is described in this chapter as amoeboid because it resembles the movement of amoeba that changes its structure and shape.

Three main factors were identified as influencers of the system's amoebic nature:

- The availability of different responders and stakeholders on the ground.
- The accessibility to the incident area.

- The nature of the incident at the current time.

Based on these factors, official decisions were made regarding the system's structure and its elements. Consequently, the system's boundaries were changing (expanding and shrinking) to accommodate the structural changes. The communication channels that governed the system were also changing to adapt to the new changes.

Section 4.3 analyses the system-in-focus when it was fully evolved. The system-in-focus was described as fully evolved because all its major functions and characteristics were present as per the SV policy and the government's emergency response guidance. However, this does not mean that the system's characteristics were permanently fixed. Rather, the system was still dynamic. Yet, the dynamicity did not involve major changes to the system's structure as was the case in the previous stages but involved changes in size. In this section, a detailed analysis of the system's characteristics and viability is carried out. The viability is tested against the VSM's structural characteristics (e.g. the five systems, recursion levels and communication channels). This analysis was only valid at the time of observation

Section 4.4 summarises the key finding and themes in the chapter's sections. It concludes with a table that lists the system's characteristics during each evolvement stage and highlights whether and how volunteers were addressed at each stage.

A different way of presenting this chapter was to separate the narrative from the systemic and VSM analysis. However, given the complexity of the cases, this would have made it more difficult for the reader to remember all the events in the narrative to reflect on the analysis. Thus, presenting the analysis when the events happen allows the reader to form a systemic picture of the events and reflect on them accordingly.

### 4.1.3. Merging Data

The data of both case studies were merged to draw a comprehensive picture of the response system, its properties, and its strategies for dealing with SVs. The system under analysis in this chapter was constructed based on the data collected in the first case study's exercise (operational focused) and enriched it with the details that the second case study exercise provided on SVs registration and deployment. Merging the data helped in obtaining a fully functional response system and in validating the conclusions that were reached from analysing each case study. Adopting this approach provided a single coherent, expressive and more generalisable story of the emergency system and its management of SVs' complexity.

The author was aware that merging case studies might result in missing the richness of each case study. Thus, before the analysis, the author conducted a detailed assessment of the data collected in both case studies' regarding the structure of the response system, the approach towards SVs, past emergency experiences, future plans to engage SVs, and the data collected in these case studies. This assessment showed that both case studies were similar in terms of their systemic plans to engage SVs, their past emergency experiences of engaging SVs, the focus of the data that was collected from the interviews, and their plans and policies for managing SVs. However, durations of the live exercises were not long enough to test the functions of the system (operational on the ground and indoors registration and deployment activities). While the first case study's exercise dedicated half a day to simulate the response operations, the second case study's exercise was dedicated entirely to the SV registration and deployment activities. Merging the data from both exercises resulted in a more representative picture of the system's activities during a real response to a disaster.

### 4.1.4. Coding

The coding scheme that is used in the findings chapters is shown in Table 4-1.

**Table 4-1: Coding Scheme and Abbreviations**

| Case Study 1 (CS1) | | Case Study 2 (CS2) | | Case Neutral Codes | |
|---|---|---|---|---|---|
| **Term** | **Code** | **Term** | **Code** | **Term** | **Code** |
| Exercise | E1 | Exercise | E2 | Strategic Coordination Group | SCG |
| Emergency Planning Manager | EPM | Civil Contingencies Manager | CCM | Tactical Coordination Group | TCG |
| Emergency Planner | EP | Senior Civil Contingencies Officer | SCCO | County Council | CC |
| Senior Emergency Planner | SEP | | | | |
| Community Group | CG | | | | |

## 4.2. THE EVOLVEMENT OF THE RESPONSE SYSTEM

Several agencies formed the evolving emergency response system such as emergency services, local authorities, and the organised voluntary sector. These agencies joined the response system gradually in a manner that was not precisely defined prior to the incident. Although the official response and the contribution of volunteers were discussed during the planning meetings, the exercises plans did not involve scheduling the arrival of the response agencies. This was not a planning weakness. Rather, it simulated the uncertainty of real disaster situations. The order in which responders and volunteers may arrive at the incident scene would be context relative. During E1, the system was formed in a bottom-up way and increased in complexity with time. This evolvement facilitated an in-depth understanding of the system's recursion levels. During the response, the system-in-focus was constructed gradually, which allowed observing the elements of the system in operation. Further, it was an opportunity to see how a single element of the system would change its recursion level, and sometimes its role, with every evolvement step. The result was a richer insight into the system's complexity.

The system-in-focus represented a typical multi-agency response system on the local level (the tactical level). However, during the data collection and analysis process, the author had to redefine the system-in-focus in light of the new SV policies and the evolvement nature of the system. Thus, the system-in-focus (unit of analysis) was identified as the *fully manifested* multi-agency response system that is *in full operation* and can *formally* manage SVs. The words emphasised in italics show the significance of the evolvement of the system in regard to analysing its complexity.

### 4.2.1. Before the Official's Arrival (CG-Led)

The incident in E1 started when an explosion took place (simulation) in one of the village's properties. The scale of the explosion was large, which indicated the need to evacuate the village and initiate an emergency response. According to the SV policy, the CG in the village was in charge of evacuating the residents to a place of safety and to initiate a response according to their response plan. However, the SV policy stated that the CG was not able to initiate such response before obtaining the CC's approval.

The emergency response guidance (Cabinet Office, 2013) assigned the CC the responsibility to manage volunteers during emergencies. Thus, it was systemically useful to analyse the CG behaviour (as a part of the response system) before and after the activation of their plan. The CG consisted of 13 members: a coordinator, and 3 teams as S1 units. Each team had 2-3 members and a team leader.

#### *4.2.1.1. Before Activation*

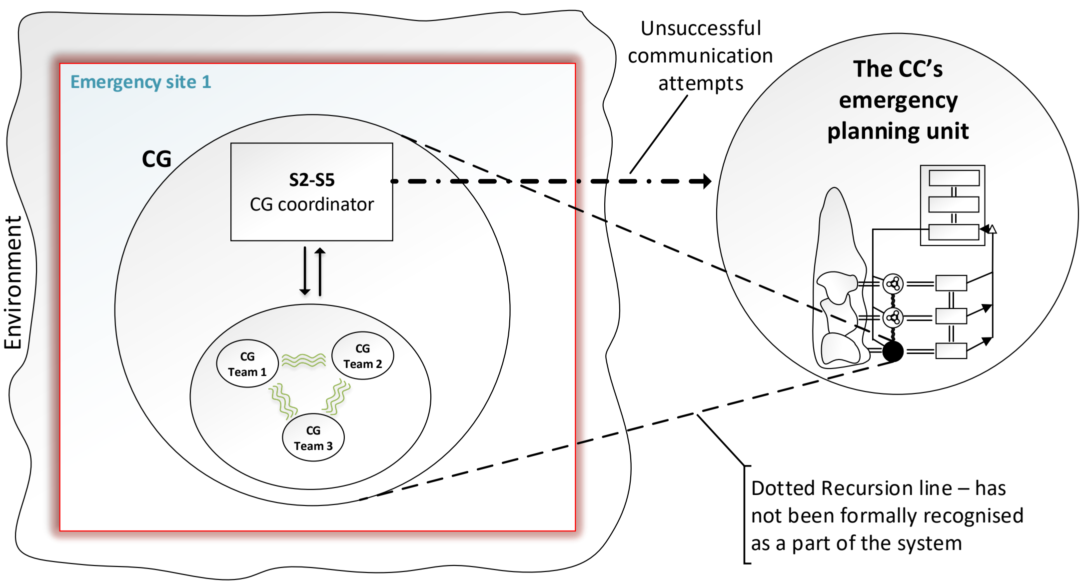
When the explosion hit the village, many residents started to leave their homes trying to understand what was happening. Immediately after recognising the danger, the CG coordinator decided to open the village hall (a predefined place of safety) and the CG members guided the residents towards the safe building. Concurrently, the CG coordinator contacted the emergency services on the hotline 999 to report the incident. He also called the CC to obtain the approval to activate the CG response plan and initiate a response. Several call attempts were unsuccessful and the CG coordinator was observed confused about what to do. Many residents were still in their homes, many were on the streets, and there was a risk that another explosion might happen. Formally, the CG, as a responder, was officially constrained to carry out any activities before obtaining the CC approval.

Analysis

As can be seen in Figure 4-1 the response system at this point was in its early formation stage. It consisted of the CG that was unsuccessfully trying to communicate with the system's management for instructions (the dashed arrow). Thus, the analysis suggests that the CG's systemic identity was not precisely defined at this stage. On one hand, the CG was formally considered as an S1 in the emergency planning unit as per the SV policy. On the other hand, the CG could have been considered an external entity because it was not bound by law to work under the CC's supervision. Also, the CC did not have the authority to engage the CG in the response without the approval from the strategic management in the higher recursion level (the LRF or the SCG). If the SCG decided that volunteers support was not required, then the CG members would either stay idle or act as random SVs. Moreover, the CC would not be accountable for any actions carried out by CG if the CG failed to communicate with them. The CG's activities would be considered autonomous on a par with any SV response. This situation and such possibilities were not covered by the SV policy in both case studies nor by the CG response plan. Nevertheless, many of the CAT 1 interviewees in both case studies (e.g. police and fire representatives) considered the CG as a support for the officials but not necessarily part of the system (expressed by dotted recursion lines in Figure 4-1). This lack of explicit consensus might explain the absence of guidance for the CG on how to act if they could not establish a connection with the CC.

During this confusing period, the CG coordinator was performing the S2 function. He was in contact with all his teams and was responsible for coordinating them. When interviewed during this stage, the CG members said that the CG coordinator was in charge of the teams. This means he was performing S3. The CG members were observed in the village hall waiting for instructions. However, they were actively collecting information about the incident and updated the coordinator via their personal mobile phones. As such, the coordinator was functioning as S4 in the CG. Regarding the strategic management (S5), the CC was supposed to be in charge of this function as per the SV policy. However, in this stage, the CG coordinator had to take control of this function in the absence of any connection with the CC. He had to decide on his strategy and communicate it to his teams. This situation put the coordinator under pressure, especially that he did not exercise autonomy to decide without the CC guidance. This might have been because the SV policy did not explicitly grant the CG such autonomy. Hence, the coordinator's efforts were mainly focused on establishing a connection with the CC.

**Figure 4-1: The Response System Before Activating the CG Response**



This communication challenge might raise reliability concerns. In such planned scenario as the live exercise, the CG coordinator had to try many times to establish a call. In real life, the CG would not be useful for the community or to officials if the communication channel was not established.

Three complexity drivers (CDs) were observed at this stage. The first was technical and procedural. Depending on mobile phones and calling an out of duty officer was not a reliable approach for a critical matter such as initiating a disaster response. The SEP was aware of this complexity driver when she said *"And really the community groups… the only means they have talked to us is through the phones. So, if we lose the phones what are other methods they are able to communicate with us?"*. Although she suggested that they could use alternative methods such as relying on voluntary organisations (e.g. Raynet), this suggestion was not practical because these methods or agencies were not available at this stage. Excluding the CG from a formal communication arrangement could mean that officials had considered the CG as external volunteer entity.

The second CD is the absence of reference to the CG autonomy in the SV policy. The coordinator's confusion and hesitation to make decisions without obtaining the CC approval was a consequence of this CD. The SV policy did not include any guidance that formally allows the CG coordinator to make a decision when faced with complexity such as that he faced.

The third CD is the absence of guidance for the CG on what do when he cannot communicate with the CC. in general terms, he was not formally advised on how to deal with CDs autonomously. This also contributed to reducing the system's efficiency and resilience. See Table 4-2 for a summary of the analysis.

**Table 4-2: Analysis of the System Before Activation**

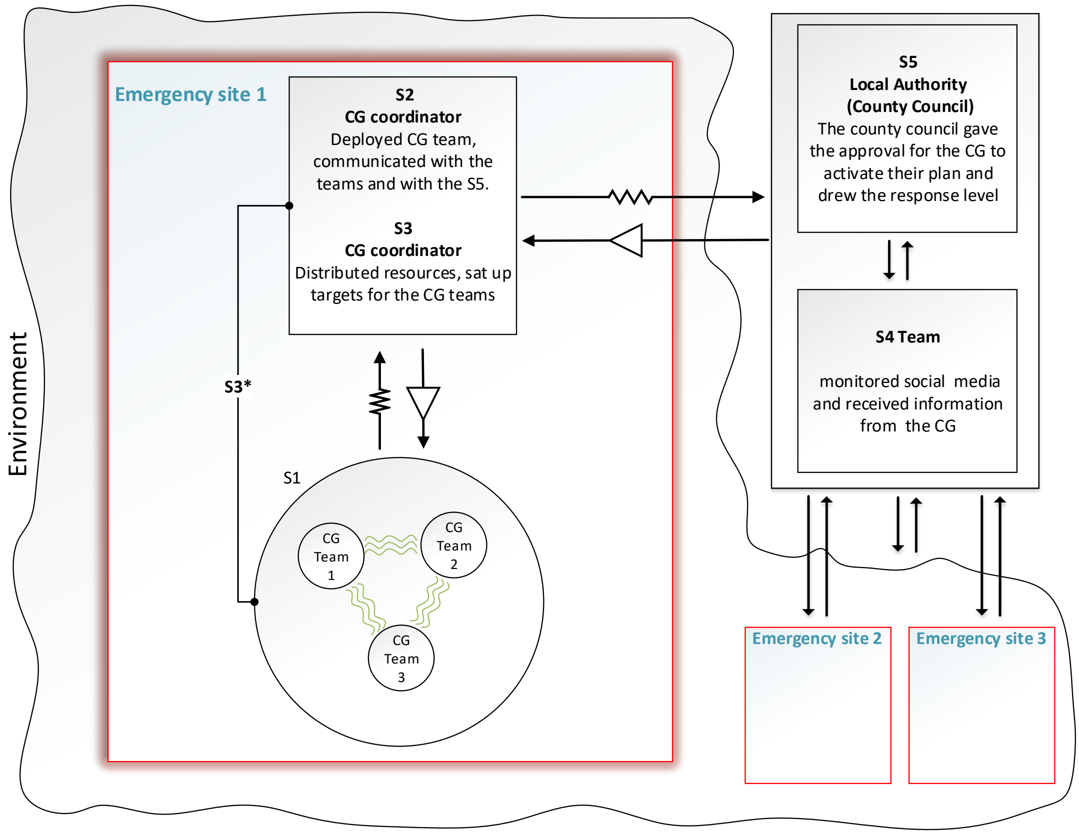
| VSM Analysis | | Organisational CDs | Generated Complexity |
|---|---|---|---|
| **S5** | The CG Coordinator was virtually in charge (He was not formally given permission to respond) | The communication arrangements between the CG and the CC | Cannot establish a connection with S5 |
| **S4** | The CG coordinator was virtually in charge S4 | Potentially limited autonomy | S1 confusion, delay of and ineffective response |
| **S3** | The CG coordinator | No guidance how to act on CDs | S1 confusion, delay of and ineffective response |
| **S2** | The CG coordinator | Not Observed | Not Observed |
| **S1** | The CG teams | Not Observed | Not Observed |

### *4.2.1.2. After Activation*

The CG coordinator managed to establish the connection with the CC and obtained the approval to activate the CG response plan. This was the first formal evolvement step of the system-in-focus. However, it was important to consider that activating the CG plan meant that the CC had already been informed by the strategic management on the LRF level that a voluntary response was needed. As such, two major elements of the emergency response system were evolving concurrently. The first was the operational units on the site and the second was the metasystem offsite. Although the metasystem was located outside the emergency site and was not observed, activating the volunteer sector was an evidence of the metasystem's activities.

As it can be seen in Figure 4-2, the activation of the communication channel with the CC changed the CG coordinator's roles that were observed in the previous stage. The CC took control of making strategic decisions (S5) and for analysing the environmental information (S4). The CC staff were observed trying to ensure that the CG activities were conducted according to the agreement (S3*). As part of the exercise preparation, the CC staff were already on site. However, according to the VSM, this is not an S5 function. Also, in real life situations, the CC might not perform S3* because it would not have access to the CG teams. Rather, it would receive reports from the CG coordinator (S3 and S3*).

**Figure 4-2: The Response System Before the Officials' Arrival – After Activating the CG Response (one CG)**




Next, the activities of the system's functions are analysed.

<u>*S1*</u>

Immediately after the activation, the CG coordinator deployed his teams to the village hall (rest centre) to support evacuees, and to the village to supervise evacuation. In the (rest centre), some CG members served tea and refreshments and offered emotional support to the evacuees. On the ground, other members managed the evacuation process. The CG members directed people who were self-evacuating to the rest centre and collected information about who needed special help. The CG response brought some order to the evacuation process in the absence of the official response. The interviewed residents in the rest centre appreciated the CG's role in the evacuation. One of the evacuees said that the CG was *"…very helpful and able to assist in evacuation."* while another considered that the CG was efficient and effective in this task.

Vulnerable people were identified and they were given priority. An interviewee who played the hearing-impaired lady acknowledged that her needs were professionally met by one of the CG members. However, the CG's effectiveness in evacuation was criticised by other vulnerable people who needed assistance in leaving their homes. An old lady was disappointed because she was asked to self-evacuate to the rest centre. She said: *"I did not expect to walk so far at 90 years old and having heart problems"*. A similar feedback was given by another disabled lady who said that she was not offered transportation. These complexities revealed three potential complexity drivers:

1. The level of autonomy that the CG had to access potentially risky areas.
2. The CG's evacuation skills.
3. Lacking the necessary resources to address diverse types of evacuees.

Exceptionally, the CG was also involved in rescuing an unconscious person who was blown away by the explosion. However, this incident showed that the CG was not fully trained to perform complex rescue tasks. The CG coordinator explained that they did not have the medical expertise to treat this person. Hence, they aimed at keeping him safe and monitored until he could be seen by a professional paramedic. Another distinguished action that the CG undertook was closing the main road in and out the village. By closing the roads, the CG mitigated against further damage to locals or other people driving through the village. This action showed a strategic knowledge of emergency response and a good planning and decision-making capabilities.

The significance of the CG experience as an S1 in the response system was that they had responded on behalf of officials before they arrived. Thus, it might be necessary for the CG to have diverse skills and resources (people and equipment) that would enable it to meet different responses needs (e.g. Rescue, first aid, and crowd management skills). In some occasions, the CG did not have the requisite skills and resources to meet some of the basic complexities (e.g. transporting old people and providing first aid to some causalities).

Furthermore, the analysis shows that a higher degree of autonomy might be necessary to enable the CG to respond effectively in the absence of supervision. This was lacking during E1. The CG coordinator adhered to the agreed plan with the CC in regard to performing tasks safe for CG's members. For instance, although the CC had activated the CG response, the CG did not do the door knocking to look for residents who might have needed assistance or might not have been aware of the scale of the incident. The CG coordinator admitted when he briefed the fire commander upon their arrival by saying *"we have not **yet** done the door knock...we wanted to wait until you [Fire] come* *to make sure it is safe to go in"*. This quote might also indicate the CG's desire to show authorities that they were responsible, follow instructions and that they were trustworthy. The word "*yet"* in the quote shows that the CG's desire and intention was to do the door knock.

With time, the complexity of the situations increased because of the increased number of evacuees and the load of information that was flowing from the site. Signs of an overwhelmed S1 were observed. Some evacuees told the author that they were left alone in the rest centre and that none of the CG members talked to them. One the interviewed ladies in the rest centre expressed that she was bored, did not know what was going on, and did not get any updates on what was required of them "*…some lone periods of waiting not knowing what was required"*. While the building was not over-occupied during this interview, many of the CG members were wandering around in the building and they did not seem very busy. Thus, such ineffectiveness could have been a result of management and coordination overwhelmedness or issues (S2 and S3).

**Table 4-3: Examples of the CDs and the Generated Complexity in S1**

| Organisational CDs | Generated Complexity |
|---|---|
| **CG's limited autonomy** | Residents at their homes did not receive service and were uninformed (problematic) |
| **Skills of the CG members** | -Unable to provide first aid to a casualty (problematic)<br>-Poor performance led to uninformed and bored evacuees (problematic) |
| **Lacking resources** | Some vulnerable people were not helped to move to a place of safety (problematic) |
| **CG response plan** | Efficient response and identification of the location of the rest centre (supportive) |
| **CG coordinator** | Closing the roads to the village (supportive) |

*S2*

Three communication channels were observed during this evolvement stage. The first connected the CG coordinator and the CC. The coordinator's mobile phone and the landline that was in the village hall were the only available mean of communication. The second communication channel connected the CG coordinator and his team leaders. Personal mobile phones were the only communication tool with the deployed teams. Occasionally, the coordinator was observed walking to communicate with the teams that operated close to the rest centre.

One of the observed challenges in regard to the coordination function was the limited capacity of the communication channels to pass information. The CG coordinator was the focal point of communication. In many cases, the team leaders could not reach him because his phone was occupied or because he was busy doing something else. In other cases, the coordinator could not reach his teams because their phones were out of coverage or occupied. The third communication channel was between the CG and the environment. The CG members were known to the residents as the formal response body in the village. Thus, it was expected that their phones would be overwhelmed by calls to get updates and instructions. However, no formal procedures for this channel were observed. For instance, there was no public number available to the residents nor there was an announced point of contact.

Accordingly, communication equipment and communication procedures were identified as two complexity drivers. The problematic complexity that these drivers generated was observed. For instance, the Parish Council Chair came to the rest centre and expressed his anger and disappointment that the CG coordinator had not called him to consult him regarding the response. From his perspective, the CG coordinator had intentionally ignored him because he did not want to engage him in the response. He expressed concerns about the way the response was conducted and that the priority should have been to close the roads rather than just following the CG plan. However, further analysis suggests that other CDs in other functions of the response system had contributed to generating this complexity. For example, this incident revealed authority issues. The parish was a lower recursion level in the CC system. It was not clear why the Parish Council was not considered in the SV policy or in the CG response plan. This incident will be discussed again in the S4 and S5 analysis.

*S3 and S3**

In addition to his S2 role, the CG coordinator was performing as S3. He communicated the CC policy, managed the teams, and made resources decisions. Occasionally, he contacted his teams to get updates on their tasks and ensure that they are achieved (S3*). However, the coordinator did not carry out S3* effectively because it was frequently done over the phone rather than visiting the operations area.

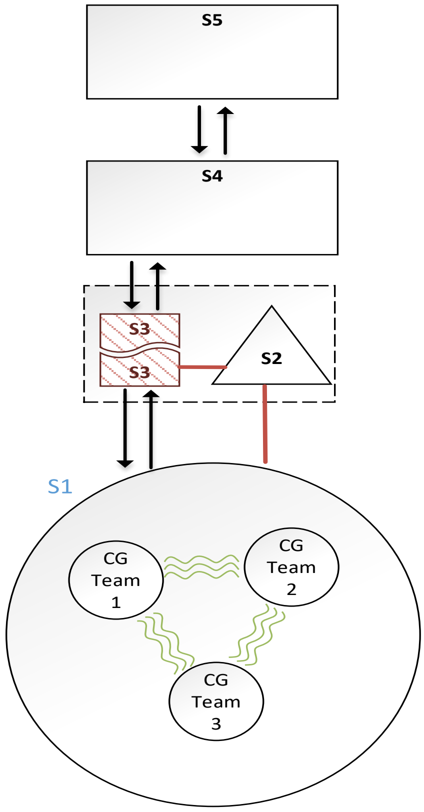
Signs of control pathologies could be observed during the exercise. The major S3 issue was the lack of consistency. The CG coordinator did not have one management style. In the early stages, he was direct, gave clear instructions, and allowed his teams to function with a degree of autonomy. When the event escalated, S3 issues were detected. For instance, some CG members were observed looking for the coordinator to inquire what they should be doing. This could indicate that these teams either over-relied on instructions from S3 to function or they did not understand what their objectives were. The former could refer to a micromanagement style while the latter might indicate that S3 failed to communicate the S5 policies to the S1 units in the form of action plans.

During his S3 role, the coordinator belonged to two systems – the CG and the metasystem. Therefore, he had to separate his roles in both systems. He needed to adopt the CC's perspective as an S3 in this system and equally to assist his teams to achieve their goals. Although the coordinator performed both roles, he might have advantaged the former. For instance, the CG coordinator was not observed negotiating the CC instructions in light of the needs of his teams. It might have been that the CG teams did not inform the CG with their needs, that the CG coordinator thought things were going well, or the CG had embedded himself in the vertical S3 role on the expenses of the S1 requests. This analysis identifies a CD that concerns the dual identity that the CG coordinator played, which was represented as a divided S3 function in Figure 4-3.

The S1 issues described earlier could be tracked in the coordinator's performance. It was clear that S3 was not able to deal with all the horizontal complexity that was arriving from the S1 units. However, that was expected as the coordinator was simultaneously performing the S2 and S3 functions. The coordinator was absorbing the entire S1 complexity in addition to the complexity arriving from the CC. Thus, the S3 function in this stage was considered weaker than it was needed to deal with the situation (smaller S3 in Figure 4-3). Having the ability to deal with complexity was a determiner of CG's effectiveness as part of the official system's response. This issue would have been mitigated by assigning the S2 function to one of the CG members, which would have freed the coordinator to function merely as S3.

Comparing the observations in E1 with the coordinator's interview showed that the coordinator's multi-role (S2 and S3) did not emerge during the exercise. In the interview, the coordinator emphasised that he was accountable for these functions. For instance, when he was asked about decision-making, he said that he would check on his teams from time to time to see that they are making good decisions *"Eventually, it'll come back to me and then, you know, you can get back to making decision or even if I just phone somebody and say how's it going, what decision did you make, just to be assured"*. This quote refers to the coordinator's S3 and S3* roles. However, when he was prompted about his role he replied: *"I think I'm gonna be almost the conjunct… really… between the guys that I've got in the rest centre and the guys that I've got out of the rest centre"*. Here, the coordinator was saying that his main role was S2.

**Figure 4-3: Weak and Dual S3 Role**




To summarise, the CG coordinator functioned as S2, S3, S3* within the CG and S3 as part of the metasystem, which put him under high pressure. Signs of lacking control was observed while the CG coordinator was idle, which can be an indicator of overwhelmedness.

**Table 4-4: The CDs and the Generated Complexity in S3**

| Organisational CDs | Generated Complexity |
|---|---|
| **S3 Dual Identity** | Full compliance with CC instructions (supportive) |
| **CG plan does not define responsibilities** | Overwhelmed S3 (problematic) |
| **Weak communication channels** | S3 could not communicate with S1 effectively (problematic) |
| **Poor S3*** | Some teams were not providing service – bored evacuees (problematic) |

*S4*

The CC was responsible for collecting and processing information on the response system's level. Typically, without the CG, people would call the emergency number (999) or call the CC on their public number to report an incident or provide updates. On the other hand, officials would communicate information to communities through radio, phones, or TV. Nonetheless, engaging the CG in the response system in E1 created a new internal CD. The CD was a new communication channel between the community and the higher recursion levels. The new CD served as a complexity regulator for S4 and collected information for S4 from the site. Both of these roles were supportive complexity for the system.

During stage1 interviews, CAT 1 participants in both case studies indicated that the flow of overwhelming amount of random information to S4 was one of the major challenges for the response system during previous disasters. However, the new channel (the CG) attenuated this external complexity before the officials arrival in E1. The CG was an affiliated and a credible source of information, which reduced the time that S4 needed to analyse the overwhelming and unverified information that flowed into the system through calls, social media, media and other unreliable sources. The CG coordinator was aware of this supportive complexity during stage 1 interview when he said that the information he would provide could assist the officials to prioritise their tasks *"You know, you can get on to the emergency services and that would grade it as a priority call"*.

Concurrently, the CG amplified S4's complexity. Prior to having the CG, the CC did not have a direct communication channel with communities. During stage 1 interviews, the CC's officers in both case studies said that the only ways to disseminate information to communities were press and media. They also explained that the effectiveness of these means was not evaluated. Therefore, the CG amplification effect was through enhancing the CC's ability to pass instructions and information to the community. The CG was in a direct contact with the community during the response in E1, which allowed a more effective information sharing. This could mitigate the problem of the inability to access media and social media during a disaster.

However, despite having the new communication channel, there were no formal procedures for operating it. The CG members were not observed contacting the residents to collect information according to existing procedures. An example of the poor use of this channel was the angry Parish Council Chair who also said that his house had been impacted by the incident but no one called to check if he was ok or to obtain the local knowledge that he had. His feelings escalated when the CG members did not address his concerns because they were overwhelmed by their duties.

*S5, the CG, and SVs*

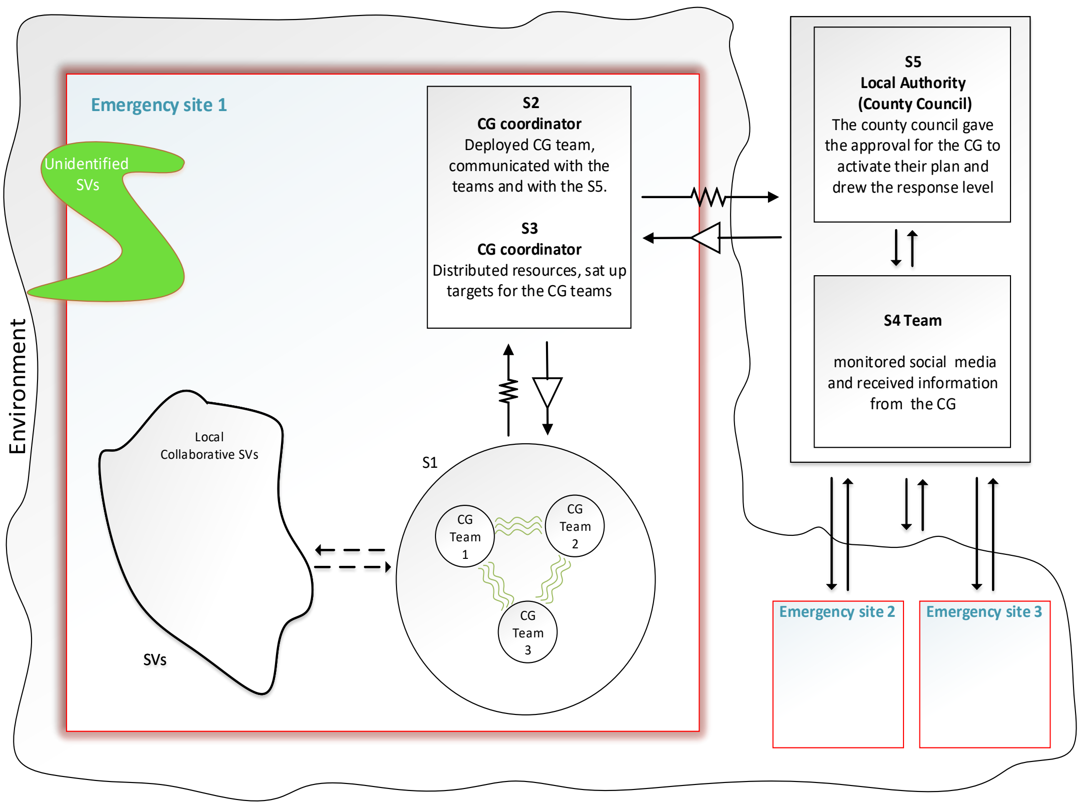
This subsection analyses different aspects of the system collectively because they were closely interconnected. The CG response plan did not include any arrangements to coordinate, manage, or engage SVs. In the stage 1 interviews, the CG coordinator was asked about the support that the CG might accept from SVs. He answered that he could contact some people in the village whose identity and skills had been known for the CG. However, when prompted about random SVs, the answer was not clear. At first, the CG coordinator said that they could. However, he became hesitant shortly and rectified by saying that he would accept selected people that he would know. The answers of the other CG members varied from being agreeable to engage them and giving them the CG-marked PPE, untrusting them, or maybe tasking them if they thought they could communicate with them. Nevertheless, this confusion shows that the CG did not receive guidance from the CC (S5) on how to deal with SVs before officials arrival. Thus, in VSM terms, the system failed to address an important CD in the environment at this evolvement stage.

There could be several explanations for excluding SVs from the CG's response plan and S5's guidance for the CG. For instance, it could have been due to the limited resources that the CG had, which reduced the CC's trust in the CG's ability to do the job. Another reason could be an objection from emergency services (S5 in the higher recursion level) in regard to what the CG can do. The information that was collected in the Stage 1 interviews in CS1 showed that these reasons were likely. For the first reason, the EPM stressed that although CGs did have some level of training and that their identities were known, they would be tasked as other SVs. This indicated a level of low expectations from the CG regarding its ability to do complicated tasks such as managing SVs. For the second, the S5 objection was expressed by the SEP when she commented that the live exercise would be an opportunity for the emergency services to experience that CGs could be dependable in initiating a response. The EP was clearer when he said that the CC was *"…trying to praise their [CG's] profile with the emergency services so they are seen as a resource to the community outside of emergency planning"*. This showed that the emergency services were sceptical of the CG response. The FCP's Police commander whom the researcher interviewed during E1 said that the exercise was *"…quite useful to see what they [CG] can do for us [emergency services]"*. However, he added that *"…the hardest part is splitting reality from the exercise…"*. Clearly, the Police commander expressed that he was still sceptical of the CG's abilities to deal with real-life complexities. While the EP declared that the CG would have a degree of autonomy before the officials arrival, this did not seem to be clearly discussed among officials in regards to making decisions on SVs.

Because of the structured design of E1, the researchers did not observe any significant SVs involvement at this stage. However, it would have been unlikely that the CG could have managed the SV phenomenon. The CG was small and was already overwhelmed with the evacuation process. This analysis was evident in the single SV case that was observed during E1. After the explosion, the CG members observed a person (SV) breaking into a property to check if there were any casualties. This person was not observed to leave the property. Yet, the CG members did not take any action or intervened in what the person was doing.

The analysis shows that the CG showed a desire to demonstrate that they were disciplined in following the officials' procedure and their own response plan. Therefore, the CG would unlikely be involved with SVs. The lack of SV management mechanisms in the CG plan or the SV policy in this stage is expressed in Figure 4-4 as dotted arrows between the CG teams and the local SVs. The dotted arrows show the potential relationship with local SVs that the CG coordinator acknowledged during the interview. Since the CG did not engage any SVs at this stage, it maintained its size during the response (the same circular shape of the CG)- see Figure 4-4.

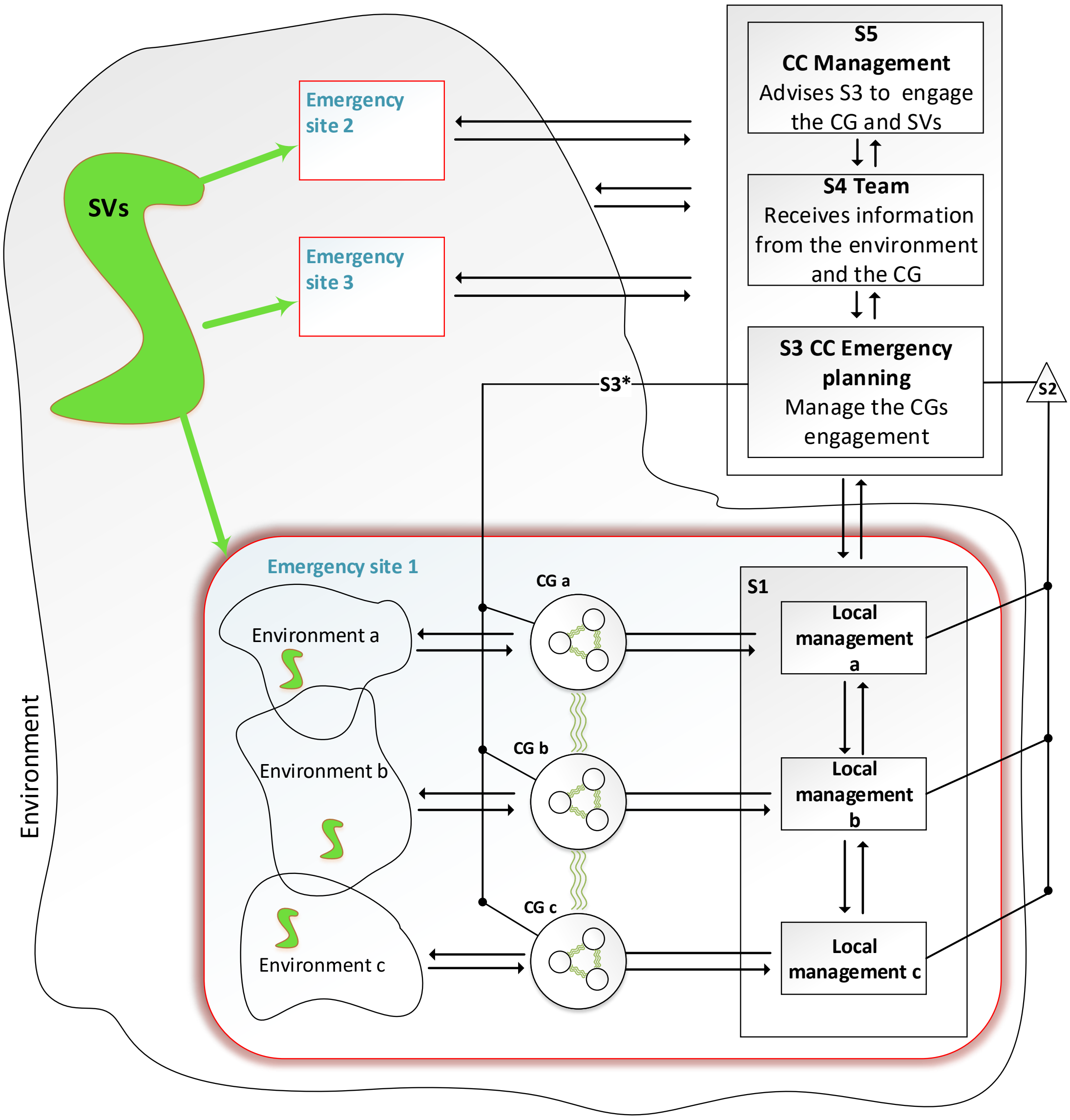
**Figure 4-4: CG-Led Response and Unidentified SVs**




## *Multi-CG Response*

This case was not observed in the exercises. However, analysing stage 1 interviews with the CC participants in both case studies showed that the CC would be in charge of the metasystem's functions if more than one CG were present in the same location. As such, the control function (S3) would be performed by the CC's emergency planning department rather than by the CG coordinator. Furthermore, a new higher recursion level will be created. This level is shown in Figure 4-5 as S1 with three CGs. The CG that was observed in E1 will be at recursion level 2 in this system instead of at recursion level 1 in the single CG scenario.

**Figure 4-5: The Response System Before the Officials' Arrival (Multiple CGs)**




## 4.2.2. After the Officials Arrival

### *4.2.2.1. One Official Agency*

This key stage started when the first official agency arrived at the scene. In E1, the fire team, led by a fire commander (FC), was the first to arrive after 40 minutes of receiving the emergency call. The FC established a control room in the rest centre and took control of the response. The first two actions he made were deploying his teams to assess the situation and meeting the CG coordinator to listen to a brief about the incident and the response progress.

The brief included information about the incident, the activities that the CG had undertaken, and the causalities and the evacuation progress. The CG informed the FC that they had not performed the door knock because they were waiting for officials to declare that the area was safe. The FC was interviewed after the brief to obtain his feedback. He said that they were still gathering information and that they took control of the response on the site *"We have taken over the operational command side"*. He also stated that Fire and Rescue had already deployed an individual to take control of the strategic level. This confirmed the previous analysis that the strategic level of the response was triggered immediately as a precaution measure.

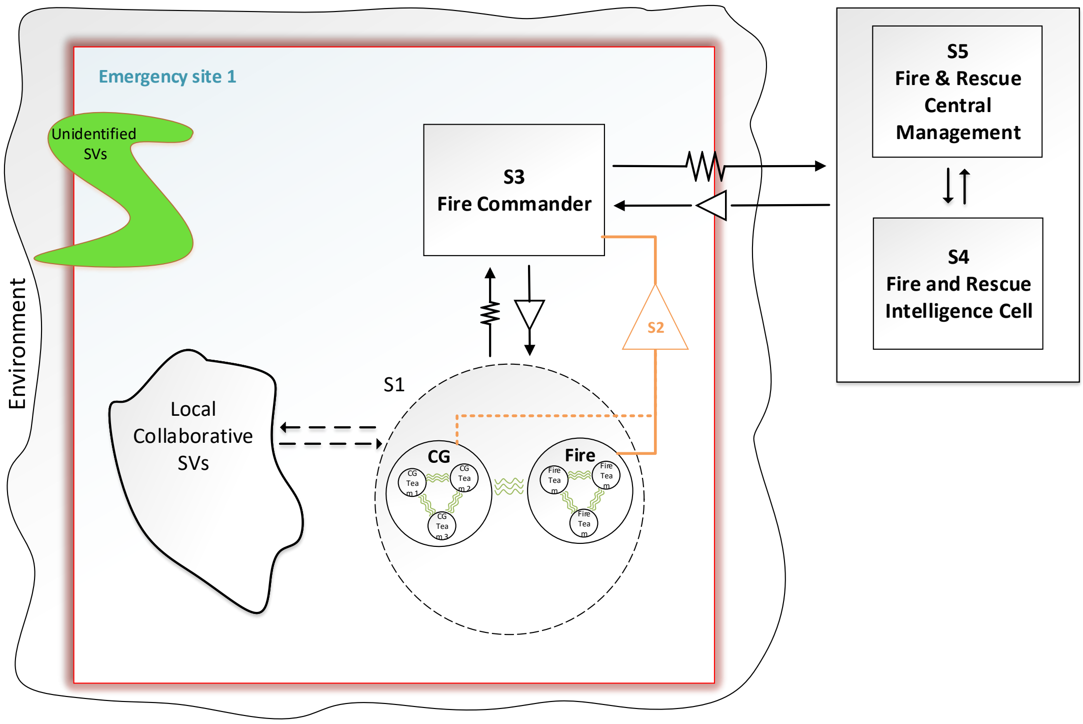
*Analysis*

Two decisions were made implicitly when Fire took control. The first was made by the CG in which they accepted to work under the FC's control. The second was made by the FC when he accepted to engaged the CG in the response under his command. Using the VSM lens shows that these decisions resulted in two structural changes in the existing response system. The first is in the recursion level of the CG. The CG was demoted to become an element in the Fire's S1. Thus, the CG became at recursion level 2 in the new system instead of being at recursion level 1 in the CG-led response (Figure 4-6). However, it is important to note that the FC did not deploy the CG to work under the supervision of one of his teams (existing fire S1 units). This would have rendered the CG to be in recursion level 3. Instead, the FC dealt with the CG as an independent S1 unit. Thus, the boundaries of the Fires' S1 did not expand to accommodate the CG. Instead, a new boundary (dashed boundary in Figure 4-6) was created to accommodate the existing Fire teams and the new S1 member. The boundary is dashed because the CG was not treated exactly as a Fire's S1. This is discussed further in the remainder of the analysis in this subsection.

The analysis suggested that the FC did not have procedures to officially engage the CG as S1. For instance, the FC did not provide the CG coordinator with a radio unit to coordinate with him, nor the CG members were formally declared as part of the Fire response. The deviation in the coordination arrangements is shown in Figure 4-6 as two different communication channels. The CG coordinator was observed searching for the FC whenever he wanted to convey information or to ask for further instructions.

However, lacking procedures did not suggest that engaging CGs was an ad-hoc decision made by the commander. The SV policy was written according to the LRF's guidance.

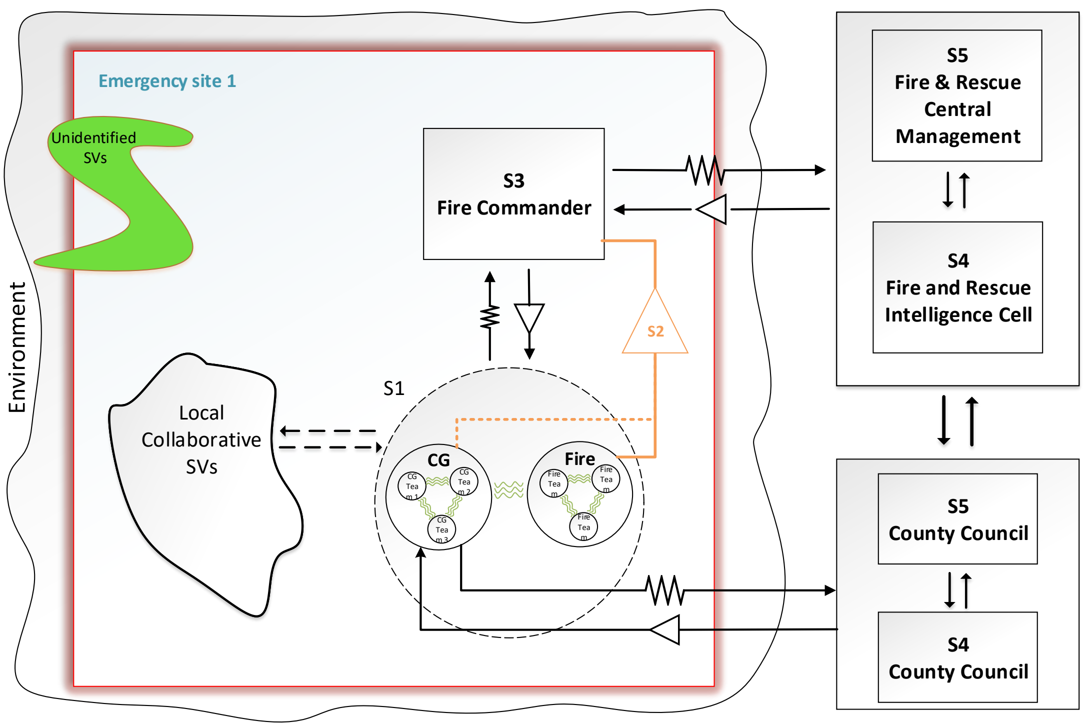
**Figure 4-6: The Response System with One Official Responder**




The contradiction between being an element within the system's boundaries and being excluded from the basic system's procedures might have created an identity conflict for the CG during this stage. This conflict has two aspects. The first is working under a system that does not fully accept them as part of it. The second is having two points of reference, and therefore two potential formal identities. The CG worked under the CC guidance in the first stage. After the fire arrival, the CG was still part of the CC as per the SV policy while its operations were managed by the Fire and Rescue policies and procedures - See Figure 4-7. The SV policy does not advise on which management the CG should follow should visions or instructions differ. The identity issue will persist during the response so it will be analysed in detail in the system-in-focus.

The CG's role in regulating complexity in the new system was clear. The CG attenuated the external complexity for the Fire and Rescue response in two ways. The first is reducing the complexity that Fire had to deal with without the CG-led response. Prior to Fire arrival, the CG evacuated most of the residents. Hence, they reduced the environmental complexity for S3 (and thus variety for S4 and S5) before they have arrived. Further, the brief that the CG provided to the fire commander was significant to reduce variety. The basic information that the CG provided directed the fire team to the explosion location, gave them information about the evacuees and on the presence of an SV in one of the properties. This revealed the situation's complexity (what was actually happening) and saved fire time. This also reduced the environment's variety (possibilities) for the fire and rescue S5.

**Figure 4-7: Identity and Management Issues**




The other CG's regulatory role was the system's complexity amplification. The CG managed a major part of the environmental complexity (evacuees) and freed up the Fire's human resources to act in the risky areas that required special training and skills.

Regarding SV management, there were no changes to the observations that were made in the previous stage. Fire and Rescue did not have their own policies to deal with SVs. Thus, if SVs were present, the CG would be bound by the Fire and Rescue policies and would not be able to deal with SVs. Given that the CG was simultaneously part of the CC's response, the CG might be subject to the identity conflict explained above when encountering SVs. As it can be seen in Figure 4-7, both S5 functions were trying to amplify their complexity through the CG. The coordination between these meta-systems would be important to avoid a severe CG identity clash. Table 4-5 shows some observed CDs and their associated complexity.

**Table 4-5: CDs and the Generated Complexity During the Single Official Response**

| Organisational (internal) CDs | Generated Complexity |
|---|---|
| **Fire does not have a volunteer policy** | The system could not address SVs or formally engage the CG (problematic). |
| **Different/lack of coordination procedures with the CG** | Ineffective communication with an S1 unit (problematic) |
| **Two S5 functions** | Identity conflict and confusion in the CG (problematic) |
| **CG is engaged** | Brief on the incident, free up the system's resources (supportive) |

### *4.2.2.2. Multi-Agency Response*

During the 30 minutes after the Fire's arrival, other CAT 1 responders and voluntary organisations such as the BRC, 4x4 and Raynet arrived separately at the scene. Police were the first to arrive after 10 minutes of the Fire arrival and took control of the response. A meeting was held between the police and the fire commanders to evaluate the situation and to set up the multi-agency response. Accordingly, a tactical tier (TCG) was formed by establishing a Forward Command Post (FCP) in a separate room in the village hall to ensure that the activities of the numerous agencies on the ground are coherent, efficient and effective. The FCP had representatives of Fire and Rescue, BRC, and was led by Police.

Establishing the FCP was completed after one hour of reporting the incident. Instantly, it started deploying the blue lights teams to the affected areas to carry out the response activities. However, communication issues and logistics were hindering a full function of the FCP. For instance, the radio system that Police had was not instantly ready for use. The handsets had to be taken out of boxes, to be programmed on a new frequency and distributed to the police teams. Also, the multi-agency system used an internet-based platform (called Resilience Direct) to share live information among responders. This system had connections issues. The entered information did not become instantly available for other agencies. Solving these issues took around 30 minutes. Nonetheless, in real life situations, the timeframe of the agencies arrival, and thus the system's evolution, would be unpredictable. It could vary from minutes (e.g. urban areas that have emergency services centres), hours in remote areas, or even longer if the access was blocked to the area by emergency-related factors.

The CG coordinator was allowed into the room to brief the FCP on the situation. The FCP asked the CG to keep looking after the evacuees in the rest centre unit they have a better assessment of the situation.

*Analysis*

In the previous stages, the system was ruled by an S5 of a single agency. This was the CC and then Fire after their arrival. Furthermore, the decisions on the operational management level (S3) was made by a single responder (the CG or Fire). In the new system, the management structure and elements fundamentally changed. This meant a change in the system's policies, vision, operations management, and operations.

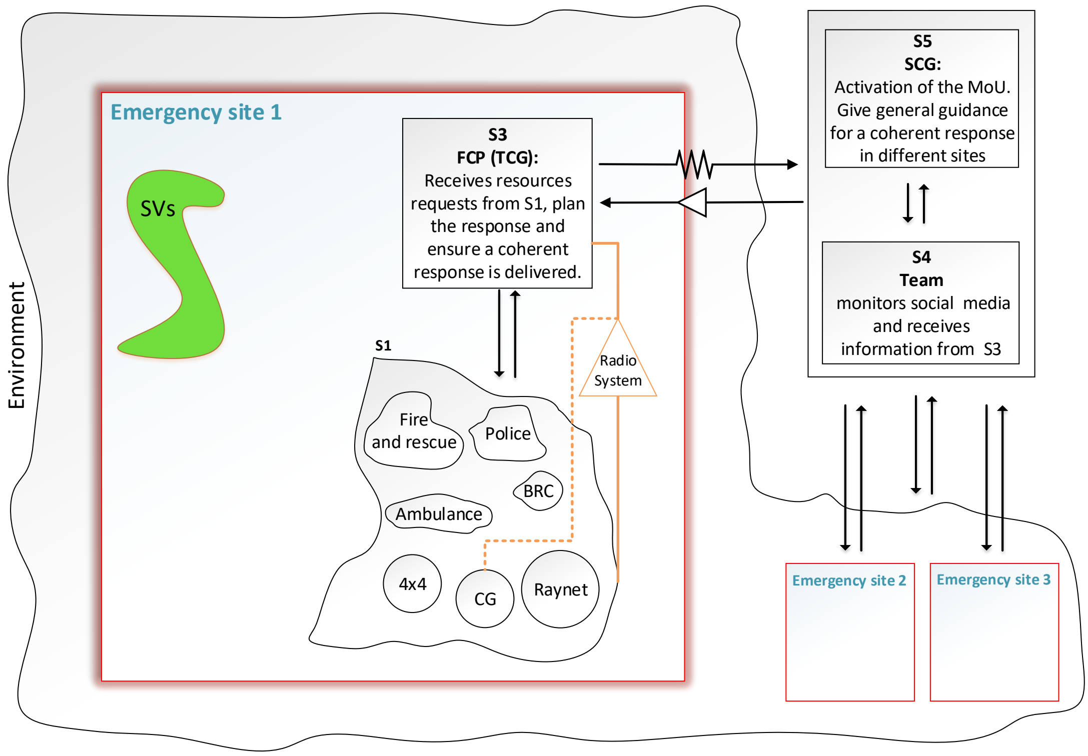
In the new system, the SCG was physically formed and located in the CC building and took over as S5. This meant that the agencies became under one policy that had been generated by the SCG. Part of this policy was the newly written SV policy. Changing S5 meant changing authority and thus changing the power balance in the system. The change also applied to the S2, S3, and S4 functions that became representative of all the forming agencies. Thus, S1 units were now instructed and supervised by a body that represented different agencies.

The multi-agency system is shown in Figure 4-8. The CAT1 units were now bound by the new SV policy that required these agencies to accept the volunteers help. The systemic implication was that their boundaries needed to be permeable and flexible to accommodate volunteers. Thus, the S1 elements' boundaries had changed their shape to amoebic. This applied to the Fire's S1 that was drawn as a circle in the previous stage. However, the SV policy did not advise if the CG or other smaller volunteers groups could accommodate SVs. Further, they were not observed to be engaging new volunteers during E1. Thus, their boundaries remained rigid and circular in the figure.

The coordination channels changed from a single agency radio system to a platform that was accessible by the system's elements. The information that was logged in involved incidents, casualties, emergency updates, and response activities. This function connected all S1 units, CAT 1 agencies' management, and passed information to S3 where decisions were made accordingly. However, the CG was excluded from accessing this platform and from using the radio system. Thus, the channel through which the FCP coordinated the CG was expressed with a separate dashed line. This channel did not follow the formal coordination procedures – see Figure 4-8.

Although the BRC was not included in using the radio system or entering information into Resilience Direct, the BRC was able to use these two tools. The BRC had a representative in the FCP and hence could listen to updates and share their information with the police and fire representatives, and hence input them into the platform. Also, the BRC did have their own radio system. This was not the case for the CG.

**Figure 4-8: A Multi-Agency Response System Including a Community Group**




Regarding the recursion levels, Figure 4-8 shows that Fire and Rescue changed their function to be an operational unit in the response system - they were demoted to become at recursion level 2. Nonetheless, the CG did not maintain its previous role as a Fire's S1. Rather, it exited the Fire and Rescue's system and operated as an independent S1 under the FCP's management. Therefore, it maintained its position at recursion level 2 in the new system.

The system at this stage did not include the SV management function. This function was a major property in the system of focus. It was also a major aspect of the SV policy. This function was not exercised concurrently with the response in E1. Rather, the SV registration process was tested indoors in the afternoon session. Thus, a more realistic representation of the function in operation was not observed in E1. However, E2 offered a comprehensive demonstration of the SV registration and deployment function during a response. Thus, the data that had been collected from E2 was combined with that of E1 to establish the comprehensive model of the following evolvement stage - the system-in-focus.

## 4.3. THE SYSTEM-IN-FOCUS

This section analyses the structure and the function of the system-in-focus. The system-in-focus was identified in this research as the multi-agency response system that formally engaged SVs. This system took its final shape when the CC had arrived at the scene and established the volunteer reception centre (VRC) locally but outside the operations area. The VRC was designed and managed by the CC to register and deploy SVs. The VRC was the function that allowed the multi-agency system to formally recruit SVs.

The analysis of the system follows Beer's (1985) suggestion to start by identifying the system's higher and lower recursion levels – this is called vertical analysis. Then, to explore the system-in-focus's elements, communication channels and dynamics in detail – called horizontal analysis.

### 4.3.1. Vertical Analysis

This subsection studies the higher and lower recursion levels of the system-in-focus and highlights the issues that can negatively impact its viability and resilience.

The lower recursion level (level 2) of the system was similar, but not identical, to that of the multi-agency system shown in Figure 4-8. The units of S1 in this system consisted of the same agencies (e.g. Police, Fire, and voluntary organisation) and the CG. The teams that formed these units were identified as being in recursion level 3 – see Figure 4-9. However, SVs were the new S1 elements that distinguished the system-in-focus.

Although this system formally engaged SVs through the VRC, modelling SVs as an S1 unit in the system was not systemically correct. Most of SVs attended as individuals. Therefore, they were processed and deployed as individuals under the supervision of the CAT 1 teams. Although some SVs arrived as a group (e.g. family, friends or neighbours), these SVs were not recognised as an organisation. Hence, they were deployed as individuals or a group within the agencies' operational units. However, the involvement of SVs resulted in systemic changes to the existing S1 units. These will be discussed in the horizontal analysis in Subsection 4.3.2.

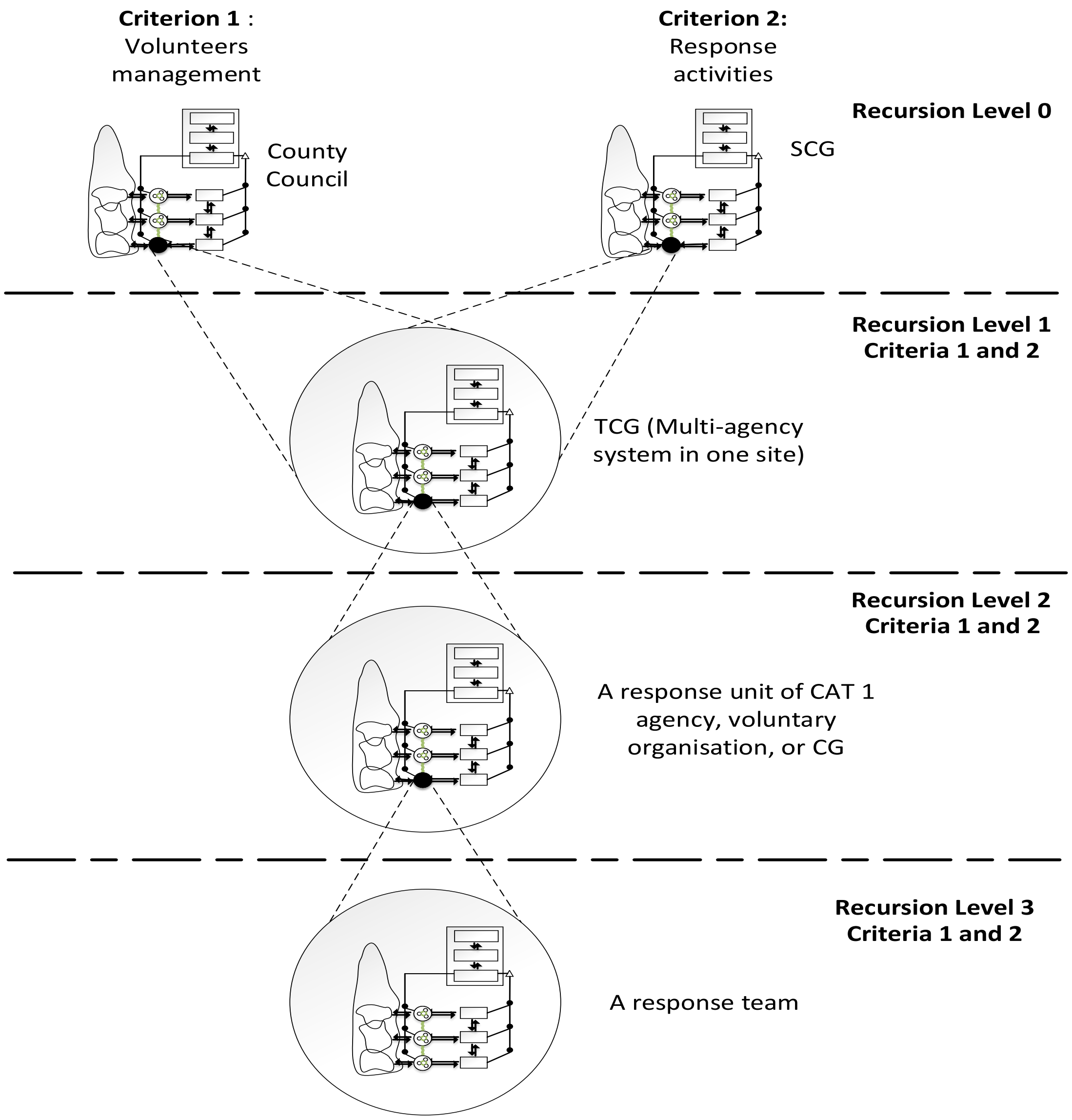
Analysing the higher recursion level (level 0) was more complex. To ease the analysis, the author utilised the system-in-focus definition to identify recursion level 0 agencies. The definition states that the system's purposes were:

- Purpose 1: Managing and engaging volunteers (CGs and SVs).
- Purpose 2: Responding to emergencies (e.g. Rescue, Firefighting, maintaining order, and saving lives)

These purposes represented two recursion criteria (criterion 1 and criterion 2) according to which the organisational complexity could be explored upwards. According to the former criterion, recursion level 0 was identified as the LRF (SCG). The SCG was the LRF's executive mechanism to strategically coordinate the overall response activities. However, according to the latter criterion, the CC was also identified as recursion level 0 because it was formally and directly in charge of managing and engaging volunteers during the response. See Figure 4-9.

The above analysis suggests viability issues. Officially, the CC was an S1 unit in the system-in-focus. Thus, it should exist only in recursion levels 2 for that system. Although the CC was represented in the SCG, this representation was on the executive level beside other executives from the CAT 1 agencies to deliver the response and coordinate the agencies on the regional level.

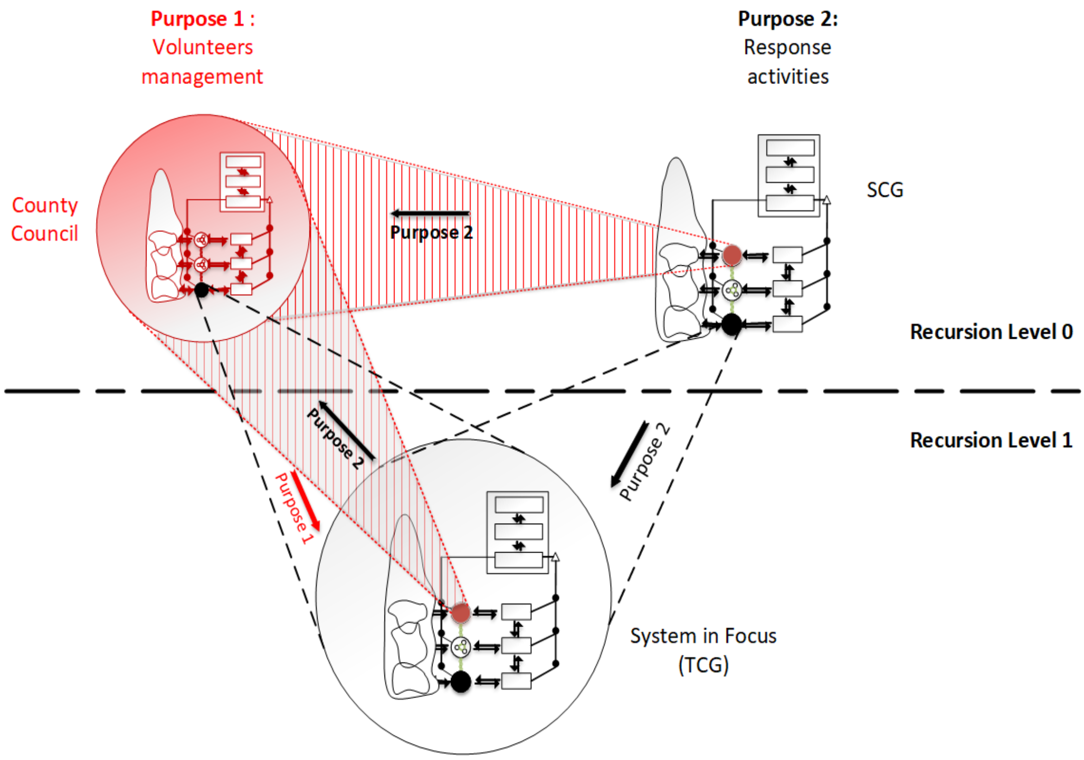
**Figure 4-9: Recursion Levels (vertical dimension) with 2 Recursion Criteria**




The issue under discussion here does not concern having two higher recursion levels. Rather, the issue emerges from (1) exercising two purposes in S5 simultaneously in the same context, (2) the CC exists two different recursion levels in the same time, and (3) having the system (CC) and its embodying system (SCG) in the same recursion level. See Figure 4-10.

The first point concerns both S5s sending potentially contradicting messages to the system-in-focus. Rios (2012, p. 147) explains that having two conceptions of the same system is pathological because it creates a schizophrenic system. For instance, the CC showed enthusiasm in E1 and E2 to engage SVs and the CG in the response as much as possible (purpose 1). The SV policies that were designed by the CC emphasised this purpose. However, in real life, the SCG's priority can be delivering the most effective response (purpose 2). The latter purpose was found in the analysis of the emergency response guidance, the interviews of the CAT1 participants, and the observation of the FCP in operation during E1. Consequently, the SCG may prefer to recruit the most reliable human resources (e.g. organised volunteers) rather than SVs. During E1, the system-in-focus showed more compliance with purpose 2 given the nature of the agencies that formed the TCG. The CG was only involved in remote operations where it was safe. When the police commander was interviewed during E1, he stated that they were testing the idea of engaging SVs and that he was not sure how this will work out in real life situations. Thus, the clash between the two purposes might be more observable in real situations compared to the exercises that were designed to test the SV policy in a safe environment.

**Figure 4-10: The CC Recursion Problem**

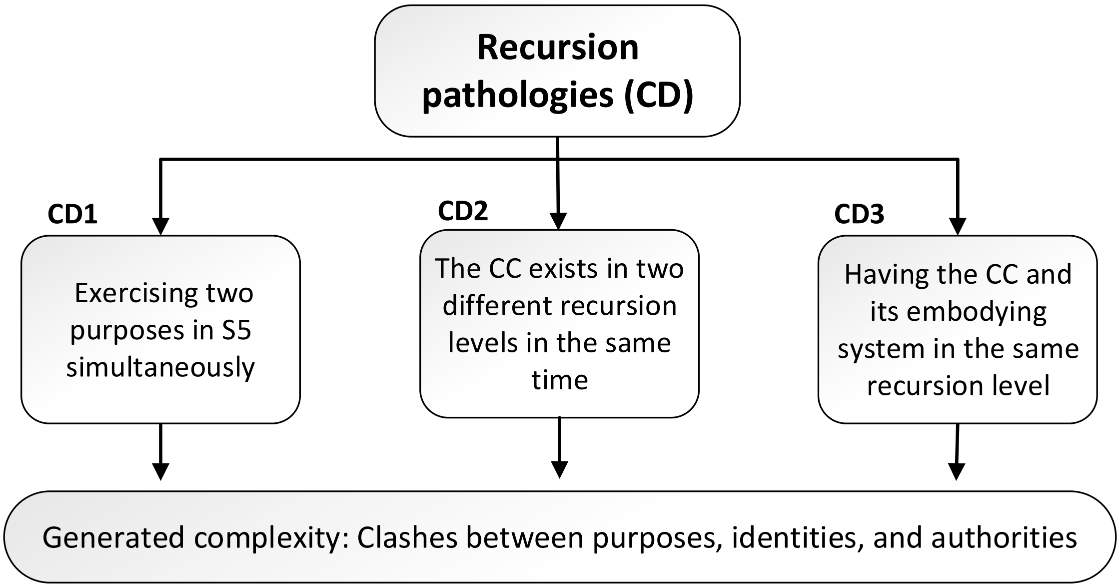



The second issue concerned having the CC in two recursion levels. This meant that the CC may have suffered an identity clash. Being in recursion level 0 meant that the CC was in charge of setting up the vision and policy for the system-in-focus, a system in which the CC was a part. Thus, in this system, the CC was the metasystem and an S1 unit. In E1 the CC took decisions regarding communicating with and recruiting SVs without the involvement of the FCP or SCG members. In real life, the CC can become confused. It would be making decisions as part of the SCG regarding the response activities and making decisions separately to engage SVs. These two goals might in many cases be conflicting.

The third issue was having an S1 unit and its management in the same recursion level. If the CC and the SCG enjoyed the same level of authority, then each of systems would be fighting to apply its policy (or purpose). If one enjoyed more authority, then the other system would feel grievance if its purpose was ignored. Hence, a potential clash at the S5 level would be likely. In E1, it was apparent that the SCG had an authority over the CC. Yet, the CC purpose was applied because E1 was designed to test the CC purpose with a partial or complete tolerance of enforcing the SCG purpose.

The problematic complexities that were explored above were outcomes of the three issues. These issues were identified as three internal CDs (themes) that fall under 'recursion pathologies' as the higher-level CD (category). This recursion CD was internal because it was about the way the system was structured - See Figure 4-11.

**Figure 4-11: The Identified CDs in the Vertical Analysis**



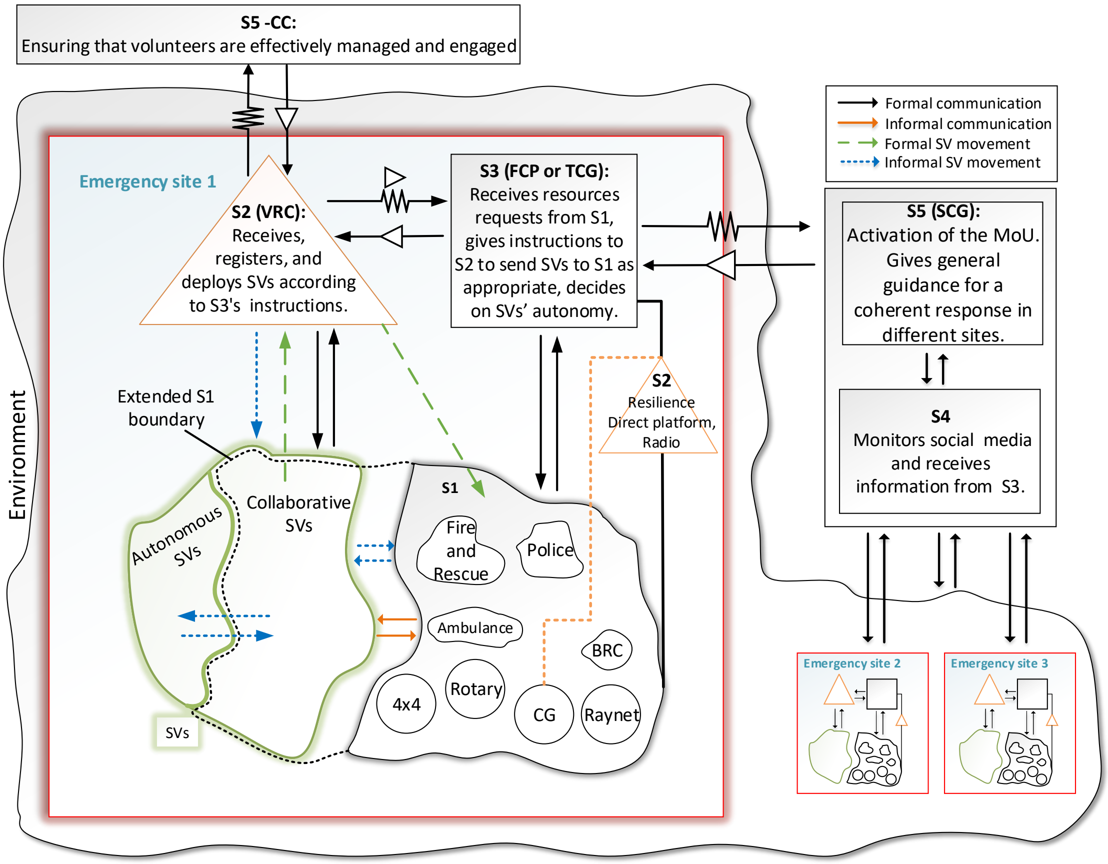
### 4.3.2. Horizontal Analysis

The final shape of the system-in-focus, its elements and the communication channels that governed it are shown in Figure 4-12. During both exercises, the following official operational units were involved: Police, Fire and Rescue, Ambulance Services, County Council, and BRC. Also, the following volunteer organisations and groups were involved: 4x4, Raynet, Rubicon, Rotary, the CG and other local charities.

SVs were not observed as a separate S1 unit because they were deployed within the formal agencies teams -mainly the emergency services and the BRC. This was expressed by representing the boundaries of the S1 units that would receive SVs as amoeba shape (Figure 4-12). These units were subject to change in size during the course of the response; that was the system's lifespan. SVs could enter the system formally or informally through direct contact with an S1 unit. Evidence of the informal engagement of SVs could be found in the stage 1 interviews in both case studies. For instance, the ambulance services representative said that, in some cases, he would allow SVs to perform some tasks if he thought they were doing a good job (more details in Chapter 5). Similar SV experience was reported by some CC participants. However, some organisations were not allowed, or were not in authority, to engage SVs. During the interview stage, the blue light and the CC's participants in both case studies stressed that the BRC was the only voluntary organisation that could engage and manage SVs according to the MoU that was signed between the LRF and the BRC. The organisations that did not have plans or were not allowed to engage SVs in their teams are drawn as circles in Figure 4-12 to express their impermeable boundaries and thus their fixed size.

Analysing the FCP showed that the different S1 units did not have equal authority in the system. Police, Fire and the BRC were the only S1 units that were represented in the FCP in E1. Therefore, the FCP decisions were expected to be influenced by these organisations' perspectives. Yet, when the author observed the FCP in operations, Police and Fire were the dominant decision makers. The BRC representative was not consulted when decisions were made. This might explain why the BRC operational units were observed idle, bored, and not aware of their role over the course of E1. When interviewed in E1, a BRC team leader expressed her frustration and said that *"We deployed two of the ladies to help Police with door knock…they travelled all the way here… we came to be part of the exercise but we were not utilised…"*. Ignoring the BRC teams might have resulted from giving the priority for the CG to respond. However, this would not explain ignoring the BRC representative in the FCP and excluding him from the decision-making process. Nevertheless, in real life situations, the FCP might prefer to task the BRC rather than the CG during the response phase as was stated by different CAT 1 participants in both case studies. This is discussed further in Chapter 5.

**Figure 4-12: The System-in-Focus**




Analysing the stage 1 interviews showed that there were two types of SVs from the CAT 1 perspective. The first was identified to be autonomous SVs. These SVs would be reluctant to work with officials and therefore they won't be potentially part of the system. The other type was collaborative SVs who were agreeable to work under official supervision. Some collaborative SVs would follow the formal registration procedures (VRC) while others might only accept to be supervised informally at the spot. Hence, these collaborative SVs would be embedded within the S1 units to become part of the system. To facilitate this engagement, the system's boundary needed to expand to accommodate SVs. The dotted part of the S1 boundary in Figure 4-12 expresses the maximum size that S1 could reach by engaging SVs.

*Coordination*

As it was the case in the first stage, Resilience Direct and the radio units on the site were the main coordination function of the system. These are depicted as an S2 triangle on the right side of Figure 4-12. Resilience Direct received the information from different agencies and made them available for the FCP. The FCP used the radio units to communicate with the S1 units on the ground. However, the radio units were not accessible by all S1 units. The CG coordinator did not have formal coordination procedures. Thus, he had to come to the FCP room whenever he wanted to communicate during E1. An additional radio system was provided by Raynet. Raynet is a charity that provides a voluntary communications services. Yet, there were no formal procedures to utilise Raynet's radio units by the CG. In theory, the Raynet service could have helped the CG coordinator communicate more efficiently with his teams.

There were two potential ways to model the VRC within the system. The first was to consider the VRC as an S1 unit because it addressed and processed part of the system's environment (SVs). However, this was declined because the VRC did not do what S1 was supposed to do –to actively respond to emergencies. What the VRC did was *supporting* the response system to recruit and coordinate SVs. The VRC was designed to attract and process SVs out of the S1 units' operation area to reduce the environmental complexity that S1 had to face. This perspective promoted the second option of modelling the VRC - as a coordination function (S2). Hence, the VRC was depicted by the large triangle (coordination) on the left side of Figure 4-12.

Typical VSM models contain a single coordination function. Having more than one S2 can be considered a structural pathology. However, the implication of this deviation from the VSM will be explored by studying the system's dynamics and analysing the type of complexity that two S2s might generate.

*S4 and S5*

The S4 function remained the same as it was the case in the multi-agency system in Figure 4-8. However, a new S5 has emerged by establishing the VRC. As explained in the vertical analysis, the CC took charge of managing volunteers and ensuring their engagement. S4 and both S5s were located in the CC's main building where information was analysed and strategic decisions were made. However, the two S5s was located in two different rooms. The CC S5 functioned form the emergency planning room while the SCG functioned form the multi-agency response control room.

#### *4.3.2.1. The System's Dynamics*

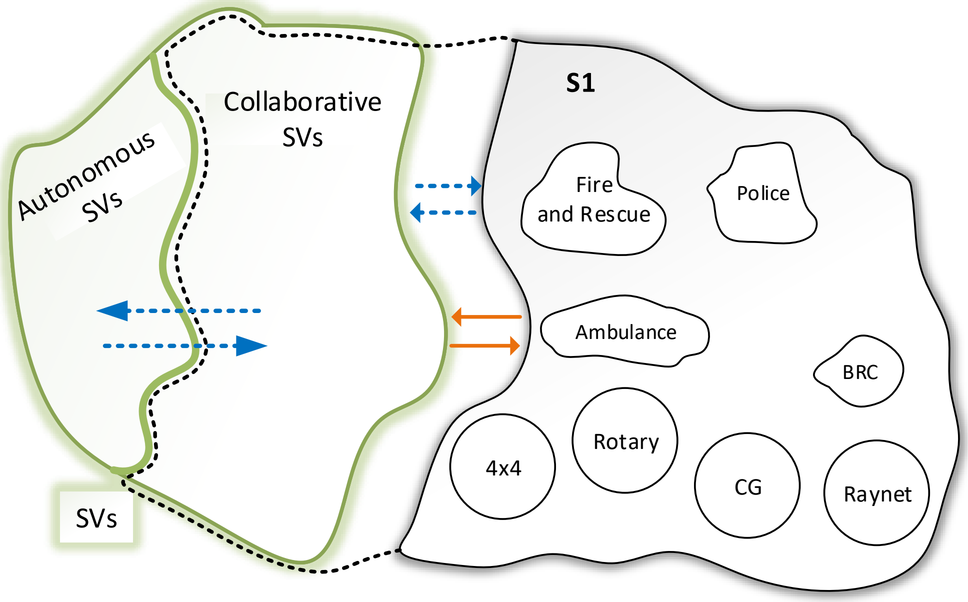
This subsection highlights the communication channels and the physical movement of SVs in the system-in-focus. The analysis is based on the interviews and the observations during the exercises. The interviews provided a real response data that complemented the observation of the exercises. The exercises ran in a controlled environment, which eliminated some of the real-life scenarios that were expressed in the interviews.

*SV-S1 Relationship*

In stage 1 interviews, the participants said that their S1 units were usually in direct contact with SVs during previous disasters. This would still apply to disasters response after establishing the VRC because autonomous SVs would still exist. Also, some collaborative SVs might be reluctant to go through the formal registration process but be willing to coordinate with official response teams on the ground. Thus, the S1 units would still have to communicate with these SVs. This communication channel was informal because it was not included in the SV policy. This channel is expressed with orange arrows between S1 and the entire SV group in Figure 4-13.

Hence, S1 may be forced to informally address random SVs in special circumstances. Some of the CAT 1 interviewees in both case studies gave examples from previous responses to disasters when they had to work with autonomous SVs. In E1, an autonomous SVs was observed breaking into a house trying to help. Once such complexity is observed in real life, S1 might be forced to address the SV to prevent any risks on the SV or the individual whom they are helping. In the system-in-focus, there was always a chance that collaborative SVs might work in the same area where a different S1 unit was functioning. This would require the S1 units to be prepared to supervise those SVs if their supervisors were not available. Further, some collaborative SVs who did not go through the VRC might be available on the ground and an S1 unit might decide to assign them an urgent task. This means that these SVs could enter the system informally. The physical movement of SVs to and from the S1was depicted in Figure 4-13 with a dotted blue line.

**Figure 4-13: SV-S1 Relationship During a Disaster**

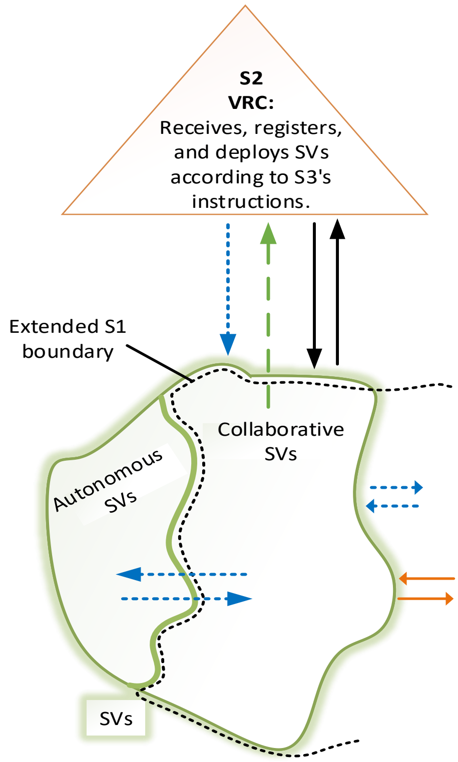



However, SVs perspectives can change with time. Some autonomous SVs might decide to collaborate and vice versa. This means that physical movement may occur between the two types of SVs. This movement is expressed by dotted blue arrows across the internal SVs boundary. An example from the findings is the individual who worked autonomously during E1 and accessed a dangerous property. This movement implied that the relationship between SVs and S1 was dynamic and could not be fully controlled by a formal procedure. Nevertheless, the dynamics of SVs and their attendance to the operations area might not be merely intentional.  For instance, the police commander in CS1 stated that *"…If we have a lot of SVs pictured [not following our instructions in the media] then we are obviously not getting the message out sufficiently"*. Hence, some SVs might still be in contact and in a relationship with S1 on the ground before going through the VRC route.

*The SV-VRC Relationship*

The CC's participants in both case studies stated in stage 1 interviews that the VRC was mainly responsible for communicating with SVs. They further explained that the VRC should initiate this communication with communities through media and social media to give instructions to potential volunteers to attend to the VRC. During both exercises, collaborative SVs followed these instructions and arrived at the VRC. This physical movement from the environment to the VRC was portrayed as a dashed green arrow heading towards the VRC in Figure 4-14.

**Figure 4-14: The SV-VRC Relationship**




Upon their arrival to the VRC in both exercises, SVs went through a process to identify the individuals, discuss their expectations, and classify them according to the type of tasks that they could perform. At the end of the process in E2, SVs were asked to wait in the deployment room until a suitable task became available. Unsuitable SVs were asked to go home and that they would be contacted if something suitable for them emerged. Given that these SVs had a level of autonomy, it was possible that they would decide to exit the process to the emergency area if their expectations were not met. Such cases were not observed during the exercises. In the emergency area, these SVs might still collaborate with the officials in the area or act in a fully autonomous manner. This informal physical movement was expressed in a blue dotted line heading back from the VRC to the SVs area in the environment Figure 4-14.

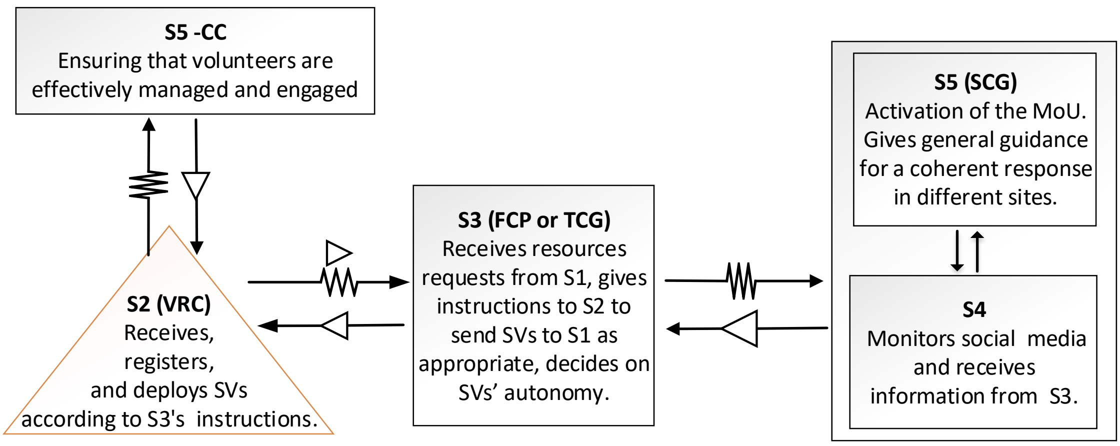
*The VRC-Metasystem Channels*

Two distinct communication channels could be observed between the VRC and the metasystem during E1. The first was between the VRC and the FCP. The VRC timely reported on the registered SVs and their skills. The FCP used this information to request for SVs and to deploy them to the S1 units. The FCP would update the VRC's reports with information about the deployed SVs and pass it to S4 and the SCG. If needed, the SCG would provide guidance to the FCP on regulating or stopping the SVs engagement.

The second channel was between the VRC and the CC. The CC was the policy maker and the controller of the VRC. However, this channel did not connect the VRC to the senior management in the CC. Rather, the information was passed to the emergency planning unit in the CC that was functioning as S3 for the VRC operations.

The VRC amplified the SVs complexity by making more distinctions (obtaining information) such as the SVs numbers, skills, expectation, identities, and health status. As stated by the CS1 participants, this information would be passed to the FCP, and then to S4 and S5. As such, the VRC was systemically increasing the complexity that the FCP (S3) was exposed to before the VRC was established. This observation was expressed in Figure 4-15 by drawing an amplification sign on the communication channel that was heading from the VRC to S3.

**Figure 4-15: The VRC-Metasystem Channels**




Such observation contradicted the VSM's logic of attenuating the complexity that passes up the hierarchy. Nevertheless, the amplified complexity that was passed to FCP was important for S3 to make effective decisions. Thus, this amplification was considered as a positive amplification. Concurrently, the VRC was attenuating the environment's complexity that passed to the metasystem. The previous communication channels that existed between SVs and the system was diverted to the VRC in the system-in-focus. Hence, the overwhelming and the unverified information that the old system used to receive was processed and organised by the VRC.

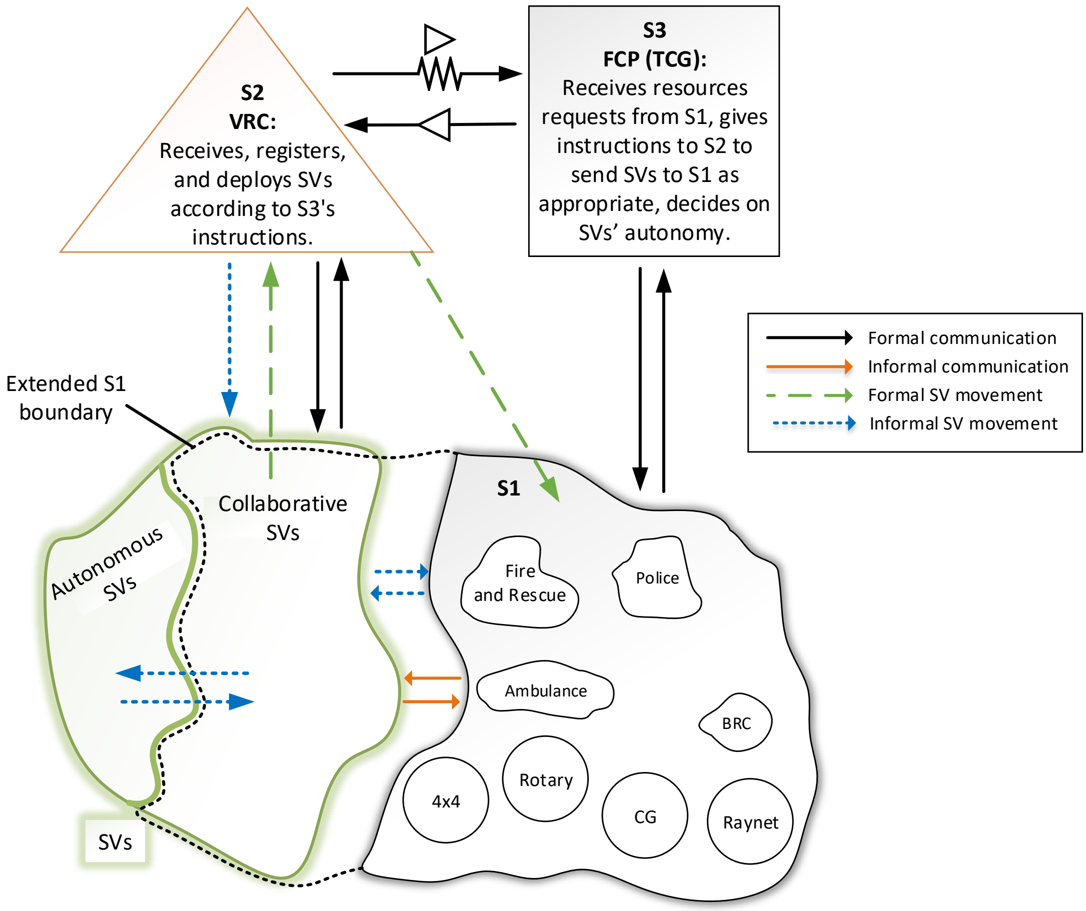
*The Deployment Process and SVs*

In E2, the deployment process began when an S1 unit, or more, requested additional human resources from the FCP (S3). The FCP assessed the available resources and their suitability for the task. When the SV support was appropriate, the FCP contacted the VRC and requested SVs with specific skills and background. The VRC then deployed these SVs directly to the relevant S1 units. This physical movement is expressed in Figure 4-16 by a dashed green arrow heading from the VRC to S1.

This scenario that was tested in E2 might have been ideal. In reality, as explained by both case studies interviewees, SVs were unpredictable and might have different attitudes towards engaging in this process. Some would be collaborative on the ground but reluctant to register. Others would leave the VRC if they were not deployed according to their expectations. As the SEP in the CC said: *"I think if you go with a dictatorship sort of, you must go and do this, then people switch-off because they want to feel like they're in charge of something"*. Further, in future real disasters, the FCP might decide not to use SVs service and engage other voluntary organisations. The priority for the most authoritative agencies in the FCP (Police and Fire and Rescue) might be their efficiency and saving lives rather than engaging SVs. The various arrows in Figure 4-16 that describe SVs' communication and physical movement explain this complexity.

Disaster researchers may consider SVs who function outside the VRC as part of the response system. However, a typical systemic analysis would tend to classify such SVs as part of the system's environment outside its expanded boundary (the dotted black line). Further, in real life situations, SVs on the ground would have direct communication channels with S1 and with other SV groups. The dotted blue arrows in Figure 4-16 show that SVs would move among different parts of the environment. For instance, autonomous SVs might decide to collaborate with officials, and in the opposite direction, collaborative SVs might decide to work autonomously. Occasionally, some collaborative SVs might *informally* join the system's operations if they were instructed by an S1 emergency responder to carry on what they were already doing, or to assist emergency services in some task without consulting the FCP. The high dynamicity that would be created by different parties and individuals' decisions may mean that the system and the environment's boundaries would be continuously changing (expressed by amoeba shape in Figure 4-16).

**Figure 4-16: The SVs Deployment Process**




## 4.4. SUMMARY

*<u>The System's Evolvement</u>*

This chapter addressed the first research question by analysing the evolvement of the emergency system using the VSM lens. Combining the interviews data, the SV policies, and the observations during the exercises in both case studies provided a rich representation of the response system. This analysis introduced a new systemic understanding of how organisations could evolve in a short time during disasters. The response system's complexity increased, its structure changed, and its functions adapted to sudden changes to its environment.

*The Systemic Characteristics*

This theme addressed the second research question. The analysis showed three interrelated systemic characteristics – the system's boundaries, the elements that formed the system, and the system's identity. The findings showed that the system's boundaries were often amoeboid and permeable. This was a mechanism to embrace the environment's complexity (SVs and other organisations) and to use it to enhance the resilience during stressful situations. The chapter showed how the Fire and Rescue system allowed the CG to move through its boundary and accommodated it as an S1 unit. Similarly, the S1 units of blue light agencies kept their boundaries permeable to accept the SVs support. The amoeboid boundaries reflected a flexibility that enabled the unit (or the system) to stretch and shrink to embrace and release external elements.

With every change in the boundaries and elements; the system had to change its identity to match the evolving system. This modification was also influenced by changing the agency or the agencies that were in charge of the S5 function. For instance, the identity of a CG-led system was different from that of the Fire-led system, and both were different from that of the multi-agency system. Table 4-6 summarises the systemic characteristics of the response system.

**Table 4-6: The Systemic Characteristics of the Response System**

| | ***Before activation*** | ***After activation-CG-led*** | ***One official*** | ***Multi-agency*** | ***System-in-focus*** |
|---|---|---|---|---|---|
| ***The Nature of the system's boundaries*** | Fixed and impermeable | Fixed and impermeable | Fixed existing and a new boundary | Undefined and informal permeability | Permeable accepting SVs |
| ***The characteristics of the system's structure*** | Predefined | Predefined | Informal inclusion of new elements (CG) | Informal inclusion of new elements (CG) | Formal and informal inclusion of new elements (CG and SVs) |
| ***Identity (from the body in charge)*** | CG identity | CC identity | Fire and Rescue identity (first to arrive) | Multi-agency | Multi-agency and SVs system |

*The Viable Characteristics*

This theme addressed the second part of the second question. Examining the system's lifecycle with the VSM lens showed that recursion levels were dynamic. Since the emergency impact, new recursion levels kept emerging as a reaction to the changing environment. These recursion levels had not been precisely predetermined. For instance, the TCG did not exist before the arrival of the second blue light agency. Prior to that Fire and Rescue was in full control of the response system.

The implication of the dynamic recursion was that the VSM functions were not assigned to a single agency permanently. The agencies' roles within the VSM structure changed over time. In other words, the function (S1-S5) evolved as a mechanism to embrace the increase in the system's complexity. For instance, in the CG-lead stage, the CC was the policy maker of the response system. However, the CC lost this function for Fire and Rescue when they arrived. The CC's VSM role changed again in the system-in-focus to play an S1 role in the TCG and an S5 for managing SVs.

*Complexity Regulation*

This theme addressed the third research question. The findings showed that complexity amplification can happen in different directions to those suggested by VSM. Yet, amplifying the complexity that arrived at the FCP had a positive impact on the FCP operations and enhanced the system's resilience and viability. This suggested the existence of an opportunity for systems to consider new ways of understanding the notions of attenuation and amplification for viability beyond survival.

The response system failed to address SVs complexity during its evolvement stages, i.e. before the system-in-focus was fully formed. Neither of the S1 units or their containing organisations did have the guidance or the authority to engage SVs. Given that the evolvement period can be uncertain in future disasters, the absence of such guidance can be considered a problematic internal CD. Nevertheless, in the system-in-focus, the VRC was effective in absorbing a large amount of the SVs complexity out of the operations area. Yet, the VRC did not address the expectations of all SVs. Thus, some SVs would still function outside the VRC processing system. Mechanisms to address these SVs were needed. Table 4-7 summarises the system's analysis during the evolvement stages.

**Table 4-7: VSM Analysis of the Evolvement Stages of the Response System**

| | ***Before activation*** | ***After activation- CG-led*** | ***One official*** | ***Multi-agency*** | ***System-in-focus*** |
|---|---|---|---|---|---|
| ***S5*** | CG Coordinator | County Council | Fire and Rescue headquarter, CC | SCG | SCG |
| ***S4*** | CG Coordinator | County Council | Fire and Rescue | Multi-agency S4 | Multi-agency S4 |
| ***S3*** | CG Coordinator | CG Coordinator | Fire Commander | FCP | FCP |
| ***S2*** | CG Coordinator | CG Coordinator | ▪ Radio system for the Fireteams<br>▪ Undefined for the CG | ▪ Radio system<br>▪ Resilience Direct - information sharing platform | ▪ Radio system<br>▪ Resilience Direct - information sharing platform<br>▪ VRC |
| ***S1*** | CG teams | CG teams | ▪ Fire teams<br>▪ CG | ▪ CAT 1 agencies<br>▪ Voluntary organisations<br>▪ CG | ▪ CAT 1 agencies<br>▪ Voluntary organisations<br>▪ CG<br>▪ SVs |
| ***SVs*** | Not addressed | Not addressed | Not addressed | Not addressed | Addressed and engaged |
| ***Recursion levels*** | ▪ Level 0: No recursion<br>▪ Level 1: CG<br>▪ Level: 2CG teams | ▪ Level 0: County Council<br>▪ Level 1: CG<br>▪ Level 2: CG teams | ▪ Level 0: Fire<br>▪ Level 1: Fire<br>▪ Level 2: CG teams, Fireteams | ▪ level 0: SCG<br>▪ level 1: TCG<br>▪ level 2: CAT1, Voluntary organisations, CG | ▪ level 0: SCG, CC<br>▪ level 1: TCG<br>▪ level 2: CAT1, Voluntary organisations, CG |

# CHAPTER 5

# SV-RELATED COMPLEXITY: TYPES AND DRIVERS

## 5.1. INTRODUCTION

This chapter investigates complexity that is related to engaging SVs and its major drivers. This complexity may be generated by SVs themselves or by other factors that can impact SVs engagement.

The worldview that considers SVs as a problem for the system is not adopted. Rather, the analysis adopts a neutral approach to understanding this complexity. This approach is consistent with the conceptual models that promote different types of complexity. A biased analysis can damage the validity of the research (Creswell, 2012), and can negatively impact the process of validating the conceptual models. However, this analysis is conducted from a response system's perspective. This perspective is operationally insightful. It informs the research on the most relevant themes regarding this phenomenon.

Section 5.2 introduces the major CDs (categories) that were obtained from the thematic analysis of the interviews and the data collected during the exercises. The CDs are discussed in detail and the lower level CDs (themes) under each of them are identified.

Section 5.3 validates the complexity classification proposition with data that was directly observed at the VRC.  Section 5.4 addresses the complexity and variety flow model that was proposed in Chapter 2. Section 5.5 validates the dynamic aspect of the CD model. Section 5.6 explores the data for evidence on how complexity was processed and regulated.

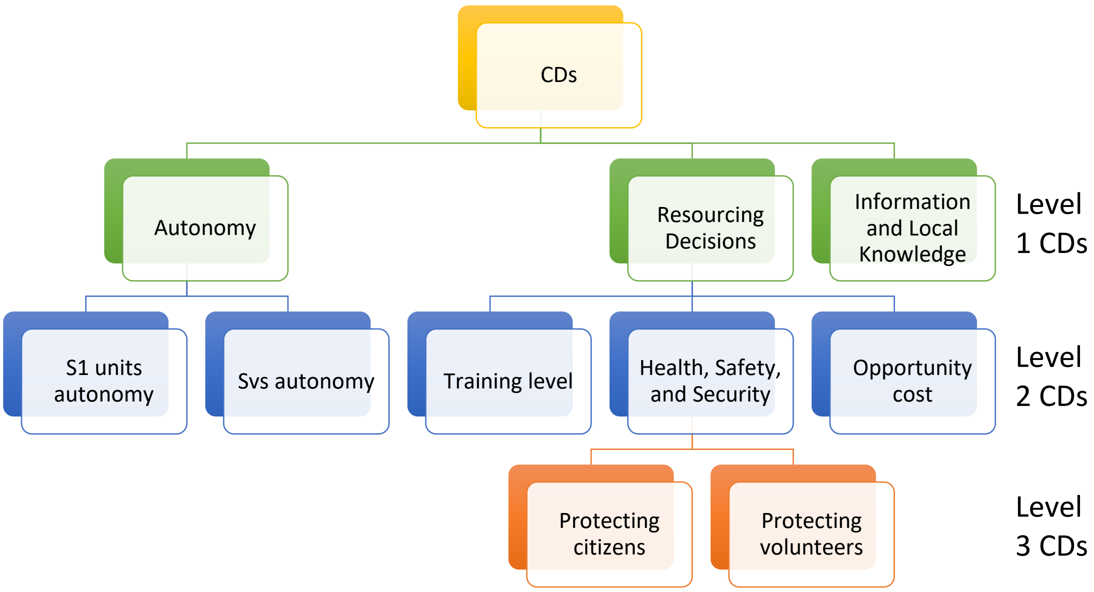
Therefore, the chapter addresses the following research questions:

1. How does this system systemically relate to and regulate SVs' complexity during the response?
   a) What generates the SVs' complexity?
   b) What are the types of the generated complexity?
   c) Where and how is this complexity processed?

## 5.2. COMPLEXITY DRIVERS

The thematic analysis of the interviews resulted in three major categories: Autonomy, resourcing decisions, and information and local knowledge. These categories are perceived as CDs. The themes that fall under these CDs are identified as a lower level CDs. Figure 5-1 shows the CDs addressed in this section.

**Figure 5-1: The Categories and Themes as CDs of SV-Related Complexity**




### 5.2.1. Autonomy

Two themes were identified under this category: the autonomy of the official S1 units and the autonomy of SVs. Both types of autonomy were found to relate to the operational complexity that the system experience in regard to managing SVs.

### *5.2.1.1. The Autonomy of S1 Units*

The disaster response system has various S1 units that can have different operational goals. These can involve emergency services, voluntary organisations, service companies and CGs. Although the deployed SVs and the CG were not formed in separate S1 units, they were still considered parts of S1 because they were supervised by the system. The data suggested that S1's autonomy regarding making a decision on engaging SVs was limited. Evidence was found in the SV policy, the government guidance, E2 observations, and the emergency services and the interviews of the CCs' participants. For instance, the government guidance and the SV policy stated that the CC was officially responsible for managing SVs. However, when the police commander in CS2 was asked during stage 1 interview if the CC had full autonomy to task SVs, he said: "*We [Police] will have an oversight as well just to make sure that we are happy this is the role that SVs can participate in"*. This meant that emergency services might intervene if they were not happy with the role that the CC had assigned to an SV. The commander added that decisions of SVs engagement would be done collectively in the SCG (S5). However, the decisions he referred to concerned activating the voluntary sector and not tasking small groups of SVs on the operational level. The observation in E2 and the analyses of the SV policy showed that tasking SVs was done by the FCP (S3). Further, the analysis showed that S1's role was limited to requesting additional resources from the FCP. This point will be discussed further when explaining the resourcing decisions in Subsection 5.2.2.

Nevertheless, the analysis of the CAT 1 interviews revealed that S1 might need to make decisions about SV in real disaster situations. The participants gave examples where S1 units (or members) had to make autonomous decisions when they encountered SVs on the ground. These decisions were not informed by, and may be against, their agencies' policies. For instance, the ambulance representative confirmed in the interview that their autonomy in dealing with SVs was limited. He explained that a paramedic might decide to break the rules and allow an SV to carry on his task if they were doing a good job *"as a paramedic, not a commander, if this person is doing a good job and the casualty does not need immediate treatment, why the hell even I care, if I am happy to do so. I have to do that against my registrations, against my professional qualification, I am happy that that person is sat out there"*. According to this quote, some S1 units might override the restraining policies that limit their autonomy and make a decision on the spot. The ambulance representative's perspective could be well justified systemically. According to the VSM, decision-making should be done at the lowest recursion level possible (Beer, 1985). This would be even more important in very dynamic and vulnerable situations such as disasters.

The above can suggest that the concerns of S1 units might not have been addressed at the managerial level. It can also suggest that the agencies that were represented in S5 might not have the same level of authority to influence decisions. These interpretations were confirmed by the analysis of the researcher's observation of the FCP in E1. The police and fire commanders were dominant in the FCP. The BRC representative was mostly ignored. He was observed sitting down on the side not engaging in discussions and not being consulted during the decision-making process. When interviewed towards the end of E1, the BRC team members expressed resentment and dissatisfaction with their idle experience.

**Finding**

*Some agencies have higher authority in the system-in-focus which can limit S1' autonomy to manage SVs*

<u>The autonomy of the CG as an S1 unit</u>

E1 focused on testing the CG deployment as an S1 unit before and after the officials arrival. Thus, it was an opportunity to understand the roles that the CGs could play in the response and in managing SVs within the system-in-focus.

In Stage 1 interviews, the CG coordinator was asked about the decisions that the CG members could make. The aim of the question was to understand the level of autonomy that the CG can have. The coordinator replied that he could trust the CG members' decisions because they were *"...fairly mature and sensible people..."*. However, he continued to say: *"...I don't think they're gonna be just running off ... making miscellaneous decisions of their own"*. This means that the CG members do not have the autonomy to make decisions of *"their own"*. The CG did not seem to have clarity on the sort of decisions that they could make.

When prompted by the interviewer, the coordinator said that he would be comfortable with the CG members making basic decisions such as providing drinks and buying food for victims: *"in the real scheme of things, if somebody is thirsty, then we'll get him a drink"*. He emphasised that this was the type of decisions that they could do and they might not be comfortable with making bigger decisions. When asked to reflect on making higher-level decisions, the CG's leader stated: *"I think we got to be guided by the emergency services"*. This may show that the CG would prefer to avoid any liability for decisions on serious matters.

However, the officials were more deterministic of the CG' autonomy. When asked during the interview, the EP stated that it was relative: *"They [CGs] will be Self-directed to a degree and they will be tasked by the Forward Control Point [FCP] at the time they set up"*. Hence, while CGs could have a higher level of autonomy before the arrival of officials, they would be tasked and supervised when the officials had arrived at the site. However, this perspective did not seem to be clearly discussed with the CG.

Compared to the CC and the BRC participants, the police and the fire and rescue participants were more careful regarding CGs' autonomy to make decisions. Police and fire agencies are trained to prevent crime, enforce the law and protect human life. Therefore, this might have been the reason they were stricter with allowing untrusted volunteers to make decisions. For the police commander, those volunteers had to adhere to the officials' policies and procedures and follow the formal reporting channels. Yet, it was unclear whether the formal reporting channels would grant the CG a certain level of autonomy. Also, the police officer did not reflect on the level of autonomy that the CG would have before their arrival or before the activation of the CG response.

The different responses about the CG autonomy stated that the CG should work according to formal procedures and under supervision. However, this did not convey a single clear message about the level of their autonomy and whether this level would be different during the CG response or before the activation of the CG response plan.

**Findings**

*The CG was not informed officially about their autonomy. Officials want the CG to follow procedures and be supervised when officials arrive.*

During the interview, the CG coordinator was asked how he would deal with SVs arriving at the site. This question aims to prompt more details about (1) the CG's autonomy and (2) to learn if the system's S1 units are informed on how to deal with SVs. The coordinator hesitantly answered that he could engage SVs within his team if he could identify and communicate with them. He also said that he was willing to make them part of the CG members by giving them CG's PPE and task them as other CG members: *"…assuming they, you know, they're able to sort of, you know, communicate with us then I think that they can, just as easy I'd take somebody out of [the CG] … we'd be able to give them an [CG] jacket so that they can be identified as working for us"*. However, he rectified that these SVs should be known for him and not any stranger. During E1, the CG coordinator saw an SVs breaking into a property. Still, he did not make any efforts to communicate with or to manage him.

Further analysis suggested two factors that can restrict the CG's autonomy regarding SVs. First, the limited CG capability to manage SVs. The CG was small in size and had limited resources. Further, some members did not have the experience and the skills required to take charge of the complexity associated with SVs. Second, the concept of engaging CG was new. Hence, the CG's endeavour to demonstrate that they are trustworthy for officials was observable. Therefore, it would be very risky for the CG to be liable for SVs actions and therefore risk their reputation. The CG coordinator referred to this fact when he commented on engaging SVs: *"…we need to know who they are, they need to have something to identify them"*. The coordinator's comment can mean that the CG is hesitant to take the risk of engaging SVs.

It was clear that the subject of SVs was not discussed within the CG or between the CG and officials. The confusion was evident during stage 1 interviews. For instance, the CG coordinator showed hesitation when he said: *"I **think**, they'll [SVs] be under either my guidance, **or** they'll be under…you know…the next day it **might** be…one of the nominated people in a [CG] jacket"*. However, the CC participants gave clearer answers. For instance, the SEP said: *"[SVs should] be coordinated by somebody that has a link with blue lights or back to the county emergency centre"* and that SVs should communicate through *"…one of the resilience and asset officers, or one of our [county council] officers or district council officer"*. Clearly, the CC did not formally consider any role for the CG to manage SVs. This explains the CG confusion about their autonomy.

**Findings**

- *The CG members are not clear about their autonomy regarding managing SV*
- *CG cannot (formally) manage SVs, even when the response is CG-led*
- *The CG autonomy regarding SVs is not covered by the SV policies.*

In conclusion, S1 units do not enjoy the same level of autonomy to make decisions regarding SVs. This issue was not discussed and formally communicated clearly to the relevant S1 units. This may have created the inconsistent behaviour towards how to deal with SVs in different evolvement stages. Such ambiguity is an internal problematic CD that can negatively impact the system's resilience and effectiveness.

### *5.2.1.2. The Autonomy of SVs*

The autonomy of collaborative SVs was a problematic subject for officials. Occasionally, in CS1, the autonomy question made some official participants uncomfortable during stage 1 interviews. These participants either avoided answering directly or answered from an ideal scenario that may not necessarily represent the actual complexity of the SV phenomenon. For instance, when the police commander was asked about the degree of autonomy that SVs can have, he paused and then laughed commenting *"that is a hard one!"* This indicated that the commander was familiar with the subject and that he was not able to rely on any relevant decisions made in this regard. Instead, he carried on to reflect on the ideal scenario for police, which is controlling and supervising all SVs by police. Similarly, the CC's participants were also unclear about how to reflect on SVs' autonomy. The EP explained that this matter was still under discussion and formal decisions were not made on this matter: *"I cannot give you an answer for that [SVs autonomy] because we have not tested it yet".* However, the SEP provided a flexible answer when she was asked about SVs' autonomy:

*"Well, not being funny, if you [SV] are given a task, as long as you deliver the task I am not bothered how you [SV] do it… they [SVs] can come back to the coordinator and say … here you go I am still alive, job is done".*

The SEP answer can suggest that she was agreeable to granting SVs autonomy providing they do the tasks that officials assigned to them safely. However, The EPM, the SEP's manager, clarified that SVs would need to take directions from officials because officials would have a holistic picture of the emergency. He said: *"if they [SVs] report to us through the process, then yes, to a degree we expect them to follow **some** direction because we know the bigger picture"*. The EPM here was not very strict when he expected SVs to follow *some* direction rather than full supervision. In comparison, the police commander was stricter by saying that SVs should be supervised closely if they wanted to collaborate with police *"…if they [SVs] are going to report and follow the chain then they will be supervised"*.

**Finding**

*There is no collective understanding or agreement among official agencies about SVs' autonomy*

The responses from CS2 participants came identical to those of CS1. However, the CC participants were more deterministic. The said that they had designed a model that restricted the autonomy of collaborative SV. The CCM responded quickly when asked if SVs would have autonomy saying: *"under our model, not at all…"*. However, she admitted that SVs *"…can choose to come, so as that they choose what they do, they can choose whether to stay"*. The SCCO added that *"they can choose to work with us"*. This confirmed the findings form CS1 that SVs had full autonomy to enter or exit the formal process and in choosing what to do.

The analysis above acknowledges SVs' control on the level of autonomy they would accept. Before any collaboration, SVs' first autonomous decision was accepting to collaborate with officials and to be willing to accept supervision: "***if** they [SVs] report to us…"*. Also, it was clear that, from the commander's perspective, police would not collaborate with SVs unless they follow the officials' policies and procedures: *"…**if** they [SVs] are going to report and follow the chain…"*. This meant that SVs *might decide not* to report and might not follow the chain.

A further examination of the data confirmed this analysis. It was found that officials would have a say on SVs' autonomy only with SVs' consent. SVs would express this consent by agreeing to follow the officials' processes, directions and supervision. When asked about whether police can prevent SVs from working autonomously, the police commander confirmed that they did not have the authority to stop SVs from doing uncoordinated tasks. He said: *"What you can't stop of course is that person that just pictures up in the middle of the event and starts doing stuff"*. The CC participants shared a similar perspective. For instance, the EP resented this fact when he said: *"volunteers [SVs], you do not expect it, we cannot force them, they are not statutory duty place"*. However, the BRC representative provided a direct and clear answer. He stressed that SVs have full autonomy: *"In the real world, they [SVs] can have the level of autonomy they want because they do not have to listen to us*". He explained that even in the presence of a formal structure and the presence of the authorities, SVs had the right to decide not to collaborate with officials and undertake tasks independently: *"people can go against that [the formal structure], they are not affiliated and required to comply with the wishes of the organisation"*. Nevertheless, the last quote may refer only to independent SVs (unaffiliated). Still, the analysis showed that even collaborative SVs can decide to exit the official process at any time. It was not clear from the exercises and the interviews whether SVs will be formally contracted during the response. Although registration forms were filled in, this does not make SVs legally required to commit to the response system. A formal contract can enable officials to be more deterministic regarding SVs autonomy.

**Finding**

*SVs have autonomy to decide on their level of autonomy*

Obtaining the CG's perspective on SVs' autonomy was important. Many CG members might be more empathetic towards SVs because they were previously SVs, and still SVs in many officials' perspectives. However, the answers of the CG members were similar to those of officials. The CG's coordinator stated clearly and firmly that he would supervise SVs very closely if he were to task them: *"No, I think straight away, I think that I'd be giving them a task to do and not really wanting them to shy too far away from them".* Further, he stressed that this would be even more applicable if they did not know the SV *"I think especially if they're unknown, we don't know their capabilities"*. The CG's deputy coordinator was orthodoxly strict and objected to engaging SVs in any task: *"for my money, I would tend not to use them [SVs] if could help it"*. The responses of the CG members might suggest a feeling of superiority over SVs.

The EP was asked whether CGs could manage SVS. From his perspective, if the CC asked CGs to manage SVs, then they would have to follow the CC's SVs management process: *"if we…utilise the community groups to manage the SVs then they will follow the same processes"*. Moreover, the EP added that CGs did not have the autonomy to manage SVs and would need to follow the process of the organisation that is supervising them *"…but again if they [CGs] are working with the organised volunteers such as BRC and that kind of thing, then they will follow their process [SVs management]"*. This assertion may contradict the EPO's previous statement that the CG would be *"self-directed"* before the officials arrival. It was evident that the CG and the officials had different expectations and assumption regarding SVs' autonomy.

**Finding**

*There is no agreement on the autonomy of the CG regarding managing SVs*

SVs' autonomy was identified as a major CD. This CD can be internal or external. Internal when autonomy-related complexity is generated by cooperative SVs when they enter the system formally or informally. It is external when the complexity is generated by uncooperative or potentially collaborative SVs. Operationally, this CD can create uncertainty that can decrease S3's confidence in depending on SVs. Hence, it may make the FCP reluctant to engage SVs in the response.

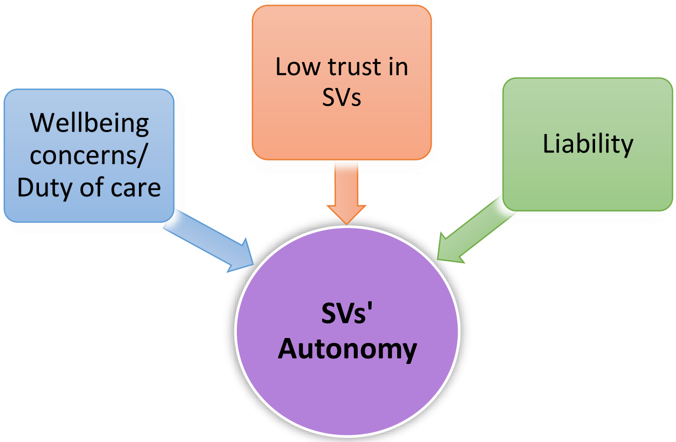
Further analysis revealed three lower-level CDs that could influence the level of autonomy that SVs could have in the response system. See Figure 5-2. The first CD was the low trust in SVs. From the police perspective, this CD was related to a lower-level CD - the unknown background and training of SVs. Police could trust SV because they simply did not know them. The commander explained that: *"Without knowledge of the person's background and training you can't ascertain any decisions that they make at that time is the correct one"*. Although defining what might make a good decision could be debatable, the police commander explained that they still needed to consider the risks that were associated with such decision-making. He said: *"Of course the other thing we are going to watch out for is risk assessments"*. He added that this risk assessment would be dynamic and conducted by an officer on the ground who would assess SVs based on the tasks: *"when we put people out on the ground, [it] will be down to duty police commander who is gonna deploy them [SVs] to risk assess the situation we are into"*.

Hence, these CDs created further complexity for the police – the need for additional risk assessment procedures.

The Second CD was wellbeing concerns. The local councils in the UK are responsible for communities' wellbeing in peace and emergency times. This might explain the emphasis of the CC participants on well-being when asked about the SVs' autonomy. They expressed concerns about SVs' safety if they were given the freedom to access emergency areas and make independent decisions. For instance, the EP commented on SVs' autonomy by saying: *"…there is a little bit…big brother… you know, health and safety work… duty of care"*. The EPM commented that SVs could make decisions but he stressed that such decisions should prioritise keeping them safe: *"Their [SVs] own responsibility for their health and safety".* The latter quote implicitly suggested an acceptance of SVs autonomy because it rendered SVs responsible for their health and safety. However, the EPM still implicitly stated that the CC shares the responsibility for SVs' safety. He said that although the CC did not wish to prevent SVs from contributing, they would have to mitigate the possible consequences of allowing SVs' into risky areas. He said in an emotional tone: *"It is overbearing to say [to SVs] you cannot do anything. What we need to do is to control it to make sure they are doing it as safe as possible"*.

The third CD was liability. Although caring for SVs was evident in the comments of the CC participants, the analysis revealed that there was a legal dimension to the autonomy dilemma. According to the Cabinet Office UK (2013, pp.27–35), local authorities were the main CAT 1 responder to coordinate with SVs. This guidance was not statutory, yet the local authorities would be liable in front of the law if they decided to engage SVs. Liability as a CD will be further explored in Subsection 5.2.2 because it is closely relevant to making resourcing decisions.

**Figure 5-2: Complexity Drivers Related to SVs' Autonomy – Level 2 Themes**




In conclusion, the officials (implicitly or explicitly) perceived SVs' autonomy as a problematic CD. The analysis revealed three themes (sub-CDs) that relate to this main CD. The CD was classified by the research as problematic because the participants mainly revealed problematic complexity when answering the autonomy question. The participants thought that SV autonomy could put the officials in an uncertain and out-of-control position. This was operationally challenging for them regarding engaging SV. Hence, there was an agreement among the participants that solutions were needed to restrict SVs' autonomy when deployed.

## 5.2.2. Resourcing Decisions and Competitive Resources

From a VSM perspective, the FCP (S3) is responsible for making resourcing decisions. In E1, after the SCG had activated the MoU with the voluntary sector, it was up to the FCP (S3) to decide when and where to use volunteers. When interviewed, the CC participants considered SVs as a resource that has the potential to reduce the high pressure on officials' resources. However, the analysis showed that some emergency services were sceptical about the reliability of this resource, especially during the initial response. Further, it was clear that S3 has alternative and more trusted resourcing choices.

The CAT1 participants emphasised the importance of human resources for an effective delivery of the response. The police commander explained that they would need to choose human resources suitable for the task: *"what we gonna try to do [we try to do] is to ensure that we put the right people in the right jobs."* and to be selective of accepting what volunteers offer during the response: *"what they [volunteers] are offering to bring and what of those resources they are willing to bring we can actually utilise"*. The police commander stated that resourcing can be a challenging task in such fast-paced and dynamic situations: "*And that is probably the hardest job in the lot"*.

A further analysis of the previous quotes can indicate that the police commander perceives the challenge as a decision-making problem rather than a shortage of resources. Rephrasing this in a VSM language, the problem can be the inability to manage and exploit existing complexity rather than the availability of supportive complexity. This supports the premise of this research that low resilience and viability may result from the inability to exploit the abundant resources that reside in the environment. Hence, it is important to understand the factors that can influence S3's decision of selecting human resources. In other words, these are the criteria that are important to classify existing complexity according to the proposed complexity classification. Three major categories (CDs) emerged from the analysis: health, safety, and security; training level; and opportunity cost.

#### *5.2.2.1. Health, Safety and Security*

There was an agreement among official participants that health, safety and security were key concerns when making resourcing human capital. From the emergency services perspective, these factors can render SVs support undesired, especially during the response phase. The Participants form voluntary organisations such as the BRC and the CG members shared the same perspective. Two main subthemes emerged from the thematic analysis of the data: protecting citizens and protecting volunteers (SVs).

*Protecting Citizens*

In CS1, the police commander was mostly concerned with the security issues that SVs could cause. He explained that since SVs motives cannot be determined, some SVs might attend to the response area to take advantage of the chaotic situation: *"from a police perspective, well, it is not known what their motives are"*. The SEP expressed the CC's same concern and gave examples of similar incidents that had happened in previous emergencies. One of the incidents happened during a major emergency when some individuals claimed to be SVs and went to a major supermarket asking for goods and equipment. Later, it was reported that these individuals were taking these goods to their homes.

The SEP stressed that there will always be some individuals who will try to exploit the situation for their advantage: *"…that they [some SVs] will make an opportunity out of this [the emergency]*. This security concern was also adopted by the CS2's participants. The CCM emphasised that these concerns are real and based on previous experience. She gave examples of previous floods where individuals were *"…coming in and pinching stuff … stealing stuff from houses"*. She continued that the consequences were that *"…some people refused to evacuate their houses and lived upstairs with downstairs flooded because they thought they are gonna get burgled"*. This caused serious disruption of the emergency services operations and a hindered achieving their goal of keeping people safe.

The operational analysis showed that identifying SVs' identities was a major CD. For officials, an unidentified person is a potential risk. The police commander highlighted this point "*The main thing…really… some form of identity. From the police point of view is identifying people who may be there for burgles reason"*. The commander gave an example from a previous response to an emergency. A group of SVs took permission to access the impacted area to assist with the evacuation. However, when the response was over, multiple robberies were reported.

The ambulance representative referred to extreme cases when individuals would claim fake identities. He exemplified from a previous incident where an SV came in a formal fire commander uniform and managed to take control of and to deploy many fire vehicles to different sites. It was a while before the officials discovered that it was fake and that: *"…he was a volunteer at the museum, nicked the uniform and turned up at the flood in fire uniform"*. Such incidents highly increased the already existing risks and put residents and responders in danger.

Without knowing their human resources, officials would feel overwhelmed and out of control. The police commander said: *"we need to know who they are, they need to identify them so that, you know, we could just see what's going on"*. He added that police will not accept to be accused of the failure of protecting the community. In other words, the police officer showed concerns about damaging his agency's reputation. This is a key CD when it comes to making resourcing decisions.

**Finding**

*Engaging unknown SVs can have security implications for the community. Police and the CC have concerns that some unidentified SVs can have criminal motives.*

The ambulance services participant was concerned about the residents' health and safety. Involving SVs in medical tasks could put casualties' lives in danger. He stressed that he acknowledges SVs' goodwill to help people in danger. However, unprofessional help could worsen casualties' medical conditions. The ambulance representative was particularly sceptical about SVs ability to perform any of the ambulances activities given their complexity: *"From the ambulance perspective, [it is] very difficult to see where you'll be able to put them [SVs]".*

The ambulance participant explained that most rescue activities would happen in the immediate aftermath of the incident. Therefore, local SVs might be injured themselves. In this case, he stressed that injured people would not be in a good condition to offer help to other victims *"An injured rescuer is not good to anyone…"*. However, this particular opinion could be debatable. In fact, the ambulance representative admitted indirectly during the interview that SVs might do a good job in caring for some of the casualties in an emergency scene before that arrival of emergency services. He said: *"…if this person is doing a good job and the causality does not need immediate treatment, why the hell even I care…"*. It was not clear, however, if this statement includes injured SVs who could do a good job. Nevertheless, these concerns might not apply to registered SVs. These are expected to be healthy and have appropriate skills. Yet, the CC, the BRC, and fire and rescue participants in both case studies shared the same concerns.

**Finding**

*SVs might not be physically able or might not have medical skills to support Ambulance*

The CC and ambulance representatives in both case studies did not accept to engage SVs in tasks related to vulnerable people. Vulnerable people could be elderly, special needs, young children and people whose physical or mental functions are restricted. The ambulance representative in CS1 stressed that vulnerable people should be addressed by specially trained rescuers to avoid physical and psychological injuries. Therefore, assigning SVs to care for these people can indeed be a risky choice, especially if the SV's identity and background are not verified. The ambulance representative stressed that *"I cannot put them [SVs] with a kiddy.... all kind of stuff can kick off"*. In agreement, the CG coordinator stressed that it is important to protect vulnerable people and to prevent their information from reaching untrustworthy individuals. He said: *"you can't have the information about, you know, people with disabilities getting into the wrong hands"*. Indeed, vulnerable people can be more prone to abuse. SVs with bad motives could take advantage of the limited abilities of vulnerable people and commit illegal crimes such as stealing.

**Finding**

*Untrained SVs can endanger vulnerable people's health and safety. Safeguarding regulations may limit SVs ability to work alone with vulnerable people.*

<u>*Protecting SVs*</u>

The residents' wellbeing was not the mere officials' concern. In CS1, the EP and the ambulance representative expressed concerns for SVs' welfare. The CC was responsible for managing SVs. Therefore, they had liability concerns regarding SVs' safety when they deploy them. From this consideration, the EP emphasised the need to take care of SVs' wellbeing. He said: *"safeguarding is the main one I think ... to ensure they [SVs] are safe as well as the people they are trying to help are safe"*. The ambulance representative went further and explained that they would be blamed if something wrong happened to SVs that had worked with them. He showed serious concerns when he stated that SVs might be *"volunteering in a good faith, [but] they might come back to me and say you put me in this scenario and now I have got traumatic stress ... I [ambulance representative] have gotta be so careful"*. Clearly, liability was a key issue here.

**Finding**

*Officials may be liable for the wellbeing of SVs they have deployed*

To mitigate such complexity, the emergency services and the CC participants in CS1 stressed that they would involve SVs in basic and risk-free tasks. They further added that they would like to engage SVs only in the recovery phase that is less risky. For instance, the police commander stressed: *"We [police] probably see them [CG and SVs] more in the recovery stage"*. This view was shared by the CC participants. For instance, the EP said that the council perceived SVs' role as part of the community's effort to recover from the damage and to return life into normality: "*... and that [SVs role] would be to assist in the recovery of the community themselves rather than the initial response".* When prompted by the interviewer, all these responders reassured that SVs would not be engaged in the response phase.

**Finding**

*Officials prefer to engage SVs in the recovery phase*

Nevertheless, this solution was not issue-free. Excluding SVs from the response could contradict SVs' expectations. Consequently, this would trigger these SVs to generate problematic complexity for the system, particularly the VRC. Hence, this would create more problematic complexity for S1 and S3 if these SVs decided to exit the system and work autonomously.

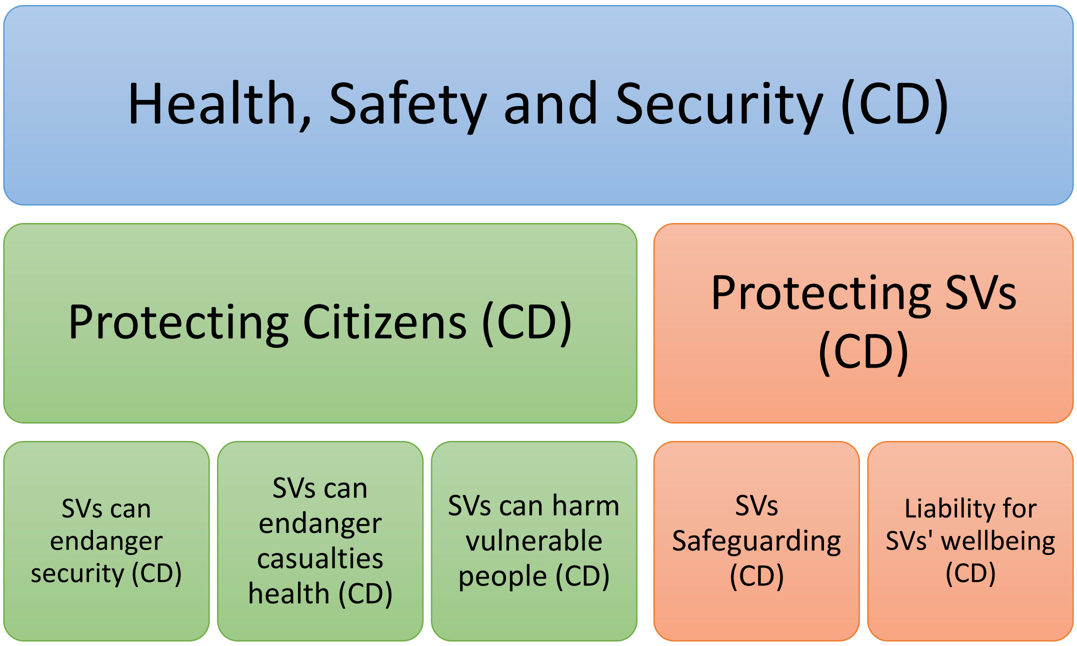
The SV policies and exercises in both case studies did not exclude the CG and SVs from the response phase. Rather, the CG and SVs were engaged in the response operations in both exercises. Hence, forcing SVs out of the response phase may be unrealistic and have proven unpractical. It might have been easy to virtually exclude SVs from the response during the interviews. In reality, the officials do not have the authority and power to apply this solution as explained earlier in this section. This was one of the motives for conducting this research.

E1 demonstrated a scenario where the CG initiated the response before the officials arrival. When the FCP was formed, it maintained the CG's engagement but deployed them to take care of evacuees in the safer areas. Contrary to the participants' concerns, the CG's members acted rationally during E1. The researcher did not observe incidents when the CG put themselves or others in danger. The CG showed that they are very aware of these risks. For instance, the CG waited for officials' approval to perform a door knock. The CG's leader said to the FCP: *"we have not yet done the door knock... we wanted to wait until you [officials] come in to make sure it is safe to go there"*. Clearly, the CG was totally compliant with the officials' instructions. The CG agreed to leave the area when asked to do so by the FCP. Likewise, SV-related issues were not observed during the response in E2.

However, the issue free response was observed in a controlled situation. During real disasters, SVs or the CG's level of collaboration might be different if they witnessed relatives and neighbours in danger. Further, it was unclear whether the volunteers would also be similarly collaborative in a milder scenario such as crossing a water stream that officials consider risky. Some volunteers might have a different perspective and be willing to take a risk.

In summary, the findings in this subsection revealed that health and safety as a major CD have various sub CDs. All of which are significant in influencing the decision of engaging SVs. These CDs are shown in Figure 5-3.

**Figure 5-3: Drivers of the Complexity of Making Resourcing Decision**



### *5.2.2.2. Training Level and Alternative Resources*

The participants identified the training level as a key CD that influenced making resourcing decisions. The police commander said that they would be very busy during the busy response phase and they might not be able to verify SVs' skills: *"But we have got to be careful of the spontaneous volunteers…we don't actually know, physically know, what their skills are"*. Hence, police may prefer obtaining volunteers from voluntary organisations rather than using SVs or CGs. The commander explained that voluntary organisations have highly trained staff, adequate resources, understanding of the multi-agency response, and some have extensive emergency experience: *"But a lot of work at the moment [is] with our [organised] volunteer groups such as the rotary clubs, etc."* because *"…they got members from all different walks of life and you probably have got some highly-trained professionals in one form or another"*.

Interestingly, although the CC is responsible for engaging SVs, the SEP had a similar resourcing perspective when she said that *"… you [we] have always got the organised voluntary sector that has been trained. It is just options… resource options"*. The SEP here referred to the fact that reliable resourcing alternatives exist that could provide quality staff and ready resources when needed. However, the same argument can apply to SVs. They are from all walks of life and have trained individuals. The difference can be that they are unknown and not pre-organised.

When asked about the CGs concept, the official participants said that they *may* have more trust in them than SVs. Yet, they stressed that it was still a new concept that needs to be tested. However, when asked to compare the CG to organised volunteers, it was clear that officials prefer large organisations because they were more trained, equipped, and capable of doing the job professionally without being supervised by officials. This may mean that officials preferred the service that was self-managed and which did not require resources from their agency to manage.

**Finding (CD)**

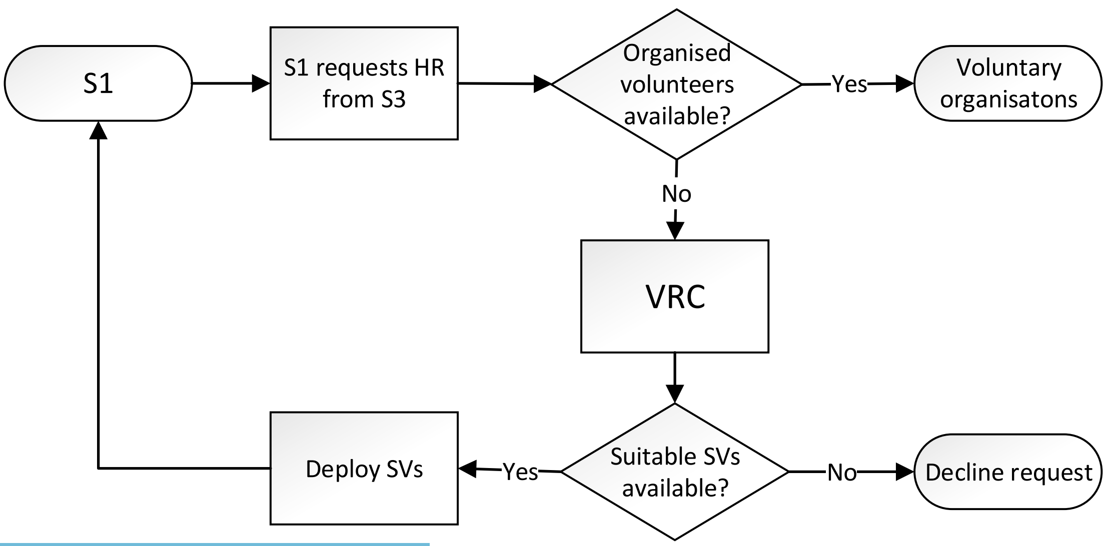
*SVs might not be the officials preferred human resources. Alternative independent and reliable resources are available.*

The official participants said that voluntary organisations were usually available and ready to support upon request during previous disasters. The established relationship between CAT1 responders and the voluntary sector was evident in the exercises. The organised voluntary sector was significantly involved in planning and executing both live exercises. For instance, Rotary groups in CS2 were involved in the VRC's admin tasks such as interviewing SVs. This indicated the trust that the CC had in these organisations.

From officials' perspective, the organised voluntary sector was a much safer and reliable choice. During the interviews, the participants identified large organisations with history and capabilities such as the BRC, Rotary International, and Lions Club International. They also acknowledged smaller organised voluntary groups such as 4x4 and local charities. From resourcing perspective, it would be unlikely for the FCP to engage SVs if organised volunteers were accessible and sufficient. However, engaging SVs can have other benefits that extend the narrower resources perspective. These benefits include social benefits, enhancing communities' resilience, building trust between officials and communities, and enhancing the resilience of the response system by addressing complexity that exists in its environment. Also excluding SVs can making the VRC function, and hence the SV policy redundant.

Figure 5-4 shows the logic that the officials in the two case studies would use when making resourcing decisions. The process shows that officials would first consider voluntary organisations.

**Figure 5-4: The S3' Resourcing Decision Process**



**Finding (CD)**

*The officials may prefer accepting resources from independent and reliable resources such as voluntary organisations over SVs.*

### *5.2.2.3. Opportunity Cost*

The analysis of stage 1 interviews showed that the opportunity cost was a major theme (CD) that can affect SV engagement. The official participants said that engaging SVs may not be cost-free as the word voluntary may suggest. Further, they were concerned that their agencies may not have the capacity to manage SVs. The SV-policy in CS1 implicitly referred to this theme when it stated that *"The County Council will continue to work with other partners… to develop the capacity for* ***additional resources*** *who can be deployed to help manage spontaneous volunteers during civil emergencies"*. Clearly, managing SVs may require significant resources and collaboration among different response agencies. The analysis revealed three factors (CDs) that can contribute to the cost of managing SVs: the cost of equipment, the cost of human resources, and financial support.

*The Cost of Equipment*

The participants stressed that one of the aspects of protecting SVs wellbeing was providing them with personal protective equipment (PPE). Examples of these equipment included reflective jackets, footwear, and helmets. The police officer in CS2 said that they might be encouraged to engage SVs who already have their own PPE in a response: *"SVs with some equipment like reflective jackets with some training can be of great use"*. Although some SVs might have their own basic PPE, responders said that they might need to mitigate for SVs not having PPE. This can be the case with the majority of SVs.

Some incidents (e.g. chemical or gas leakages or fire) might need special PPE that SVs would not be expected to have. This by itself can put additional pressure on the officials' resources. The dilemma for CAT1 participants was that SVs attendance to the area was described to be unpredictable. The CC participants in both case studies explained that maintaining a large stock of PPE would be costly to purchase, store, and maintain. The officials stressed that, currently, it would not be possible for them to stock a large number of PPE, especially with a continuously decreasing budget. However, the SEP explained that the CCs have mitigated for shortages in resources. For instance, the CC in CS2 had a contract with Tesco stores to provide such equipment in the case of emergencies. In the previous floods in CS2, SVs attended local supermarkets and collected what they needed for free. Still, it is not clear how much support these stores can provide.

The ambulance representative said that it might not be necessary to provide SVs with PPE. Instead, he suggested deploying SVs to safer areas where PPE would not be necessary: *"so they will be working in the cold zone. Cold zone means that I can make people work without PPE"*. Despite the importance of providing SVs with equipment and the limited budgets, operational solutions seemed to be available when a strategic decision of engaging SVs is made. Nevertheless, this still can increase the cost of this engagement for officials compared to other available resourcing options.

*The Cost of Human Resources*

The data suggested that SVs can significantly pressure the officials' human resources. Since SVs are unaffiliated individuals, the responders would need to brief, train, and supervise them.

Briefings SVs was one of the tasks that could occupy officials staff especially if SVs attended in large numbers. Both CCs' participants stressed that they would need to deliver safeguarding briefing to all SVs before they are deployed. The SEP pointed out that SVs would need to know the risky areas, the protective cloths that they would need, and how to perform their tasks safely *"So they know where not to go where they can go, whether they have got appropriate footwear, you know, that sort of thing…"*. She added that they would need to explain the incident to SVs to make them aware of the kind of situations that they might find themselves in *"I think they [SVs] need to be aware of the circumstances that they are going into so all part of the briefing that they are given by the coordinator"*. In agreement, the EP said that SVs would go through the officials' process that involved briefing staff before deployment. The police commander summarised by stressing that all types of deployed volunteers (including SVs) should be briefed on the situation by the FCP for them to understand the scale of the emergency, the strategic response, and their role in this response. He said: *"…situational awareness* *amongst all the volunteers from the general command, to make sure everybody is fully aware of what the situation is and their role…"*. The EPM could not agree more with the police commander when he stressed that the SV engagement plan should integrate with the multi-agency response if it was to be practical: *"Actually the one thing we really need to make sure we can do is integrate it [SV plan] into the overall emergency response…"*. The EP added that this integration would include inducting SVs on the officials' response process *"By going through our own processes, we [CC] will brief them, give them health and safety guidance, very briefly"*.

However, such pressure on resources could be mitigated. For instance, the response system made an agreement with the BRC to assist in managing SVs. In previous disasters, the BRC could attract SVs to be registered and deployed as a BRC staff. During E2, the BRC supported the VRC with their own staff. The BRC helped the CC in preparing training materials for SVs and running the registration process in the VRC. Experienced BRC staff acted as higher-level supervisors for the interviewers. These supervisors were consulted about difficult cases – e.g. the earlier example from E2 when the author played the role of an SVs with back pain.

The second source of pressure on officials' human resources is SV supervision. As per the SV policy, SVs need to be supervised when deployed. In E2, every group of SVs were assigned a supervisor who briefed them and accompanied them to the response area. Although it was a planned exercise, a bottleneck could be observed in the deployment room. When the VRC deployment staff were enquired about delays in deployment, they said that the number of supervisors is not enough. It was unclear how the emergency services' supervisors would manage a large number of SVs in real-life situations when they would be concurrently supervising their own teams. As it was the case in equipment, maybe it is unfeasible to employ additional supervisors in peace times to be part of the response system. Figure 5-5 summarises the identified human resources CDs.

**Figure 5-5: The Human Resources CDs Associated with SVs Engagement**


*<u>Financial Support</u>*

The findings show that volunteers may ask officials to provide them with financial support. The CG participants said in the interviews that they expect local authorities to support them in buying a stock of basic community needs such as food supplies, nappies for babies, and animal food. The CG's coordinator explained that since they were prone to floods, they might be trapped in the area for a certain period. Hence, he said: "***Currently***, *this form here is to go for some extra funding just for the battle box really and, you know, battle box, space blankets, first aid kit, head torches, hand torches, miscellaneous stationery, things like clip points, pens…"*. As this quote suggested, the list is comprehensive, which showed the CG's high expectations. The CG expected to be provided with this support as a preparedness measure rather than during an actual response.

Nevertheless, the coordinator continued to say that they would expect the authorities to provide more financial aid (even in peace times) for them to feel that their voluntary work was appreciated and that their voluntary work *"…doesn't feel like one-way traffic and I think that's what I'm after, a little bit of two-way traffic"*. When prompted to provide details on why they would need such financial aid, the CG's coordinator clarified that it was to cover regular training and transportation. He complained that the CC had not supported them in financing the fuel. Therefore, he stressed that *"…if the government and all the county want to continue with **asking** people into doing voluntary work, my idea is that they should at least finance something"*. The CG coordinator was clearly saying that for them to collaborate, officials would need to provide resources. This can generate extra problematic complexity for officials.

The EPM was aware of the CG's financial expectations. During the interview, he expressed disappointment that the CG had asked the CC to pave their main road as a condition to participate in the exercise. In a confirmatory note to the EPM claims, the CG leader expressed dissatisfaction of the level of services in his village when he said: *"we aren't able to put flowers out down the road or something that we are fairly desperate to do"*. Negotiating for services that are not related to disasters response was indeed interesting. It was evident that the CG expected a relationship with the CC that extends beyond financing response activities in return for their collaboration with officials.

To summarise, subsection 5.2.2 showed that there are different CDs that can influence the feasibility of engaging SVs as a resource from the officials' perspective. The higher-level CDs involved (1) training and competitive resources and (2) opportunity cost. Most of the officials think that these CDs can generate problematic complexity that overweighs the distinguished supportive complexity. Hence, managing these CDs to generate more supportive complexity and less problematic complexity may encourage officials to engage SVs in their operations.

### 5.2.3. Information and Local Knowledge

The intelligence function in the VSM concerns gathering information about the environment during the response. This section explores the data to locate the intelligence-related CDs that were related to engaging SVs. Analysing the data revealed that there are two major categories: local knowledge and gathering information during the response.

#### *5.2.3.1. Local Knowledge*

This involved knowing the response area and its residents. This knowledge was very important for supporting responders' operations. All participants acknowledged that if SVs belonged to the impacted area then they would be a very important source of local information. For instance, SVs might inform the responders about the existence of vulnerable people in some properties, the condition of local roads and footpaths, and alternative unknown ways to access blocked areas. Other information could be critical such as the storage places of dangerous materials. The CG leader expressed an awareness of such contribution to the officials' response *"Local knowledge is a big thing to have… You know, we've [CGs] got the maps, we know the area"*. The SEP explained that whatever information emergency services might have, local SVs would be much more familiar with their environment *"they [SVs] are more familiar with the community than you [responders] are"*. The EP reflected on the operational side and said that locals could direct emergency responders to critical cases that would need immediate care. He said: *"they [CGs] also put that local knowledge, in that expertise they know where the vulnerabilities lie that includes vulnerable people"*.

Although there was a wide acknowledgement among participants that SVs have the important local knowledge, none of them reflected on the implications of depending on SVs for learning about the area. It seemed that there were no previous experiences were SVs claimed to have that knowledge and provided inaccurate or misleading information (problematic complexity). However, this possibility must have been considered by the emergency responders who witnessed SVs with either fake IDs or with counterproductive motives as reported in the previous section. Maybe the officials were considering local SVs when they talked about obtaining local knowledge from SVs. The police officer, the ambulance representative, and the LA's participants reported fake SVs being strangers to the area.

#### *5.2.3.2. Gathering Information*

The other important aspect of the intelligence function was to keep decision makers up-to-date with the progress of the incident and with the emerging critical situations that need an urgent attention. As the emergency services participants said, local SVs can be the only source of such information before officials arrival at the scene. Local SVs would usually try to check on neighbours, family members, and on the areas prone to high damage. During this initial response, SVs would assess the aspects that would need to be addressed by emergency responders and they might do the tasks that they think they can manage. Making this information available to the SCG or the TCG in the early stages will facilitate effective planning and efficient coordination of the multi-agency response.

The EP confirmed this particular role that SVs could play and said that the information provided by SVs can be warning signals for officials. He continued to explain that the significance of depending on SVs for this intelligence function was that it would convey information much quicker. He said that *"They [CG] can get information…warning and informing very quickly on the ground"*. Indeed, waiting for emergency services to gather information can significantly limit the efficiency of S4 and negatively impact the response quality. However, getting the information quickly to officials would require effective communication channels with SVs. This was available with the CG during E1. This could have been the reason why the EPO's latter quote promoted the CG as the source of information. The CC recognised the CG, knew their members, and had engaged them officially in the initial response. Therefore, the CG could reach the higher management level faster than an ordinary SV. Further, the information provided by the CG would be considered more trustworthy compared to SVs. Still, this still suggests that collaborating with SVs in the community can enhance the trustworthiness of SVs and support the system's S4.

SVs may also be an important source of information after the officials' arrival. The emergency services participants stated clearly that they would not be able to cover every spot of the impacted area. The ambulance representative highlighted this when he was asked if they can manage SVs: *"We [officials] do not have the manpower [necessary to control SVs]"*. Hence, SVs have the potential to be the officials' eyes and ears where officials cannot attend. This can extend the effectiveness of the officials' intelligence function. The EPM provided the management's perspective on this aspect and emphasised that SVs could indeed be part of the intelligence function of their coordinated response. When he was asked about the tasks that SVs can do to support the response, he summarised *"So anything from local information, real-time intelligence to activities especially because they have a skill, or anything useful for us or the community"*. In the quote, information gathering and intelligence came first in what the management wanted SVs to do. As it was the case before the officials arrival, the information provided by SVs would help officials in prioritising their tasks and hence, increase efficiency and resilience. The CG's coordinator was aware of this point when he was asked about the tasks that they could do. He stated that they could help officials in prioritising by reporting needs: *"Prioritising, that would be your [CG] coordinate, if something' s needed, you can get on to the emergency services, they would grade it as a* *priority call"*. However, the CG' leader seemed to be confident that officials would respond to all the requests that his group would make, which may not be realistic from officials' perspective.

# 5.3. COMPLEXITY ANALYSIS

## 5.3.1. Complexity Classification

The four types of complexity that were introduced in the complexity classification proposition were observed in the analysis of the exercises and the interviews. The data is large in size and would not be feasible to extensively discuss the four types in this chapter. However, examples are presented in this section and a summary of these examples are shown in Table 5-1 and Table 5-2 at the end of the section.

### *5.3.1.1. Internal Problematic*

The VRC was the area where evidence of problematic complexity that is generated by staff was identified. For instance, as part of the author's role as participative observant, he played an SVs and went through the registration process in E2. He declared to the interviewer that he had a back pain. Yet, he requested to do manual fieldwork. Although the interviewer declined initially, with little negotiations the interviewer agreed and gave the author a fieldwork permission. Yet, a supervisor was consulted and the decision was modified to only distribute flyers in the field without performing a physically demanding work. The inexperienced interviewer (CD) generated a complexity that was passed to the supervisor and interrupted what she was doing. Additional problematic complexity would have been caused if this form had gone through (e.g. injury during field work).

When interviewed in the waiting room in E2, SVs said that they had not been told about the nature of the disaster and were not updated while they were waiting. This was identified as internal problematic complexity that might have resulted from gaps in the plan or from communication issues within the response system (CDs). This made the SVs feel ignored. Another example of internal problematic complexity was obtained during a group interview with SVs in the waiting room. Three SVs said that the forms were not informative enough for them *"…we need to have a list to know what tasks are* *available…”*. The added that this created confusion regarding the tasks that were available. This complexity was generated by the registration forms (CD).

### *5.3.1.2. Internal Supportive*

However, the example of playing the SV who had back pain in subsection above can demonstrate internal supportive complexity. Having an experienced supervisor (CD) near the interviewers facilitated a quick treatment of challenging cases and mitigating for undesired complexity that might have escalated after deployment.

Another example of internal supportive complexity that was observed during E1 is the well-coordinated response of the blue lights agencies. For instance, the CAT 1 agencies had an agreement to use a shared technical language. This facilitated efficient and effective communication and mitigated against any misunderstanding that may generate negative consequences. The EP in CS1said: *“We [Officials] have done it [agreed on common language] … and it worked very well”.*

Additionally, the complexity that the CG generated during the response was mostly internal supportive. For instance, the CG helped in evacuating residents before the officials’ arrival. Further, the CG activities freed up the officials’ human resources to focus on responding in riskiest areas. The SV-policy was the CD that facilitated the generation of this complexity.

### *5.3.1.3. External Problematic*

Despite being external, this complexity was observed in the VRC in E2. The VRC staff were interviewed to inquire about the reasons for the delayed deployment of SVs. Many SVs were complaining that they waited for hours without being deployed. The VRC staff said that the number of supervisors was not enough to meet the need. This problematic complexity was external to the VRC because they had no control over them. However, this can be an internal problematic complexity form the system-in-focus perspective.

The VRC staff said that a second reason for the delay in deployment was that they did not receive enough requests for SVs from the control room. This complexity was a consequence of two potential external problematic complexities. The first was the overwhelming conditions on the ground that might have prevented S1 from planning and requesting additional resources. The second might have been the nature of the incident that rendered SVs skills unsuitable for the tasks.

The CC's participants in the CS2 provided an example from previous floods of external problematic complexity. During those floods, social media was much more effective in reaching to the communities than the local authorities. The senior civil contingencies officer said that some communities could self-organise in a short time and established groups on social media. These groups attracted the attention and became sources of information for and coordinators of potential SVs. Inaccurate information was disseminated. Consequently, a large number of SVs turned up to the incident area. The CCM said that they felt that they lost the battle with social media and the control over the situation.

### *5.3.1.4. External Supportive*

Given the nature of the exercises, this type of complexity was not sufficiently observed. The exercises did not involve autonomous SVs or unaffiliated players (external). However, stage 1 interviews provided diverse examples where SVs supported the official response. For instance, the police commander in CS2 referenced an incident where autonomous SVs were very helpful. Three days before the interview there was an accident on the motorway in the county. A group of SVs parked their cars and started directing traffic away from the accident. The police commander said that this was *"brilliant...stopping their car and helping direct cars".* Procedures to communicate with such SVs, especially if they have the right equipment would have helped SVs to enhance the external supportive complexity they generated for police: *"SVs in such cases are welcome but you need to send them guidance quickly and say do not send them [cars] this way send them that way. SVs with some equipment like reflective jackets with some training can be of great use"*.

Examples of the four types of complexity can be found in Table 5-1 and Table 5-2.

**Table 5-1: Data Examples of Four Types of Complexity**

| | **Supportive C** | **CD** | **Problematic C** | **CD** |
|---|---|---|---|---|
| **Internal** | VSM's S2<br>1. The blue lights units worked in harmony<br>2. The CG worked in harmony with officials<br>3. Enhanced communication among S1 units | VSM's S2<br>1. & 3. Having common language *"We [Officials] have done it [agreed on common language]…and it worked very well"*<br>2. Cooperative CG | VSM's S2<br>1. Not Sharing formal S2 Equipment with the CG<br>2. The radio system required some time to set up<br>3. The BRC units were ignored | VSM's S2<br>1. Lack of policies and procedures<br>2. Technology/IT<br>3. Politics/planning |
| | VRC<br>1. A supervisor corrected wrong decision.<br>2. Happy demanding SV | VRC<br>1. & 2. Convincing staff | VRC<br>1. Long waiting time for deployment<br>2. Wrong SV deployment decisions<br>3. Staff did not brief SVs on the incident | VRC<br>1. (a) A limited number of supervisors<br>(b) Slow process<br>2. Inexperienced staff<br>3. Plan, management |
| **External** | VSM's S2<br>1. SV shared knowledge on intentions and numbers of SVs in the area | VSM's S2<br>1. Supportive SV | VSM's S2<br>1. Technical issues with Resilience Direct | VSM's S2<br>1. Technology/IT |
| | VRC<br>1. Many SVs were deployed | VRC<br>1. Suitable SVs attended to the VRC | VRC<br>1. Staff had problems dealing with a drunk SV and filling his form.<br>2. Long waiting time for deployment | VRC<br>1. Problematic SV<br>2. Poor demand for SVs service |

**Table 5-2: Data Examples of Four Types of Complexity**

| | **Supportive** | **Problematic** |
|---|---|---|
| **Internal** | Resources (CD)<br>• SVs can have some experienced individuals who can be tasked to brief other SVs.<br>• CGs might be able to purchase resources independently.<br>• SVs can provide physical resources<br>• *“we'd [CG] be able to give them [SVs] an avert jacket so that they can be identified as working for us”*<br>Health & Safety (CD)<br>• The CG rescued an injured person<br>• The CG evacuated the residents<br>• CG members did not put themselves in danger<br>• The CG closed the roads to prevented further injuries<br>Control (CD)<br>• The CG followed formal procedures<br>Communication (CD)<br>• The CG created a new communication channel between the officials and the community<br>Intelligence (CD)<br>The CG shared their local knowledge of a shortcut to arrive at the impacted area. | Resources (CD)<br>• The number of official staff to brief SVs is limited<br>• CG size is small *“We won't have enough [CG] members to do that [Cover all tasks]”*<br>• The preparedness budget to support CGs is limited<br>• CG had unrealistic financial expectations: *“if the county or the council want us[CG] to do voluntary work then I think that they should meet expenses to put things into place”*<br>• SVs can overwhelm officials with the wrong resources *“ we had SVs turned up with rescue boats and things like that but they were turned away… they were in the wrong place with the wrong equipment”*<br>Coordination (CD)<br>• CG members had internal coordination issues<br>• Political/communication issues: the parish Council chair was not contacted.<br>• The CG members did not update evacuees on the incident.<br>Reliability (CD)<br>• CG did not have the skills to deal with an unconscious person although they had a registered nurse in the team<br>• CG members failed (did not) to contact a person whose house was impacted by the explosion.<br>• CG cannot respond unless they get approval.<br>Control (CD)<br>• CG did not have autonomy to initiate a response.<br>• A CG team leader was not sure what his role was |

| | | |
|---|---|---|
| | | • A CG team leader was acting as S3 on some occasions when the coordinator was idle.<br>• Organisation and communication<br>• CG member had challenges contacting LA to activate their response.<br>• CG team leaders making a decision on SVs<br>• CG coordinator taking several roles (functions)<br>• CG coordinator was interrupted frequently by the CG members. |
| **External** | Resources (CD)<br>• Autonomous SVs brought their own resources.<br>• Autonomous SVs donated resources to officials and supervised SVs.<br>Health and safety (CD)<br>• SVs broke into a house to help trapped people (+-)<br>Communication (CD)<br>CG reported the incident and provided a trustworthy information on its scale and nature. | Resources (CD)<br>• Autonomous SVs can ask officials to provide them with PPE and other resources.<br>• An overwhelming number of autonomous SVs *"Nobody is gonna chuck them [SVs] out of the way because we do not have the manpower to chuck them out of the way"*<br>Health & Safety (CD)<br>• An SVs broke into a property and did not come out<br>• An unexploded bomb was found on the site.<br>The parish Council chair came to the rest centre and disturbed the operations. |

## 5.4. VARIETY AND COMPLEXITY FLOW

In both exercises, the VRC only passed complexity to and received complexity from the FCP. Variety was not observed during the operations of the VRC. The observation showed that the VRC staff were only concerned with serving the SVs who had arrived at their premise. They welcomed them, dealt with the challenging cases, and attempted to meet their requests for prompt deployment. These activities act on what is distinguished and did not include any prediction of what might happen. The reason was that these tasks were already overwhelming. For instance, a VRC's staff said in an interview during the exercise: *"We need to make people feel comfortable and welcomed…I need to make sure they fill in the forms right…and pass them to my colleagues for the next stage…"*. And about the challenges that they consider during their job she said: *"to make sure that people give their phone number[s] for safety reasons…who are going out to do something are contactable…"* and dealing with challenging people: *"We had somebody who was drunk and they did not want to fill in the form…we need to find a way to persuade them…"*. However, this

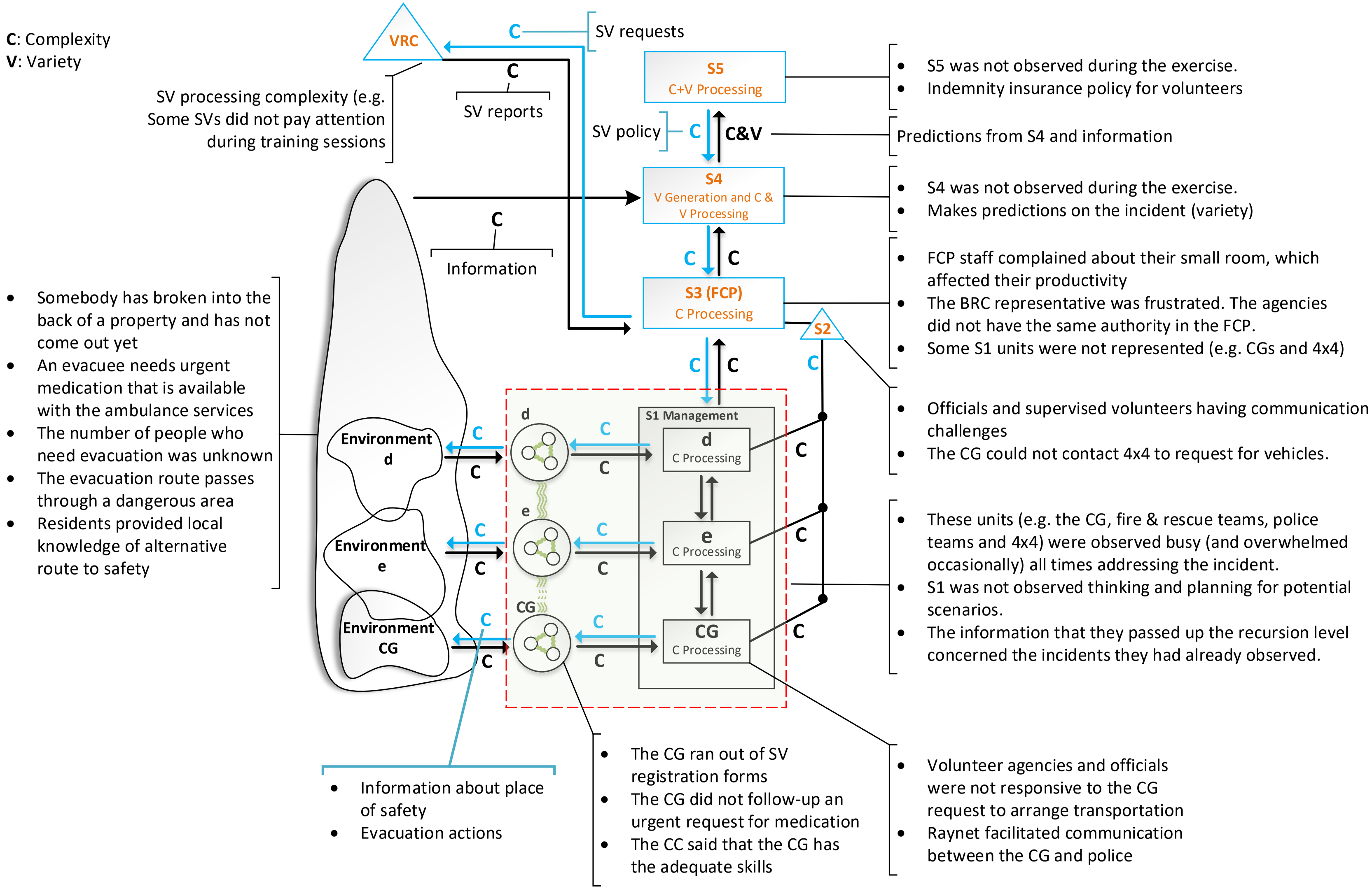
Although the design of the VRC capacity was made to meet a predicted number of SVs, this prediction was not made at the VRC level. Rather, the design was stated in the SV policy and the capacity was decided in the planning meetings that preceded the exercises (S5). Hence, the VRC did not report potential states to S3 neither it processed it.

***Finding***

*S2 acted on complexity and did not process nor create variety during operations.*

Detailed examples of variety and complexity and where they were communicated and processed are shown in Figure 5-6. The figure validates the model that was proposed in Chapter 2. As shown in the figure, variety was only observed in S4 and S5 while examples of complexity were observed in the entire system.

**Figure 5-6: Analysis of the Observed Complexity and its Movement**



## 5.5. THE DYNAMICS OF COMPLEXITY DRIVERS

The CDs that were identified in Table 5-1 and Table 5-2 generated different types of complexity. For instance, the interviewer who made the wrong decision by assigning physical work to an SV with back pain was mostly supportive and successfully managed to register a large number of SVs. Hence this internal CD was identified as a supportive CD for the VRC. On the other hand, the IT-related issues that were observed. For instance, the problems of Resilience Direct. Also, the limited number of radio units would be an issue if CGs requested these units during a real disaster.

As it can be seen in Table 5-3, CDs were classified according to the dominant type of complexity they generated. For instance, the registration forms were classified as supportive CDs because they were most useful. This was confirmed by the interviewed SVs. The feedback of the long paperwork and not having task lists in the forms were problematic complexity that was generated by the forms. Yet, these were minor compared to the supportive complexity that they generated.

To validate the dynamic aspect of the CD model, the author observed a group of SVs who went through the registration process - from the welcoming stage until they were deployment was due. The following incident is an example of this validity. An SV came to the VRC and asked questions at the door before he decided to start the registration process. He appreciated the VRC principle and said that he would encourage other SVs to attend. Hence, he was classified at that point as an external supportive CD. It was likely that he will communicate with other SVs to advise them to attend to the VRC (supportive complexity). During the interviews, he was cooperative with staff and completed the forms and the interviews quickly. By the end of this process, he formally became part of the VRC resources. Hence, his classification changed to internal supportive. However, in the deployment room, the person became angry because he waited for more than 2 hours without being deployed. He started to show challenging behaviour. For instance, he entered a no access area in a closed bar and tried to access the drinks. He also started to talk with SVs in the waiting room and encouraged them to leave if not deployed soon. Hence, the classification of this SV (and the impatient SVs) changed to internal problematic. Shortly after, this person decided to leave the VRC. Hence, he became an external CD. The type of complexity that he would generate in the operations area (supportive or problematic) would determine his new classification. See Table 5-3.

**Table 5-3: Examples of the Dynamicity of CDs**

| VRC CDs | Supportive | Problematic |
|---|---|---|
| **Internal** | The observed SV1 (Chris)<br>**1.** Chris attends to the VRC and encourages others to attend.<br>**2.** Chris enrols and collaborates during the registration.<br>*The observed SV2 (John)*<br>**1.** John approaches the VRC directly.<br>*Other CDs*<br>**a.** Modified policy to address SVs<br>Modified shorter registration forms. | The observed SV1 (Chris)<br>**3.** Chris creates problems while waiting for deployment.<br>*The observed SV2 (John)*<br>**2.** John demonstrated challenging behaviour during deployment because his expectations were not met.<br>*Other CDs*<br>**b.** The response policy does not address SVs<br>**c.** Long registration forms |
| **External** | The observed SV1 (Chris)<br>**4.** Chris leaves the VRC and discourages others from attending to the VRC (hypothetical).<br>*The observed SV2 (John)*<br>**3.** John exits the VRC and works autonomously. He was a professional medic and helped in providing first aid (hypothetical). | The observed SV1 (Chris)<br>**5.** Chris operates autonomously in the area and creates problems for the officials (hypothetical).<br>*The observed SV2 (John)*<br>**4.** N/A |

The CG during E1 was another example of the validity of dynamicity of CDs. Before the activation of the CG plan, the CG was an external CD whose complexity was not identified. However, after the officials arrival and the brief that the CG coordinator gave to the FCP, they acknowledged the CG as a supportive CD that had generated supportive complexity. Hence, they engaged the CG in the system and rendered him an internal CD. After the engagement, the FCP did not closely supervise the CG's operations because of the established trust.

## 5.6. COMPLEXITY REGULATION BY THE VRC

The VRC (S2) performed the VSM's two complexity regulation functions – attenuation and amplification. Yet, the analysis showed that these functions often behaved differently from what is suggested by the VSM.

For attenuation, the VRC created an attraction point for SVs to remove most SVs and their associated complexity from the operations site. In practice, the VRC addressed SVs on behalf of S1. Theoretically, the VRC attenuated part of the environmental complexity that S1 had to deal with. This did not comply with the VSM where S2 is not supposed to communicate with or address the environment. Furthermore, the SV-related residual complexity that used to arrive at S3 was attenuated by the VRC. However, this is a result of attenuating complexity that S1 had to deal with.

The attenuation function of the VRC was effective. Nevertheless, is not clear if it will be as effective during real disasters. The exercises were arranged events. It was expected that most of the players would comply with the exercise plan (e.g. SVs attend to the VRC and officials deploy SVs). However, the observation that was made in the exercises showed indications of what could happen if the SVs' expectations were not addressed in the VRC. In the E1, problematic complexity was observed when some SVs complained about the long registration process, that they were not assigned the kind of tasks they would have liked to do, and communication procedures (e.g. that they did not know the VRC location). In E2, some SVs waited for hours without being deployed, others said that they were not updated about the incident and did not know how long they were expected to wait. Other SVs said that they did not know what tasks were available in the VRC and that they might be offered tasks that they would not do. In real-life situations, such problematic complexity can make SVs exit the VRC back to the environment, which would negatively impact the attenuation function of the VRC.

The second complexity management function that the VRC performed was the amplification of the complexity that was heading from the environment towards S4. Information about skills, numbers, motives, and background of SVs was not accessible by S4. However, the VRC collected, processed, and organised this complexity. This was then passed to the FCP and S4. This function was different from the attenuation function because it did not reduce the information load that was passed to the metasystem. Rather, the registration forms and the face-to-face interviews revealed (unfolded) the SVs' identify, their motives, skills, training, background, health status, and the tasks that they would like to do. This comprehensive information would not have been available without the VRC.

Another amplification function was enhancing the system's ability to apply its procedures on SVs. The SV assessment that was done in the forms and interviews were based on criteria that were decided by the response system (e.g. health and safety and task requirements). During the interviews, the VRC staff discussed with SVs the possible roles that they could do based on in the information they provide. Through this discussion, SVs could learn about the risks involved in the tasks, the needed skills to address different tasks, and the tasks they could do. Further, the induction and the brief training materials that were given to SVs in the VRC amplified the system's ability to communicate their induction and training to a large number of SVs. The fire commander in CS2 was aware of the significant support from the VRC when he said: *"The role of the VRC is important because it is verifying those people, what they can and what they cannot do.... that sort of decision making".*

Again, the S2 amplification function was located on two channels that were not consistent with the traditional VSM. The first amplification function worked on the complexity that was passing from the environment to S3 and S4 (SVs information). This was the opposite direction of traditional amplification. S2 increased the complexity that was passing to the system instead of reducing it. However, the second amplification role (amplified the S3 capacity to communicate and manage SVs) was consistent with the VSM logic of amplification. Still, the VSM does not contain an additional S2 that can perform this role.

## 5.7. SUMMARY

This chapter explored the SV-related complexity and validated the relevant conceptual models that were proposed in Chapter 2. First, the SV complexity was classified as per the conceptual proposition of complexity classification. It was found that the proposed complexity classification can support decisionmakers to timely reflect on the type of distinctions that they observe. Further, this classification facilitated a new perspective of SV – that is they can be operationally useful rather than perceiving them as a problem. The problematic aspects of this complexity could be isolated and addressed separately.

Second, the CD model was also verified. Individual SVs, the CG and other CDs were also classified successfully according to the CD model. The benefit of this model for the operations was evident. For instance, when the CG was classified by the FCP as a supportive CD and was consequently minimally supervised. The analysis of the exercise data also verified the dynamicity of CDs. Examples were provided were the same CD (e.g. SV) generated different types of complexity in different stages of the exercise. Hence, the classification of this CD was changing accordingly.

Lastly, the findings in this chapter showed that the proposed variety and complexity flow model is valid. The observed system was only dealing with overwhelming complexity. S3 was not observed studying the potential states of the system. When this was needed, they delegated or escalated the task. Their main concern was to address the already manifested and critical complexity.

# CHAPTER 6

# DISCUSSION

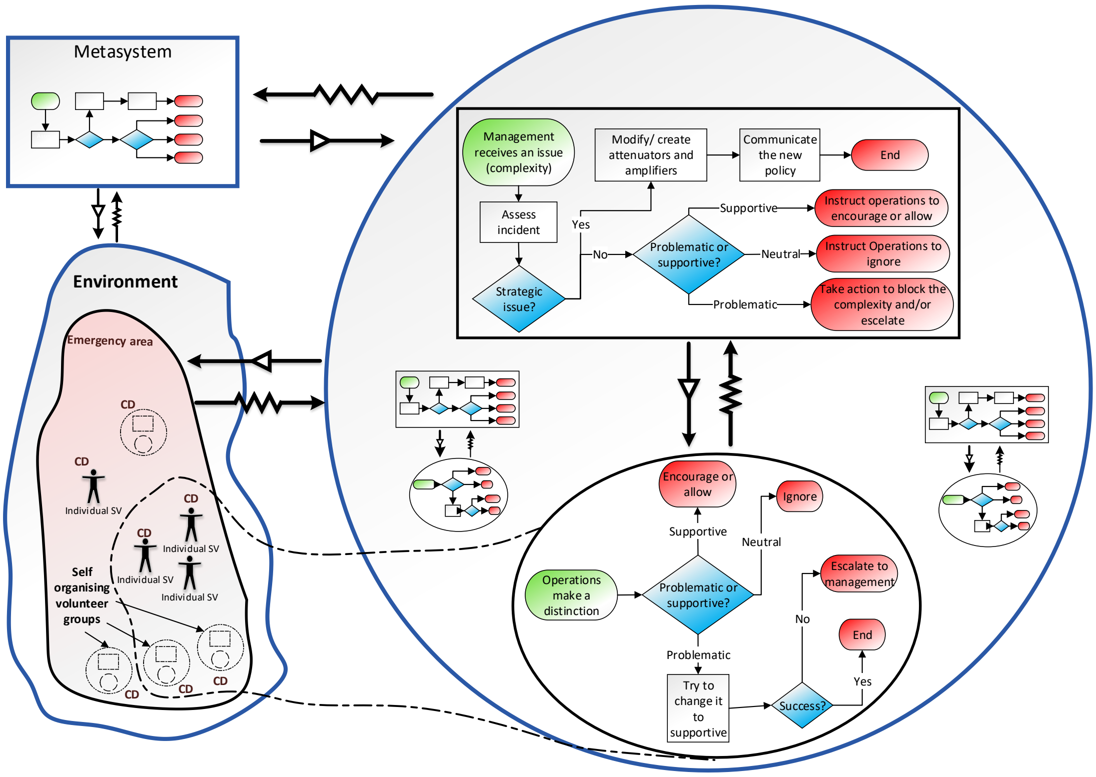
## 6.1. INTRODUCTION

This chapter discusses the validity of the proposed comprehensive model in light of the findings and the existing literature. The comprehensive model results from a systemic and VSM analysis of the system-in-focus. The significance of this model is that it embeds the conceptual models and propositions that were developed in Chapter 2. These propositions involve the notions of boundaries, complexity and variety, complexity classification and complexity regulation (i.e. attenuation and amplification).

The proposed comprehensive model (Figure 6-1) argued that systems' boundaries should be flexible to extend and acquire environmental elements (SVs) as resources. These resources can increase the system's resilience and its complexity to achieve the requisite complexity that is required for viability (Ashby, 1957; Beer, 1979; Espejo and Reyes, 2011) during disasters. Also, the model used the proposed conceptual distinction that was made in Chapter 2 between complexity and variety. This distinction defined complexity as the manifested and experienced states, and argued that priority should be given to addressing complexity by operations during disasters.

Lastly, the comprehensive model adopted the proposed novel classifications of complexity and its generators (CDs). The premise was that these classifications can facilitate rapid decision-making on the operational level and enable the system to respond to different types of emerging complexity. As a result, using this classification can enhance the resilience of the VSM during disasters. An example of how this classification can be used in the comprehensive model was presented in the decision-making flowcharts within the comprehensive model See Figure 6-1.

**Figure 6-1: The Proposed Comprehensive Model**




Section 6.2 of this chapter discusses the systemic characteristics of the system. Two main themes emerged from the findings: the notions of (1) boundaries and (2) identity (Table 4-6). The relationship between these notions, the environment and higher resilience are also discussed. New propositions and novel definitions of these notions are presented. These propositions are argued to facilitate higher resilience and viability during disasters.

Sections 6.3 discusses the viable characteristics of the response system. Section 6.3.1 discusses the functional characteristics of the VSM (see Subsection 2.4.2). The finding shows that the system-in-focus contained an additional S2 function. The section discusses whether this experience has enhanced the system's viability and resilience. Section 6.3.2 discusses the system's managerial characteristics. This mainly concerns the system's complexity management practices compared to what is suggested by the VSM. This includes a reflection on the conceptual proposition that distinguished between variety and complexity (Subsection 2.6.1); and the need for the proposed complexity classification and the CD model.

Section 6.4 combines the propositions and the conclusions of the previous sections and uses them to improve the comprehensive model.

# 6.2. THE SYSTEMIC CHARACTERISTICS

This section addresses the first part of the following research question:

- What are the systemic and viable characteristics of the emergency response system that contribute to its resilience?

Four major systemic themes emerged from the findings that were relevant to the comprehensive model and to VSM's resilience during disasters: boundaries permeability (Findings in Sections 4.2.2 and 4.3 and Table 4-6), ethics, identity (findings in sections 4.2 and 5.2, and Figure 5-3), and having holistic worldview findings in Subsection 4.3.2.1 and Figure 4-12).

## *6.2.1.* The Notion of Boundary Permeability

The findings in Chapter 4 showed that the response system had permeable boundaries that allowed additional human and physical resources to enter the system (Table 4-6). This permeability was necessary for the system to adapt to the overwhelming complexity and enhance its resilience. The analysis in Chapter 4 also showed that the early stages of the system evolvement (before activation) was less resilient because their boundaries were impermeable (subsection 4.2.1.1). The decision-makers were unable to *formally* utilise the resources in the environment (e.g. SVs) – see Table 4-6. The notion of boundaries is discussed extensively in the system thinking literature (e.g. Jevnaker, 2003; Chick and Dow, 2005; Mingers, 2006; Checkland and Poulter, 2010). This literature is reviewed for perspectives on the notion of boundaries permeability in light of the findings of this research.

Hernes and Paulsen (2003) assert that the notion of boundaries is often manipulated and defined to address theoretical needs. This means that the nature of boundaries (e.g. stable or dynamic) is usually imposed on the system for theoretical reasons rather than for addressing the complex reality. Therefore, Hernes and Paulsen (2003, p. 8) stress the need for *"...perspectives that allow boundary selection from realities rather than from* *analytical neatness"*. Chick and Dow (2005) agree that a disconnection between reality and theory exists when studying social systems and refer to Lawson's (1997, 2003, 2004) claim that closed systems do not exist in the social realm. Checkland and Poulter (2010) support the previous claims when they state that modelled boundaries are arbitrary and change over time. The findings in Chapter 4 empirically support these arguments in the disasters context. In peace times, the system-in-focus did not exist in reality. Separate agencies could maintain their individual rigid boundaries. However, in stressful situations, these agencies had to compromise their boundaries in favour of obtaining more resilience and achieving viability. This mainly happened by integrating other agencies, voluntary organisations and volunteers; or accepting to be part of another organisation. An example of the latter was observed in E1 when the BRC accepted to be coordinated by the multi-agency response system. These empirical findings contribute to the ontological discussion of organisational boundaries.

The change that happened to the boundary of the response system over the response involved mainly its permeability. Allowing permeability was the mechanism by which the system could utilise external support. See the findings in sections 4.2.2 and 4.3. Theoretically, the systems thinkers have discussed boundaries permeability within three distinctive and relevant notions. These are open systems, Human activity systems (HAS), and boundary spanning.

Open systems communicate, cooperate, influence and are influenced by external stakeholders. Thus, it is argued that open systems have semi-permeable boundaries that permit such interaction with the environment (Chick and Dow, 2005). According to this definition, the response system can be described as an open system. During both exercises, the response system liaised and communicated with a large number of stakeholders. These included voluntary organisations, the army (E1), government policy-makers, communities (parishes), and individuals who are impacted by the incident. Further, the decisions that were made in the system were influenced by these stakeholders.

The second notion is HAS. According to the notable Soft Systems Methodology (SSM), HAS is a system whose "*...boundary is permeable in both directions, and there is communication and interaction across the boundary...*" (Pidd, 2003, p. 115). As such, HAS boundaries share the characteristics of those of open systems. However, Chick and

Dow's (2005) description of boundaries as semi-permeable (rather than permeable) may be more representative of HAS because it expresses the argued limited permeability. The findings suggest that the response systems in both case studies were HAS. Before the incidents, they shared information with stakeholders through the LRF. During the response, they shared information with external agencies (e.g. the environment agency) and the agencies that formed the System-in-focus.

The third notion is boundary spanning. Similar to the last two notions, the advocates of boundary spanning suggest that effective organisations should cut across their boundaries and gather information from the environment, influence stakeholders and move information and talents where they are mainly needed (Beechler *et al.*, 2004). Although boundary spanning believes that internal elements should be protected from the outside environment (Hernes and Paulsen, 2003), Jevnaker (2003) stresses that the "in-between" dynamics of creative actors (boundary spanners) can enable innovation. Nevertheless, the analysis of the empirical data in this research does not suggest that this notion can be utilised by the operational units (S1) during the response. The operational units in both exercises were overwhelmed by responding to the manifested complexity and did not have time to share talents. Still, the data provided evidence that boundary spanning existed at the managerial level before the response. For instance, the CC in CS2 asked the BRC to design training materials for SVs during the preparation meetings. This was a talent sharing across boundaries.

**Table 6-1: Theoretical Lenses to Understand the Response System's Boundaries During the Response**

| | **Open Systems** | **HAS** | **Boundary Spanning (Spanners)** |
|---|---|---|---|
| **CS1 Response system** | Yes | Yes | NO |
| **CS2 Response system** | Yes | Yes | NO |

Nonetheless, all the three notions above relate permeability to being able to communicate and allow mutual influence with the external world. In today's complex and rapidly-changing world, it is rare to find scholars who can argue against the need to communicate and collaborate with other organisations and stakeholders. However, the major permeability discussion in the systems thinking literature is limited to the informational domain. The discussion of permeability regarding physical elements, as suggested by the data, seems to be missing from the three theories above. Although the notion of boundary spanners might seem as an exception, these actors travel across systems' boundaries to share knowledge and to maintain organisational linkages (Beechler *et al.*, 2004). This physical movement is limited to a single or few *organisational* elements (e.g. experts and consultants) to collect and share information in peace times.

The analysis shows that this degree of permeability may not be sufficient during disasters. Although the response systems in both case studies had had an open relationship with stakeholders, they needed to support S1 with physical and human resources during the response to meet the high demand. They transcended the limitations of their boundaries and permitted S1 to utilise the available physical and human resources in the environment (e.g. volunteers). The boundary stretched and shrank according to the relative flow of SVs in and out of the system. With these elements, new information, knowledge, and resources became *part* of the system. The VSM analysis showed that this approach had enhanced the resilience of the response system. Indeed, the analysis is justified by the fact that S1 is the system (Beer, 1979, 1981, 1985). Beer stresses that the rest of the functions are supportive services to ensure effective, efficient and coherent operations. The SGC's decision to increase the boundaries permeability aimed at supporting S1.

This impact of the observed notion of permeability on the size of the system is different from the common natural change in the size of organisations that results in hiring and firing, improvement, and from the conceptual change that is based on modelling (Checkland and Poulter, 2010). It is also different from the practices of boundary spanners who belong to their organisations (Leifer and Delbecq, 1978). These cases may be suitable for conditions where changes and operations occur normally and according to a strategy. However, the observed permeability was an adaption to severe circumstances to enable the system to face the unexpected. It was temporary, open to physical resources and information, and embracing of actors who may not belong to the stakeholder group. The observed permeable boundaries allowed physical elements and information to embed in the system and to resign from it. It was temporary because the boundaries reclaimed their original features and returned to normality at the end of the response to the emergency.

Nevertheless, Chick and Dow's (2005) stress that the notion of boundaries is implied as long as social systems are perceived as systems or structure. In agreement, the VSM analysis showed that the extended permeability of the response system did not dismiss boundaries as a notion and function (i.e. having uncontrolled boundaries). Rather, the boundaries were controlled by the VRC that filtered the inflowing SVs, and by the FCP who made decisions on the number and the type of volunteers to accept. This analysis provides a new explanation of Mingers' (2006, p. 71) emphasis that systems' boundaries cannot be perfectly impermeable. It also shows that higher permeability can positively impact systems' resilience. Although the data provided evidence that higher permeability has enhanced resilience, eventually, the level of permeability should be decided by management according to the system's circumstances. The management should always consider Haynes' (2003, p. 32) warning that losing the minimal sense of boundary in chaotic situations can put the system in trouble.

***Proposition 1***

*For higher resilience during disasters, permeable boundaries should allow the movement of knowledge, information, and physical and human elements to enter and be part of, or exit the system.*

**Novel Concept A: Ultra-permeability**

*Ultra-permeable boundaries temporarily adapt to disasters by allowing, in addition to knowledge and information, physical and human resources to cross. The higher permeability aims at enhancing resilience and can be reversed after the disaster.*

However, ultra-permeable boundaries can have ethical consequences. These consequences should be discussed to mitigate the risk of losing the benefits of adopting ultra-permeability. By embracing environmental elements, the nature of the relationship between the system and the environment can change. It can also trigger a sense of competition or grievance among stakeholders be it in the environment or inside the system.

### 6.2.2. Permeability and Ethics

Midgley's (1992) discussion on the relationship between ethics and boundaries is relevant to, and is insightful for, this research. Midgley questions what happens if two stakeholders have different ethics (values in action). When boundaries are rigid, Midgley argues, one can expect conflicts such as *"We should ensure our workers' survival in the marketplace"* versus *"all people should have equal opportunities for employment"* (p. 10). The findings contained evidence of such ethical conflicts. For instance, the official participants were reluctant to engage volunteers in the response because they were concerned that they may be liable for SVs activities and wellbeing – See Figure 5-3 in subsection 5.2.2.1. However, the SVs who were interviewed in E2 expressed a duty to support their communities and others in need. The volunteers' motive of helping others is widely reported in disasters publications (e.g. Cox and Hamlen, 2015; Harris *et al.*, 2017). On the other hand, the CG in CS1 emphasised that they need to be rewarded financially for helping the officials – See the findings in subsection 5.2.2.3.

The analysis of S5, the CG, and SVs in subsection 4.2.1.1 provides a similar example. While the CCs in both case studies were keen to convince the blue lights agencies of the value of engaging the CG and SVs in the response, the blue light agencies stressed the priority of maintaining order and control. Rephrasing the above findings according to Midgley's quote becomes: "we should ensure our operations smoothness" (blue lights) versus "all people should have the opportunity to support their communities and their peer human beings" (volunteers and the CC). Nevertheless, the successful planning and execution of the exercises showed that overcoming such ethical conflicts is possible. The task of evacuation was delegated to the CG in a manner that did not negatively impact the operations smoothness.

Also, the interviews with officials showed that their actions were bound by their organisations' policies. The tight, structured and process-based policies might not necessarily work in harmony with the self-driven and motivation to help that volunteers wish to exercise (Barraket *et al.*, 2013) – see relevant findings in subsection 5.2.1.1. These policies impact how the system's boundary is perceived by staff and stakeholders. Such ethical conflicts are also reported and discussed widely in the disasters literature (e.g. Cone, Weir and Bogucki, 2003; Fernandez, Barbera and Van Dorp, 2006;

Geographical Science Committee, 2010; Zakour and Gillespie, 2013; Cutter, Ash and Emrich, 2016). Hence, considering the morality and ethics issues might require the system to go beyond the limitations of its boundary (Churchman, 1970).

The official interviewees indirectly admitted that tightening the response system's boundaries and excluding SVs was not ideal. In many occasions, it distanced the system from its environment (and stakeholders) and resulted in more undesired complexity. This aspect of the finding is consistent with Midgley's (1992) discussion on the ethical conflicts with the environment. For instance, the CC interviewees in CS2 talked about an incident when volunteers were not satisfied with official operations and took control of and managed the donation inventory. The response system was alienated and had no power to manage many of the problematic complexity that the volunteers generated. The CC interviewees expressed their worries about the impact of this incident on the official's reputation and thus viability. On the positive side, designing the SV policy and the successful experience of engaging SVs during the live exercises proved that such ethical conflicts can be overcome.

***Proposition 2***

*Planning for and overcoming ethical issues when adopting boundary permeability can support resilience and viability, and attenuate environmental complexity by mitigating conflicts with the environment during disasters*

The findings showed that boundaries are not sacred. During both exercises, volunteers were entering and exiting the boundaries of the system-in-focus and the individual agencies – see the analysis of the evolvement of the system in Section 4.2. This breach of the traditional protective attitude to boundaries did not alter the definition of the boundary, the enclosed elements, or what the system does. Rather, it enhanced the system's resilience in the face of the overwhelming complexity.

The system thinking literature offers a philosophical debate that can inform the above findings. On one hand, critical realists discuss systems and their boundaries ontologically (e.g. Maki, 1992; Midgley, 1992; Lawson, 1997; Runde, 2002; Nash, 2004). They argue that systems and boundaries are perceived as *"existing in the world"* (Mingers, 2006, p. 87). On the other hand, interpretivists (e.g. Checkland, 1983, 1999; Checkland and Scholes, 1990) discard the existential nature of systems and boundaries and discuss them epistemologically, or from *"...a mode of conceptualising"* (Mingers, 2006, p. 87). For instance, Checkland (1983, p. 671) strictly states that *"...systems thinking is only an epistemology, a particular way of describing the world. It does not tell us what the world* ***is****"*.

The VSM's perspective on boundaries may be closer to the interpretivist side of the debate. Stafford Beer admits that *"A system is not something given in nature, but something defined by intelligence"* (Beer, 1966, p. 242). Beer also stresses that perceiving systems' purposes, identity and boundaries can be subjective (Beer, 1979). The empirical findings of this research advantages the interpretive party. Apart from debating whether boundaries are real, analysing the data clearly showed that there was no agreement among participants on what the response system is. Some (e.g. some voluntary organisations) would include all types of volunteers and businesses within the system's boundaries while others who have more power (e.g. police and Fire) considered them as external stakeholders. Again, the empirical findings showed that these subjective perspectives on boundaries were temporarily and partially sacrificed for obtaining a more resilience and coherent system during disasters.

***Proposition 3***

*Boundaries are not scared but subjective. Systems can be agreeable to modify them during disasters in favour of enhancing their resilience and viability*

**Concept B: Ethical systems**

*Ethical systems acknowledge the subjectivity of ethics. They appreciate that adopting ultra-permeable boundaries can have ethical implications. They acknowledge others' ethics and openly share their values to enhance resilience and viability beyond survival.*

## 6.2.3. Identity, Structure and Boundaries

The notions of identity and boundaries are inseparable. Therefore, discussing organisational boundaries cannot be sufficient without discussing identity. The findings showed that activating ultra-permeable boundaries had identity implications – see Figure 4-7, Table 4-5, Figure 4-10, Table 4-6. The systemic analysis showed that there was a need to redefine the identity of the volunteers who joined and were supervised by the system. For the volunteers, they could keep their original identity as external supporters or identify themselves as part of the system (accept to adhere to policies as is the case for staff). For the system, it had to identify whether the new volunteers could become officially part of the system. During the preparatory meetings in CS2, the practical aspects of this issue were discussed (e.g. SVs insurance, the rights of supervised SVs, and uniforms and badges). The same aspects also were expressed during stage 1 interviews in CS1. Theoretically, this discussion concerns the relationship between boundary and identity.

The systems scholars have debated how each notion influences the other. Some scholars, such as Mingers (2006), argue that drawing boundaries precedes and determines the system's identity. However, Brannen *et al.* (2004, p. 49) argues that identity starts with questioning *"who am I?",* which then influences *"with whom to associate"*. Brannen *et al.* (2004, p. 49) say that answering the identity question leads to the identification with existing groups, societies, organisations, nations, political parties and so forth. Hence, a person or a group might have different identities that associate with different groups.

Brannen's *et al.* (2004) argument suggests that systems select from pre-existing identities to match the self-perception. On contrary, Mingers' (2006) perspective suggests that systems create their identities. Both perspectives can be valid. For example, some of the identity decisions can be made unconsciously such as nationality and religion while others may be made intentionally such as being identified with a technology manufacturer or a social media service (e.g. loyalists of Apple vs Windows and Google vs Facebook).

The findings of this research suggest that Brannen's *et al.* (2004) and Mingers' (2006) ways of identifying identity can manifest concurrently during a disaster. One example is the CG's multiple identities. One identity was the SV identity that belongs to the village's residents/community. This was likely made unconsciously when the CG members were already part of the community. Another identity was the CC identity that they acquired after they had accepted working with the CC. Nonetheless, the latter identity was not permanent. During E1, the CG made several decisions and adopted the identity of the agency that was most powerful (e.g. the CC then Fire, then the FCP –

mainly Police). When the CG operated in the community before the officials arrival, it exercised the community identity rather than acting as an official responder. This helped the CG to maintain the community's trust in the system and in the CG. The change in the CG identity was always made consciously and was driven by maintaining the CG's existence (viability) as a recognised and accepted responder.

***Proposition 4***

*Adapting and changing the identities of different responders to disasters (including volunteers) can create coherence, enhance resilience, and maintain viability.*

However, the findings showed that the volunteers' identity within the system was ambiguous. Sometimes the CG members expressed that they were part of the official system. In other incidents, they would state that they are only supporting the officials. For the blue light agencies, the CG was a supportive group but not necessarily part of their agencies. Nevertheless, some participants from the voluntary sector and the CC said that CGs might be part of the entire system. Operationally speaking, supervised volunteers belonged to this system because they were operating according to the system's policies and command system.

On the other hand, the identities of the official agencies did not effectively adapt to the changes in its boundaries and elements. For instance, Police and Fire maintained their own identities when the system-in-focus was formed. Police teams worked as and were instructed by police (not as disasters responders under the FCP for instance). The same applied to Fire. Further, these two agencies did not involve the CG in the decision-making process, did not share their resources with the CG (vehicles or uniform) and did not include them in the formal communication channels. Such adaptive identity may not support viability. The VSM defines organisational identity as its purpose (Espejo and Reyes, 2011). However, Christopher (2007) explains that this purpose comes from four types of stakeholders: staff, customers, suppliers and whoever affected by the organisational operations. As such, the purposes of individual agencies should be adapted to align with the overall purpose of the system-in-focus – the purpose of the response. Individual identities should not be rigid but changing to meet any changes in the culture and expectations of its peers. That is to fulfil its and others' needs and legitimate desires (Ackoff, 1999). This should be adopted by the response agencies that work under the system-in-focus and/or engage collaborative volunteers.

Likely, the official agencies did not feel the need of making identity changes because they were unaware that rigid identities can be a threat to their viability (Espejo and Reyes, 2011). On contrary, they protected their identities as a way of staying viable. This can explain the concerns that some blue lights participants expressed about the consequences of engaging SVs. For instance, the EP in CS1 was concerned that *"... [SVs] are not part of the bigger picture and therefore they do not understand the situation"*. However, it was unclear if these concerns were applicable to the system-in-focus as a collective system; i.e. it was unclear if this system has its own identity. As was explained in the findings in Section 4.2, the system evolved to embrace different types of agencies, organisations and volunteers, which formed a sociocultural system. Although the system had an embracing structure, its elements maintained rigid individual identities. Adopting such behaviour in the face of social complexity may not be a resilient, or a viable, option.

The VSM analysis in Chapter 4 showed that the constituent agencies considered the system-in-focus as collaboration mechanism rather than a uniting system. Hence, they did not adapt their identities to create a new identity that is more resilient than the individual identities. That is, most of the S1 elements collaborated or coordinated through the FCP rather than being part of one system that has one identity. Internally, at the management level (FCP), the system's identity was implicitly imposed by a dominant responder (e.g. police or Fire). This was observed during the FCP in action when the BRC representative was ignored by the police and fire representatives. Also, this imposed identity was not necessarily shared by the other S1 units. Each agency operated according to its policies (e.g. they used their own radios, uniform, and procedures). Externally, the system's customers did not clearly see a multi-agency response system. During the stage 3 interviews with SVs in CS1, the participants were talking about Police, Fire and County Council. Although this may seem consistent with the VSM's autonomy of S1 units (Beer, 1979), the VSM does not suggest having multiple identities that may have different purposes. A uniting identity and a policy are key for viability (Beer, 1979; Schwaninger, 2006a; Espejo and Reyes, 2011).

***Proposition 5***

*An adaptive and shared identity is required for a collective to enhance resilience and viability during disasters.*

A relevant epistemological discussion about Proposition 5 (the relationship between structure and identity) exist in the VSM and system thinking literature. Espejo (2011) stresses that a collective is observed as an operational closure (i.e. organisation) when it modifies its structure to maintain a collective identity. Yet, this does not mean that the individual identities should be eliminated. Espejo (2011) explains that having groups within the organisation that exercise their own identity is a sign of a recursive structure, which is a VSM's mechanism of absorbing complexity. For dynamic systems, as is the case for the multi-agency response system, *"An organisation creates and produces the meanings that its dynamic structure allows it to produce"* (Espejo, 2011, p. 900).

Espejo (2011) argues that viable systems use recursive structures where S1 units produce their own meanings as a strategy to enhance the systems' capacity to manage complexity. This argument suggests that although S1 units have their own identities, these identities should be defined and agreed upon by the systems' management. The findings showed that this was not the case for the official agencies, CG or SVs. For I instance, neither the CG members nor the official interviewees could state clearly define the CG or the SVs identity for the system.

Nonetheless, this does not suggest that a defined identity should be rigid and permanent. Rather, the identity should be dynamic to adapt to changes in the structure and the response needs. For instance, after the response, the SVs existed the response system. Hence, their collective 'responder identity' had changed to various individual identities (e.g. citizens, employees, and occasional volunteers). Still, the system's management (S5) should validate, acknowledge, and explicitly declare the identities of supervised volunteers. The ambiguity of the identity of some elements can create confusion for operations (e.g. whether to deal with CGs as externals or internals). Confusion can hinder resilience and viability, and abolish the merits that Espejo (2011) proposed - each of the additional S1 units would implicitly assume its identity and operate accordingly.

Espejo's point is well established in the systems literature (e.g. Beer, 1979; Schwaninger, 2006b; Rios, 2012). For instance, Ashforth, Rogers and Corley (2011, p.

1144) argue that a collective's generic understanding emerges from the interaction among its members. The *"intrasubjective understanding ('I think') fosters intersubjective understanding ('we think') …"* (Ashforth, Rogers and Corley, 2011, p. 1144), which when applied results in the collective identity *"it is"*. This argument intersects with Espejo's (2011) emphasis that a collective should have a collective identity.

***Proposition 6***

*The structural changes that during the system's evolvement require changes in identity.*

### *6.2.3.1. The Implication of Ambiguous Identities*

Assuming an identity might result in having unrealistic expectations. For instance, if the CG assumed that they are an operational unit in the response system, then they would expect a similar treatment to other voluntary agencies or groups. Thus, to be connected to the formal communication channels, and maybe to be represented in the decision-making process. In CS1, the CG was part of the response system model in the SV policy and was involved in the E1 planning meetings. However, during E1, the FCP did not include the CG in the formal communication channels nor they involved the CG coordinator in the FCP. For the CG, this could be interpreted as rejection from the system. For the blue lights, excluding the CG from formal procedures may be normal because they considered it an external group.

An S1 unit may enforce a desired or reject an undesired assumed identity. The enforcement can increase the expectation gap, which may lead to frustration and conflict. However, rejecting the undesired assumed identity can result in resentment. Both cases can create problematic complexity during the unit's operations. In CS1, the CG assumed that they were part of the CC response and expected special treatment. For instance, the CG asked for financial support and services for their village that were unrelated to the response was an example. Also, the CG was not involved in the FCP or provided with a radio unit. These expectations were not met, which created resentment. Espejo (2011) stresses that having diverse meanings might make each of the S1 units more concerned with its own identity, which would create communication difficulties with the rest of the organisation. This was observed in E1 when Raynet did not initiate communication with the CG to offer help even when they were observed idle with no tasks to do. The FCP might not have confirmed Raynet's identity as part of the system, and hence formalising its rights and responsibilities.

### *6.2.3.2. Identity and Viability Beyond Survival*

Schwaninger (2006) presents an insightful perspective when he suggests that organisations should aim at viability beyond survival. He stresses that viability should transcend the mere protection of the existing identity to adopt an evolving-structure approach that facilitates a modification of or a total change in identity. Otherwise, he argues, organisations would generate a dysfunctional behaviour within the whole. Beer (1979) calls such dysfunctional behaviour pathological autopoiesis. Having highly rigid identity can make organisations autopoietic beasts. They are beasts because they consider their individual goals as the only reason of existing without taking into consideration any other perspectives and interests (Schwaninger, 2006b). Jackson (2003) explains that a rigid identity is an attribute of biological systems as these identities are ascribed to them by an external observer. However, human systems are proactive, purposeful and can have multiple purposes.

Accordingly, for the system-in-focus to be effective, it should acknowledge the different players that join and exit the system as part of its identity – (Propositions 4-6). The findings showed that S5 accepted that some elements of the system (or its stakeholders) were self-organising. For instance, the CC participants in both case studies recognised the role of social media in organising SVs. Here, it might be useful to highlight the importance of Juarrero's (1999) idea that self-organising systems are dynamic and do not have concrete structures. Expecting volunteers to obtain the exact identity of a single official agency can lead these volunteers to be more autonomous and hence pathologically autopoietic. A flexible and evolving identity and structure may be needed for resilience and viability beyond survival.

***Proposition 7***

*Organisations should be reflective and open to changing identity and structure to achieve resilience and viability beyond survival.*

**Concept C: The adaptive identity**

*The identity that can adapt to changes in the system's structure and the environment. It can share its attributes with and adopt some of the identity attributes of the new elements that temporarily operate under the system's command system. Adaptive identity can enhance cohesion and resilience during the response to disasters.*

### 6.2.4. Holistic Worldview

The adaptive identity and the ultra-permeable boundaries imply a systemic necessity – a holistic perspective. The findings showed that the system was more agreeable to adopt a holistic worldview regarding the relationship between the system and its environment. Refer to Figure 4-12 that depicts the system as part of the environment. Also, refer to the findings in subsection 4.3.2.1 about the dynamic and close relationship between the system and volunteers. Holistic worldview is considered a key principle of systems thinking (Senge, 1990; Checkland, 1999; Gharajedaghi, 2011). The systemic analysis of the response system across Chapter 4 corresponds with Gharajedaghi's (2011, p. 89) statement that *"The ability to synthesize separate findings into a coherent whole is far more critical than the ability to generate information from different perspectives"*. For instance, adopting a holistic worldview by the system allowed it to accept the volunteers and other environmental elements' support during the response. This worldview played an important part in enhancing the system's resilience and viability. From a disasters literature perspective, the holistic worldview that the systems adopted allowed it to utilise the social capital (volunteers and different resources). This capital is a major catalyst for resilience during disasters (Cavallo and Ireland, 2014).

**Concept D: Holistic worldview**

*Holistic worldview considers the system as part of its environment. The system collaborates and works with its environment to achieve mutual resilience and viability beyond survival.*

### 6.2.5. Conclusion – The Amoeboid System

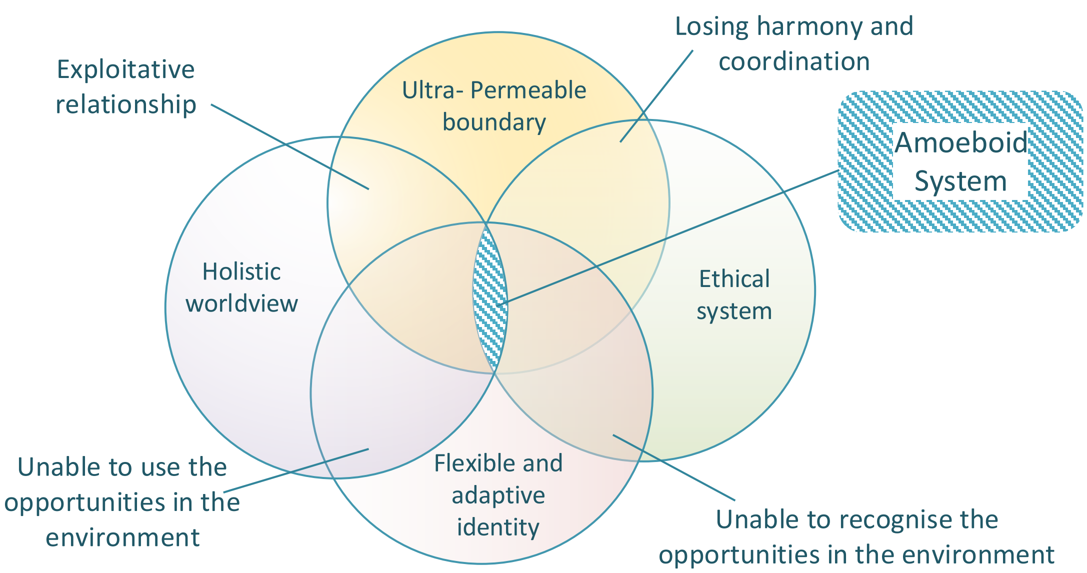
This section discussed four systemic notions that emerged from the findings of this research as important for resilience during disasters. These are permeability, Ethics, identity, and holism. Discussing these notions in light of the existing literature resulted in proposing four concepts: the novel concept of ultra-permeability (Concept A), ethical systems (Concept B), the adaptive identity (Concept C), and the holistic worldview (Concept D). In this conclusion, these interrelated concepts are combined to introduce the novel concept of amoeboid systems (Novel Concept 1).

**Novel Concept 1: Amoeboid Systems**

*An amoeboid system is a system that adopts a holistic perspective regarding its relationship with its environment. Its boundaries are ultra-permeable during disasters to allow different types of resources and interactions to cross the boundaries. Its identity adapts to embrace the new resources. It ethically acknowledges and embraces the purposes and values of the different environmental elements and the new elements that can join the system. Amoeboid systems can achieve higher resilience and viability beyond survival during disasters.*

Figure 6-2 illustrated the concept of amoeboid systems. As it can be seen in the figure, eliminating any of the four sub-concepts from the model may have negative consequences on the system's resilience and operations.

**Figure 6-2: Concept 1 - The Amoeboid System**



# 6.3. THE VIABLE CHARACTERISTICS

This section answers two research questions. Subsections 6.3.1 and 6.3.2 address the underlined part of the following question:

- What are the systemic and viable characteristics of the emergency response system that contribute to its resilience?

One theme emerged from the findings as significantly different from the traditional VSM. This was the existence of an additional S2 function (refer to Figure 4-16). The findings showed that this function was closely related to the system's resilience during disasters. This discussion concerns the functional characteristics of viability.

The discussion in Subsection 6.3.2 focuses on the following research question:

- How does this system systemically relate to and regulate SVs' complexity during the response?

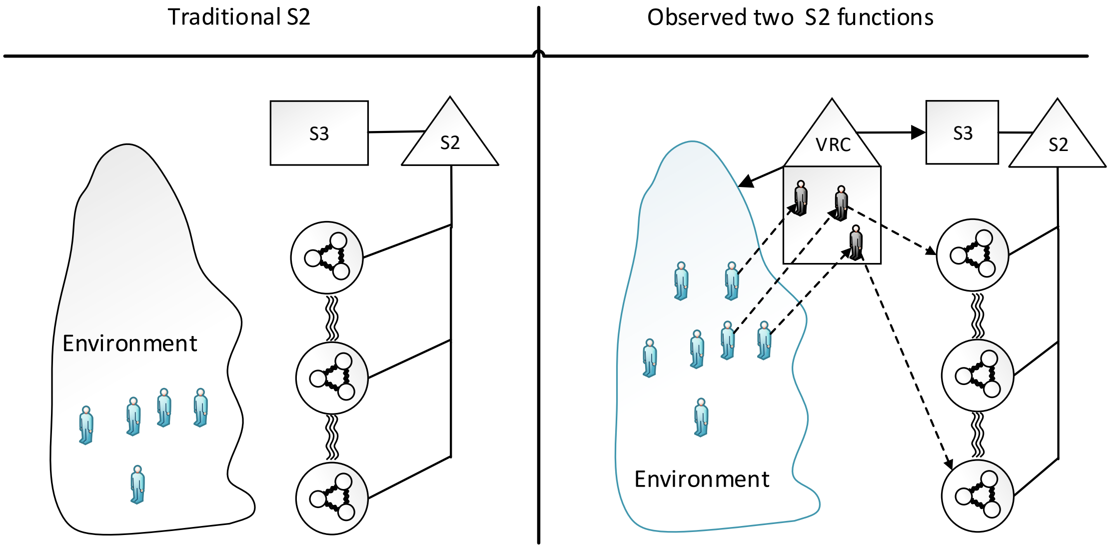
This question concerns the VSM's complexity management principles. The findings showed that these principles could be developed to enhance resilience and agility during disasters.

## 6.3.1. Additional Coordination Function

A viable system must have a coordination function to ensure the coherence of the S1 units (Beer, 1985). Systems who have coordination issues usually either suffer the absence or the ineffectiveness of S2 (Flood and Jackson, 1991; Rios, 2012). However, having two distinctive coordination functions has not been discussed in the VSM publications, in particular when discussing the S2 pathologies. Such cases might not have been observed in real-life case studies nor were they conceptually considered. Another explanation for this absence might be the limited criticality of the VSM. Scholars' efforts might have been directed to testing reality against the VSM rather than testing the VSM against reality. In other words, confusing conceptual models with reality (Checkland, 1983) and crediting sacredness to theory (Mingers, 2006).

The system in focus was a novel case where two S2 functions could be identified. The first was Resilience Direct and the radio systems that coordinated the S1 activities. This was the traditional S2. The second was the VRC that coordinated SVs outside S1. As such, the VRC was not a duplication of the VSM's S2 neither did it have any communication channel with the traditional S2. The VRC was a connection between SVs (the environment) and S3. From a VSM perspective, S2 (1) communicates with S1 units and (2) does not engage with the environment (Beer, 1985). The VRC did not meet these two criteria. In essence, the VRC did not coordinate S1 units. Even the registered SVs who became officially part of the system were not grouped as S1 units. Further, the VRC physically and informationally engaged with the environment by processing SVs. See Figure 6-3.

**Figure 6-3: Traditional S2 Versus a VSM with Two S2 Functions at the Operational Site**




To avoid facing the conceptual-reality dilemma above, this phenomenon was not prematurely considered a pathology. Rather, this section will address the valid question of whether having two S2 functions in the system-in-focus hinders or enhances the system's resilience and viability. The analysis shows that adding the VRC to the system can be beneficial in some areas and may be disadvantageous in others. These areas are discussed next.

Figure 6-3 shows that some environmental elements (SVs) were not addressed by the traditional system. They were not part of S1's responsibility and thus served as a disturbance for the operations. However, on the right side, the additional S2 function addressed these elements, processed them outside the operations area, and made it possible for the system to use them as a resource.

#### *6.3.1.1. Fragmentation of S2 Information System*

The VRC and the S2 function did not share information or coordinate their activities. Information about SVs profiles, registration and deployment was not logged into Resilience Direct and was not accessible to all responding agencies and groups. Thus, the system's information was passing through two separate channels. This caused a fragmentation of information systems, which Rios (2012) considers a pathology that risks viability.

However, this was not a fragmentation of existing information. This VRC-generated information was new and has not been accessible by the system. Acquiring this information was important for the system resilience. The traditional VSM could not supplement the system with the VRC function for three reasons. Firstly, transitional S2 is not designed for this purpose as discussed at the beginning of this section. Secondly, S4 is the function that is officially responsible for collecting information from the environment (Schwaninger, 2006a). Yet, the VSM literature (e.g. Beer, 1985; Schwaninger, 2001; Espejo and Reyes, 2011; Rios, 2012) does not advise that S4 can engage with or act physically on the environment. Thus, S4 could not manage and process SVs. Thirdly, although S1 physically interacts with the environment (Beer, 1979), it is unable to perform the VRC duties. The VSM analysis of the exercises showed that S1 did not have the intelligence duties of S4 that would allow it to effectively collect and analyse information. Further, it was not operationally possible to address SVs because of the uncertainty associated with SVs, the S1's limited resources, and more importantly, because managing SVs is not part of 'what the system does' (Beer, 1979). Hence, according to the VSM, S1 is not responsible for processing SVs. This proved that the principle of an additional S2 can be beneficial for enhancing VSM's resilience. Another benefit is that this additional function can take some of the load of processing information from S4. In E1 and E2, the VRC provided processed, trustworthy and cleaned data that was ready to be used by the system.

***Proposition 8***

*An additional coordination function that engages with the environment can support the complexity management function of the VSM, which can enhance resilience during disasters.*

To reduce bias in the previous discussion, significant VSM publications (Beer, 1985; e.g. FLOOD and JACKSON, 1988; Jackson, 2003; Espejo and Reyes, 2011) were reviewed to learn (1) how the VSM addresses the environment's complexity and (2) whether the traditional VSM can accommodate the VRC in one of its functions. The review showed that the VSM methods to address environmental complexity is attenuation. These were mostly discussed cognitively according to variety engineering principles (e.g. Espejo and Reyes, 2011). Examples of physical engagements and making a tangible impact on the environment were not found. Furthermore, the reviewed publications do not clearly identify a function that is responsible for managing environmental complexity. A reason for the absence of such function in the VSM might be the narrow perception that the notion of complexity attenuation might imply. Such perception does not take advantage of the full potential of the holistic worldview of system thinking and its assertiveness about the importance of the relationship with the environment.

***Proposition 9***

*The VSM does not advise on how to physically coordinate aspects of the environment.*

### *6.3.1.2. Implications on the VSM*

Despite the benefits that the VRC provided, the uncareful insertion of this function within the VSM could have had undesired consequences – mainly on S3 (FCP). As per the SVs policies and the exercises observation, the FCP analysed S1' needs, the VRC reports, and made resourcing decisions accordingly. Then, SV deployment instructions were sent to the VRC. The first negative impact on FCP was the additional complexity (VRC reports) that needs immediate processing. In a real disaster, this may require S3 to amplify its complexity to achieve the requisite complexity. The second disadvantage was that FCP was practically coordinating the VRC-S1 relations (S2). This meant that the FCP members who were in charge of S3 were facing a new duty that is not of their responsibility (Beer, 1979).

Adding S2 duties to S3 might cause a pathology similar to what Rios (2012) calls schizophrenic S3. According to Rios (2012), a schizophrenic S3 belongs to both S1 and metasystem and cannot integrate both identities harmoniously. However, in the case of the S3 in the system-in-focus, adding S2 duties to it can make it schizophrenic between playing S2 and S3. Such cases were not common in the VSM publications. Maybe because the major VSM literature (Beer, 1985, p. e.g.; Christopher, 2007; Espejo and Reyes, 2011) distinguishes the duties of S2 and S3 as two separate functions (Beer, 1979).

S3's failure to effectively perform this coordination role because of the above complexities can result in the failure of the VRC experience. The ability of the VRC to meet SVs' expectations of effective and efficient deployment is critical to maintaining the viability of the VRC. This might explain why there was a bottleneck in the waiting room in the E2's VRC. Many of the waiting SVs got frustrated and wanted to leave the system.

However, the latter disadvantages might not be a VRC issue. Rather, it could stem in the way the VRC is integrated into the system. For instance, the VRC could have direct communication channels with the S1 units. In the exercises, S2 could have given the duty of making deployment decisions. One can contest that this is against the VSM logic – that managing and negotiating resources is an S3 duty (Beer, 1979, 1985). However, the VRC's role as pure S2 does not follow a strict model and should be modified to best support the system. Another possibility is to merge the VRC reports with the existing S2 system's resilience. This will require developing the existing S2 to be able to facilitate a rapid decision-making for S3. The later suggestion can make the VRC more integrated into the system according to the VSM principles. Also, it can mitigate ignoring the VRC reports or considering them of low priority.

***Proposition 10***

*Integrating an additional S2 into the VSM structure to coordinate the environment complexity can be possible. This should be done considering the implications for other functions.*

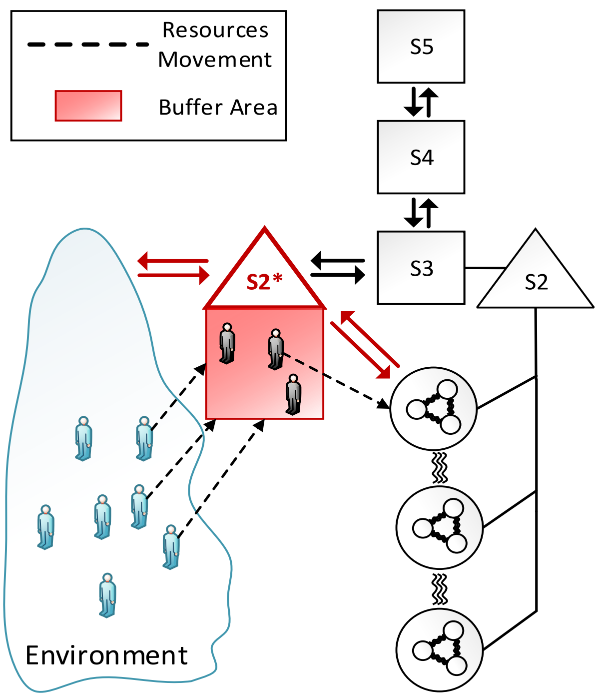
### *6.3.1.3. Conclusion*

The findings of having an additional S2 function within the VSM structure were discussed. As Proposition 8 states, this function was found to be beneficial for viability and resilience during disasters. However, the findings showed that this function needs to be integrated well into the VSM to avoid information fragmentation and schizophrenic S3. This function was found to be a novel contribution to the VSM. Hence, it will be introduced as a novel concept (S2*).

**Novel Concept 2: An additional S2 Function (S2*).**

*S2* is an additional coordination function that is activated during disasters to process and coordinate the potential resources that may join the viable system. It attenuates the additional complexity that amoeboid system can face. Hence S2* can support resilience and viability beyond survival during disasters. See Figure* 6-4.

**Figure 6-4: The Concept of S2* Within the VSM**



## 6.3.2. Complexity Management (Managerial Characteristics)

The conceptual propositions and models that were proposed in Chapter 2 are used as points of discussion. It was argued in Section 2.6 that these models can contribute to enhancing systems' resilience during disasters through timely response to complexity. Further, it was argued that these models can support the system to overcome the autonomy-control dilemma and grant S1 more autonomy to enhance resilience. This argument was consistent with Hoverstadt's (2008) note that the Taylorist (traditional) controlling model has become absolute and that systems need to be proactive and adaptive to compete. Many organisations have followed this notion through adopting continuous improvement and change management approaches. However, this research focuses on enabling systems to timely adapt and respond to sudden adversity.

### *6.3.2.1. Variety VS Complexity*

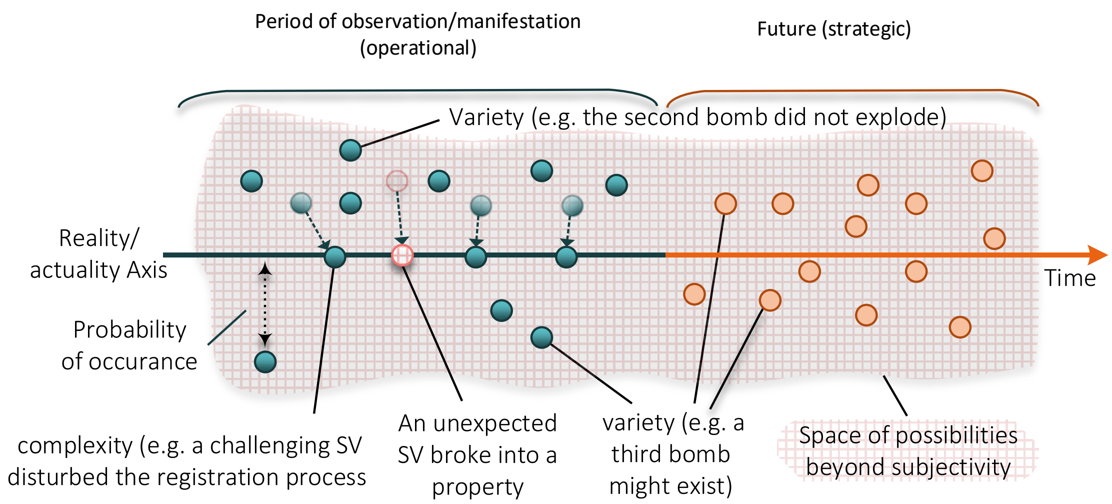
The findings proved that Espejo's (2000) concern of the unpracticality of managing variety is valid.  During the exercises, the system-in-focus was overwhelmed by the number of incidents that needed urgent attention. The FCP was not seen planning for what might happen (potential states) beyond what was observed (experienced). Although S5 and S4 were not observed during E1 and E2, the official participants in stage 1 interviews said that these functions' job is to collect information, plan, mitigate for problems and guide the FCPs accordingly. They also said that S4 became busy analysing the overwhelming flow of information during previous responses. Therefore, it can be strongly argued that the system-in-focus in E1 and E2 only addressed the current distinctions and not all the possible states of the environment. The planning that was done by the system at this time was on how to respond to the manifested distinctions and a limited speculation of what can go wrong.  In other words, the system did not address variety as per its definitions (Beer's and the proposed definition in Chapter 2). Rather, it addressed complexity. Complexity as a portion of variety was not distinguished in the major VSM literature (e.g. Beer, 1985; Espejo and Reyes, 2011; Rios, 2012). Therefore, the novel proposed conceptual model in Figure 2-15 that distinguished complexity from variety can be practically and theoretically meaningful. Such distinction can boost S1's ability to prioritise and effectively and efficiently act on the most important distinctions. This agility is critical for S1's autonomy because it enables S1 to adequately absorb the environmental complexity (Beer, 1985; FLOOD and JACKSON, 1988; Espejo and Reyes, 2011). See the model in Figure 5-6.

***Proposition 11***

*Using the proposed distinction made between variety and complexity supports the system's resilience and viability.*

A fundamental argument of managing complexity is whether variety is an adequate measure of complexity (Beer, 1979). This was conceptually discussed in Chapter 2. In light of the findings, evidence of the response system's ability to quantify the environment's complexity was inexistent during the exercises. It was also unclear whether having such a number would have helped the system to be more resilient; especially that variety is not an intrinsic property of the system (Ashby, 1957, p. 125).

**Figure 6-5: Proposed Model: Redefining the Notions of Complexity and Variety with Examples from Findings**




The findings showed that the environment's complexity manifested in different forms; e.g. explosions, evacuees, equipment, injuries, and challenging behaviour during the exercises. If these complexities were to be quantified into a number, the system would not have been able to make decisions on how to address each of these complexities. For instance, in E2, most of the observed complexities were those of SVs. The VRC's complexity was sufficient to address this complexity because it consisted mainly of human resources who could communicate with SVs. The effectiveness of the VRC might have been different (likely less based on the findings) if the VRC had used self-serving machines to register instead of human resources, although the complexity numeral value is equal in the two cases.

Espejo (2011) was sceptical of the value of considering variety because it is too large to be managed or studied. The above discussion suggests that this scepticism is more justifiable during disasters. Still, this does not render the notion of variety as the potential states of a system unusable. The proposed definition of variety in Table 2-4 can indeed be useful if the system had enough resources to address complexity and dedicated resources to study variety. Addressing variety helps in identifying longer-term opportunities and mitigate future problems. However, it is unlikely that variety would be processed during disaster response.

***Proposition 12***

*Variety as a measure of complexity might not be practical during disasters. The proposed definitions of complexity and variety are valuable for enhancing resilience and viability during and after disasters.*

However, the distinction between complexity and variety might not be operationally sufficient to achieve potential resilience and agility operations. There was a need to enable S1 to timely identify the types of complexity it faced to timely manage it. Timely assessment and management of complexity was important for higher resilience and agility.

#### *6.3.2.2. The Need for a Complexity Model*

The findings showed that the CAT 1 interviewees were aware of many merits and issues of engaging volunteers in the response. However, these merits and issues were not perceived as complexity. Hence, the actions that generate this complexity were not classified. Instead, a simplistic and generalised approach to volunteers was adopted. Consequently, the officials preferred to consider volunteers as a source of risk and avoid the risk by eliminating the involvement of volunteers in the response, especially in what they may consider risky areas. The absence of a model to classify volunteers' complexity might render volunteer actions as chaotic and overwhelming. Nevertheless, as was observed in E1, volunteers managed to evacuate most of the village residents to a safe area before the officials arrival. This was crucial for protecting the residents and enhancing the community's resilience. Although this intervention supported the response system's resilience and reputation, the officials who were interviewed during E1 were still sceptical of engaging volunteers in real disasters.

From a traditional VSM perspective, the officials were attenuating the external complexity that they considered overwhelming or threatening (Beer, 1985). Such indiscriminate attenuation does not totally contradict the VSM's perspective because the VSM does not provide formal guidance on how to assess and filter complexity (e.g. Beer, 1985; Rios, 2012). The exception is the very brief reference that Espejo and Reyes (2011) make to performance criteria as a benchmark for assessing CDs. However, this advice lacks the distinction between CDs and complexity, which can lead the user to use the indiscriminate and generalizable approach above.

Likewise, the findings show that the complexity classification that is proposed by Espejo and Reyes (2011) may not be of a practical use during busy operations. Classifying complexity to individual, situational or collective can only inform S1 about the source of complexity. However, S1 is likely to be more interested in learning the operational implications of complexity. For instance, S1 can be more interested in the implications of actions on the system and whether these actions belong to the system or not. This is consistent with the VSM logic of using attenuation because of the overwhelming implication of complexity (Beer, 1979; Schwaninger, 2006b). In the absence of such information, S1 might find itself in a position of attenuating any unauthorised or unrecognised complexity to avoid risks and liability. In practice, an easy way to attenuate external complexity can be preventing complexity drivers (e.g. SVs) from having a contact with the system; or ignoring the existence of this complexity (Beer, 1979), which is an uninformed attenuation. These are common in terms of dealing with SVs during disasters (Barraket *et al.*, 2013). The findings showed that such approach might lead to a conflict between the system and the environment and to endangering the system's viability; e.g. when SVs in CS2 took control of donations and did not allow officials to get involved in managing and distributing them.

***Proposition 13***

*Effective and agile operations require an operationally usable classification of complexity.*

The interviewees in both case studies declined that they could successfully force all SVs to leave their operations area. In such cases, they escalated the cases to their management for guidance. Escalation may be unhelpful to achieve higher resilience during disasters for three reasons. First, the management would face the same problem that S1 had faced.

The VSM did not provide the management of a model to classify complexity. Second, in the absence of operationally-useful complexity classification, it is unlikely that S5 would have created a relevant and informed policy that would enable robust and rapid decision-making. Third, escalating complexity contradicts a key viability principle: to act on complexity at the lowest possible recursion level (Beer, 1985). In support of this principle, Rios (2012) stresses the cybernetics principle of making decisions at the level that has the most relevant information about the problem. Hence, escalating all SVs' complexities is not a resilient approach nor it would be effective in solving lower-level problems and enhancing resilience.

***Proposition 14***

*Resilience requires an agile complexity management at S1 level. Complexity classification can support this goal.*

The complexity model that was proposed in Chapter 2 classified complexity to internal, external supportive, and problematic (Table 6-2). The findings in Section 5.3 (refer to Table 5-1 and Table 5-2) suggest that this model is useful to classify SVs complexity. It was also easy to use by the researcher during the observation of both exercises. Theoretically, this model addresses propositions 13 and 14. Further, the model can be operationally useful for different types of organisations and contexts because (1) it informs and enables S1 to assess complexities when they occur, (2) it is simple and enables quick decision-making and (3) it is flexible – it defines the four elements of the matrix in a general, logical and systemic way. For the VSM, the model is useful for S5 to (1) design a policy that grants S1 the authority that they need to make decisions and (2) to reflect on the decision made in the past. The latter is particularly important to ease staff's fear of being liable for the consequences of their decisions as expressed by the official interviewees. Lastly, this model supports the notion of amoeboid systems because it acknowledges the new elements that join the system.

However, it is important to note that political support is essential for acquiring the level of autonomy that is needed for resilience and viability (Beer, 1979; Schwaninger, 2006b). hence, S5 need to support S1 when using the above model. Otherwise, S1 would revert to escalation as a safer way to avoid liability.

**Table 6-2: The Proposed Complexity Classification**

| | ***Supportive*** | ***Problematic*** |
|---|---|---|
| ***Internal*** | The complexity that is generated by the system's elements or the external elements that are temporarily managed by the system. This complexity supports the system in achieving its purposes and facilitates its operations. | The complexity that is generated by the system's elements or the external elements that are temporarily managed by the system. This complexity disturbs the system's operations and can hinder achieving its purpose. |
| ***External*** | The complexity that is generated by the environment's elements. This complexity supports the system in achieving its purposes and facilitates its operations. | The complexity that is generated by any element that is not formally operating under the system's management. This complexity disturbs the system's operations and can hinder achieving its purpose. |

### *6.3.2.3. The Need for a CD Model*

Despite the novel contribution of the complexity model for systems' resilience, a complementary model is needed to make it more efficient. Applying the complexity model directly into operations requires S1 to be always attendant to all complexities in its operations area. In other words, once the system makes a distinction, it should observe all the complexities generated by the CD that generated the original complexity. The findings showed that this can overwhelm the system. This is why the VSM suggests attenuating external complexity (Beer, 1979). For instance, in E2, the SV waiting time was extended significantly when the VRC's deploying process became under pressure when the number of SVs increased. As a result, some SVs in the waiting room started to generate problematic complexity (e.g. complaining, leaving the VRC, and changing their opinion of what they want to do). It is unlikely, or maybe impossible, that the S1 staff would be able to observe individuals and attend to all their actions on the ground during the real response. As such, the complexity model can face the same criticism that Espejo (2011) made about the unpracticality and the large scale of variety. The proposed CD model in Chapter 2 addresses this issue and offers a way to overcome this obstacle. It organises the complexity so that a single decision can address numerous complexities.

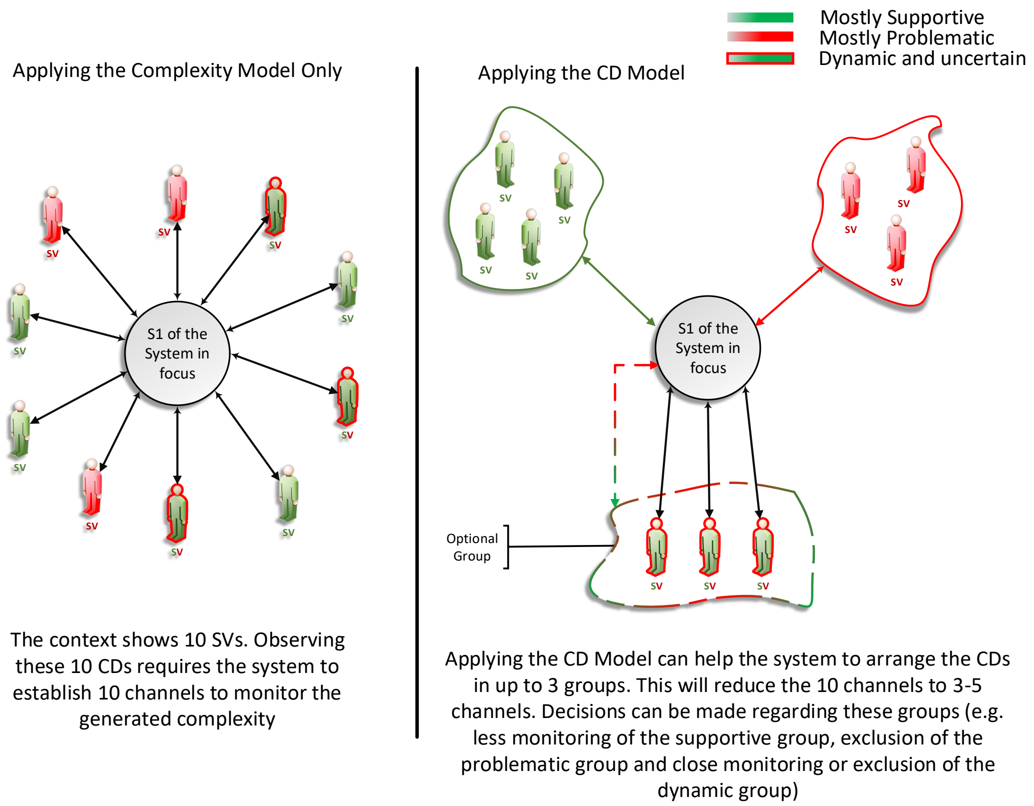
The proposed CD model utilises the concepts of the complexity model to group the complexity sources (i.e. CDs). In particular, it allows the user to classify the CDs that predominantly generate one type of complexity. For instance, some SVs can be trusted to generate supportive complexity because of their expertise, professional experience or the quality of work they perform. In such cases, it would be a waste of the system's resources to assess all the complexities that these individuals would generate. The same argument applies to CDs that consistently generate problematic complexity.

The findings confirmed the usefulness of the CD model. During E1, the FCP implicitly identified the CG members as trustworthy CDs because they had observed the effectiveness of the CG-led evacuation (supportive complexity). Trusting the CG was not because the FCP was following the SV policy. The officials would have excluded the CG upon their arrival if the CG initial response was problematic. However, the FCP tasked the CG to carry out the evacuation process to a nearby village and granted them with an extended level of autonomy. For the FCP, the CG members were grouped as a single supportive CD and the complexity they generated was not closely monitored.

The CD model is well rooted in the VSM theory because it is consistent with the attenuation principles (Beer, 1985). It is similar to Espejo and Reyes' (2011) attenuation strategy that clusters information into themes to reduce the complexity resolution. Nonetheless, another impact of this attenuation strategy is amplifying management's decisions. Clustering allows each decision to impact numerous CDs simultaneously. Such impact is overlooked by the VSM literature (e.g. Beer, 1979, 1985; Espejo and Reyes, 2011; Rios, 2012). Figure 6-6 shows the difference between using the complexity model versus using the CD model. The CD model enables the system to reduce the channels needed to observe complexity and to reduce the frequency of using the existing channels. For example, the problematic SVs are grouped in Figure 6-6. Therefore, the system may decide to create basic jobs for them to perform (e.g. filling in sandbags during floods), which makes frequent monitoring of individuals in this group unnecessary.

Evidence of the practicality of the CD model was found in the VRC in E2. The registration forms that the SVs filled allowed the system to group SVs according to operations enabling criteria. This was clustering strategy similar to that of the CD model. However, the VRC experience may be different from that of S1. S1 would need to operate the model cognitively while performing their operations. The simplicity of the CD model can facilitate its use by S1, which can boost resilience and agility.

**Figure 6-6: The Difference Between Using the Proposed Complexity and CD Models**




The CD model does not suggest rigidity. The dynamic nature of CDs (Hoverstadt, 2008) was addressed in the CD model (See conceptual discussion in subsection 2.6.3). The classification is acknowledged to be a time and context relative. Furthermore, the complexity classification that is used in the CD model allows for a subjective use and, thus, to be modified according to different organisations' needs. Yet, one can critique the subjectivity of the model and argue that a more specifically defined complexity typology could eliminate bias and facilitate process standardisation. Nonetheless, achieving high levels of resilience might need to sacrifice some of standardisation and objectivity. Stage 1 interviews showed that different agencies had a unique relationship with the CG. For instance, the CC had a closer and empathetic relationship with the CG and supported their wider engagement in the response because the CC had a socially-focused vision. On contrary, Police was more sceptical towards the CG experience because it was more concerned with keeping order in the area. Hence, the supportive and problematic criteria (the CD model) for the CC and police would be different. Allowing the subjective judgment that is communicated and agreed upon by different stakeholders would enhance the model and the system's resilience in dealing with the unexpected. The dynamicity of the CD model can be a merit rather than a criticism, especially when facing a dynamic, subjective, and chaotic reality.

***Proposition 15***

*The CD model can enhance the capability of the system to manage complexity and its resilience.*

As is the case for the complexity model, S5 can use the CD model to design policies for certain types of external complexity. In addition of the operational advantage of such policies, they can grant S1 the necessary political support to apply the model. This would enable S1 to perform an automatic and effortless decision-making that is backed up with political support.

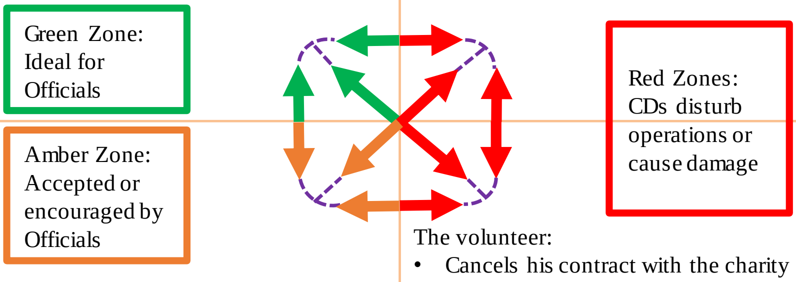
The decision-making flowcharts that were part of the comprehensive model (Figure 6-1) serve as an illustrative example of how S1 and S5 can apply the complexity and the CD models. Amendments to this process can be made as long as they adhere to model principles. As explained earlier, the models are flexible enough to allow different criterion to be used to define the four categories in the complexity and the CD models. This makes the models suitable for different organisations and contexts. The usability of the CD model extends to the other VSM functions (Beer, 1985) that deal with complexity. For instance, S4 can use the model to produce more simple, effective, and compatible reports to S5. These simple reports serve as complexity attenuators (Beer, 1979; Espejo and Reyes, 2011). This can, in turn, enhance the effectiveness of S4 and supports the other functions resilience.

The vague identity of the CG that was suggested by the findings and the discussion in Section 6.2.3.1 can now be explicitly addressed by the response system. The FCP can have the political support and the ability to classify CGs to support the system's resilience. Hence, it may be easier for the FCP to tag the CG with a selected identity (e.g. the system's identity). This identity can then be exercised and shared with the stakeholders.

In addition to benefit of using the CD model in operations, intelligence and policy generation, it can be used as a diagnostic tool. It is a means of examining the rationale and effectiveness of decision-making in organisations that aim at high levels of resilience and viability beyond survival.

**Figure 6-7: The Proposed CD Model with an Example**

| **Complexity Drivers** | *Supportive* | *Problematic* | |
|---|---|---|---|
| *Internal* | An experienced volunteer contracts with a responder during a disaster:<br>• The charity needs his skills in rescue casualties<br>• He uses his own car during emergencies.<br>• He uses his social network to support the charity function | The volunteer<br>• Is still contracted with the charity<br>• Start to ask for more autonomy doing the things his way<br>• Accepts help from friends in the disaster site, which might endanger the charity reputation.<br>• Makes a mistake that leads to putting some casualties' lives in risks. | Official Responsibility |
| *External* | The volunteer:<br>• Cancels his contract with the charity<br>• Work independently to raise funds for the charity<br>• Form an experienced SVs group to communicate the charity messages to the affected communities. | The volunteer:<br>• Cancels his contract with the charity<br>• He and his SV group operate chaotically in the charity operations area.<br>• He accesses a dangerous building in the affected area.<br>• Contribute to convey exaggerated news about the disaster | No defined Responsibility |




The novel proposition of the distinction between complexity and variety (Subsection 6.3.2.1), the complexity model (Table 6-2), and the CD model (Figure 6-1) are complementary. They also close gaps in the existing classifying of complexity for the VSM (Espejo and Reyes, 2011). Hence, the combination of these three novel models is introduced as a component of a new concept for the VSM (Concept E).

**Concept E: Agile and resilient complexity assessment**

*The ability of all the functions of the system to timely distinguish, classify, and group complexity during disasters. This is done by using operationally useful models (the models noted above) to support resilience and viability beyond survival.*

### *6.3.2.4. A New Perspective on Complexity Regulation*

The indiscriminate rule of attenuating inward flowing complexity was identified in Chapter 2 as a gap in the VSM's approach to managing complexity. A conceptual analysis of the VSM and cybernetics literature (e.g. Ashby, 1957; Beer, 1985; FLOOD and JACKSON, 1988; Jackson, 2003; Schwaninger, 2006a; Christopher, 2007; Espejo and Reyes, 2011; Rios, 2012) showed that inward flowing complexity (e.g. obtaining more knowledge of the environment) may grant the system more control over the situation. In particular, the notions of (1) distinctions as a source of complexity (Espejo and Reyes, 2011) and (2) knowledge leads to control (Jackson, 2003; Rios, 2012) were meaningful to arrive at this conclusion. Supportive evidence of this conclusion existed in the findings. For instance, the VRC's SV reports increased the information flow (complexity) for the FCP. Yet, this complexity granted the system more control over the situation.

Furthermore, the findings suggested that physical forms of complexity can also increase the system's control over the situation if managed well – see findings in Section 5.6. This is a novel case that transcends the focus on relating complexity to information, which is found the focus of most reputable VSM publications (e.g. Beer, 1979; Espejo and Reyes, 2011; Rios, 2012). For instance, the presence of a large number of collaborative SVs in E2 allowed the response system to respond to a wider area in the operational domain.

***Proposition 16***

*Attenuating external complexity may lead to missing opportunities and less resilience. More utilisation of external complexity can lead to higher resilience and viability*

However, this evidence that was found in the case studies does not render this proposition an absolute rule. The exercise was a planned scenario and was executed in a controlled environment. Problematic SVs were not present in a large number neither they manifested their complexity during operations. In real-life situations, the types of complexity and their impact on the system can be uncertain and unpredictable. This could be the reason why Beer (1979) avoided discussing ways to utilise external complexity when he admitted that attenuation can result in missing opportunities. Beer's peers talked about looking for opportunities through acquiring more knowledge (Schwaninger, 2006a) and examining the environment for threats (Jackson, 2003). Yet, they have not discussed the relationship between taking advantage of these opportunities and complexity regulation, especially during disasters. This gap could be a result of the inability of classifying complexity. Concept E closes this gap and facilitates discussing complexity regulation for enhanced resilience.

Similarly, Section 2.6.2 argued that amplifying management decisions may have problematic consequences on the system (e.g. the implications of disseminating bad decisions). Supportive evidence was not found in the exercises. The exercises were tightly planned. This might not have put the decision makers under significant pressure as could happen in real disasters. Still, evidence could be tracked in the example from previous major floods incidents. In stage 1 interviews, the CCM and SCCO narrated a case when a voluntary group set up a donation warehouse and spread a message through media to direct the donations towards them. The CC decision in the early stages was to ignore the group and not to get involved because it was not their own warehouse. The consequences of applying this decision to the response system appeared shortly. A huge amount of physical donation was directed to the warehouse, immoral and unorganised management and distribution were observed, and the CC lost control over what became their own issue – the wellbeing of the society. The CC decision to intervene was late because the voluntary group refused to allow the CC to involve in their operations. Hence, amplifying similar management decisions to wider areas could have had even more serious consequences. However, the VSM literature (e.g. Beer, 1979, 1985; Schwaninger, 2006a; Espejo and Reyes, 2011; Rios, 2012) does not seem to mitigate such issues when discussing the amplification function. Schwaninger (2006a) touches lightly on the subject when he says that ignorance is a bad attenuator. *"…functional and dysfunctional attenuators and amplifiers can be clearly distinguished"* (p. 16). While he explains that ignorance is dysfunctional attenuator, he does not expand to discuss what dysfunctional amplifiers are.

**Proposition 17**

*The amplification of management complexity is not always beneficial for systems' resilience.*

The previous attenuation and amplification gaps were conceptually identified in Chapter 2. However, the VSM analysis of the system-in-focus led to a new understanding of complexity regulation. The VSM suggests that attenuation happens on the inward flowing complexity and amplification happens on the outward flowing (Beer, 1979, 1985; Espejo and Reyes, 2011). However, the findings showed that attenuation and amplification can happen in a different direction. The flow of complexity from the VRC to the FCP was an example. The VRC reports provided the FCP with extensive information about SVs. These reports were an amplification of the SVs' complexity because they increased the distinctions that the FCP made about SVs. Examples of the distinctions are SVs ages, fitness, numbers, skills, collaboration level and so forth. This amplification activity was flowing from S2 to S3 in contrary to the VSM logic (Beer, 1979. Yet, this amplification activity had a positive impact on the system's resilience.

One can argue that the reports did not have an amplification effect. Rather, they filtered SVs' information, which completely adheres to the VSM's attenuation principle (Beer, 1985; Rios, 2012). Nevertheless, this argument misses that the official participants said that a major problem with SVs is the unavailability of information. Thus, this information was not previously accessible by the system. The VRC made new distinctions (complexity), analysed them and generated extended knowledge that was not observable. Hence, the VRC activities can strongly be argued to be an amplification process although it contradicts the VSM (Beer, 1979). The findings showed that this inward amplification was useful because it enabled the system to control this complexity through systematic engagement (or exclusion) of SVs.

**Proposition 18**

*Amplification and attenuation may take a different direction to those suggested by the VSM. Still, this can support resilience.*

Propositions 16, 17, 18 may suggest that classifying attenuators and amplifiers can be operationally useful. Such classification does not exist in the VSM literature (e.g. Beer, 1979, 1985; Espejo and Reyes, 2011; Rios, 2012). Hence, a novel model for classifying regulators is proposed using the same logic of complexity classification - see Table 6-3.

The model proposes that an attenuator or amplifier is positive if it supports the system's resilience and viability and is negative if it hinders them. In other words, amplification is positive if it increases supportive complexity and negative if it increases problematic complexity. Similarly, attenuation is positive if blocks problematic complexity and negative if it blocks supportive complexity. Theoretically, this classification makes explicit the logic used in regulatory decisions, including those suggested by traditional VSM (Beer, 1979). Although this novel classification is not discussed in the VSM literature (e.g. Beer, 1979; Schwaninger, 2006a), it can be argued that this logic is intuitive for a decisionmaker who is aware of the complexity and the CD classification. Yet, making this logic explicit and documented contributes to the VSM because it can facilitate planning, execution, reflection, diagnosis, and theoretical development. Further, it explicitly emphasises the fact that regulation can still be applied in contrary to the VSM's logic as long as it supports resilience and viability, especially during disasters.

***Proposition 19***

*The impact of amplification and attenuation on the system's resilience and viability is not necessarily related to their direction.*

**Table 6-3: A Proposed Regulators Classification**

| | ***Positive*** | ***Negative*** |
|---|---|---|
| ***Attenuation*** | The activities block problematic complexity | The activities block supportive complexity |
| ***Amplification*** | The activities increase supportive complexity | The activities increase problematic complexity |

Neutral

As is the case with the CD model, a regulatory action may not be a 100% positive or negative. Thus, the proposed model should allow locating regulators anywhere inside the table area - see the circles that represent regulators in Table 6-3. This suggests that the regulatory functions may not always be separable or controllable as suggested by the VSM (Beer, 1979). The findings suggested that some attenuation actions might have an amplification impact or would need to have associated amplifiers actions to be effective. Also, They provided evidence that a strict application of attenuation and amplification as suggested by Beer (1985) and Espejo and Reyes (2011) might hinder flexibility, which can be counterproductive and damaging for resilience. Refer to the findings on the VRC-FCP commination channel in subsection 4.3.2.1.

***Proposition 20***

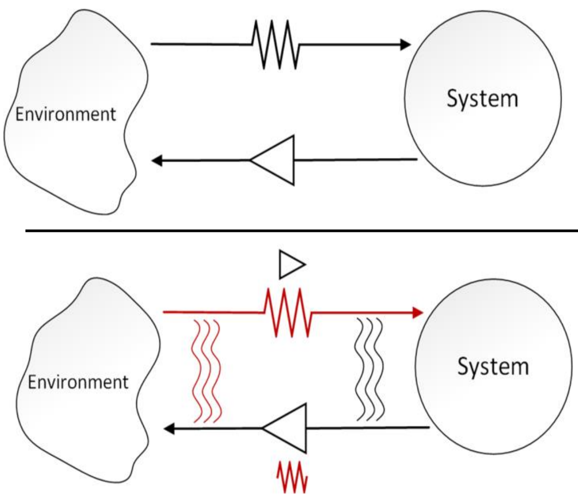
*The regulation functions can be interrelated and have mutual influence.*

The proposed modified regulation model in Figure 6-8 is a visual manifestation of the merged propositions in Subsection 6.3.2.4. The model embeds the mutual influence of both functions by showing a minor amplification symbol (Beer, 1979) over the main attenuation function and vice versa. The symbols are located above the arrow and not in a separate arrow to demonstrate the possibility of addressing the same complexity flow. The wavy lines between the arrows illustrate the relationship between attenuation and amplification (Beer, 1979). They remind decision makers to avoid overlooking, or being unconscious of, the mutual influence. Another message that the wavy lines convey is the continuous communication and coordination between these two functions (Beer, 1979). The colour code shows that the communication happens before the action (or designing the function) is carried out. For instance, the red waves near the environment are located before the attenuation symbol (red) because the coordination occurs before processing the targeted complexity at the attenuation symbol.

The VSM literature (e.g. Beer, 1979, 1985; Schwaninger, 2006a; Espejo and Reyes, 2011; Rios, 2012) does not critique the direction in which regulators work. Examples of how amplifiers and attenuator work can be found in Espejo and Reyes (2011), Rios (2012), Jackson (2003) and others. These examples discuss how, for instance, to amplify complexity. Nevertheless, the attenuation effects of the amplifier are not usually covered. For instance, Espejo and Reyes (2011) exemplify that a lecturer can attenuate students' complexity by selecting a handful of the students' questions randomly. However, they did not discuss the amplification consequences of such action (e.g. complaints and bad feedback on the teaching quality).

The findings on the VRC-FCP communication provided empirical evidence that supports this model (see relevant findings in subsection 4.3.2.1). However, these findings validate the model on the S2*-S3 communication channel. Further research may be needed to test and develop the above models in different situations, contexts, and in different VSM functions.

**Figure 6-8: A Proposed Complexity Regulation Model**




**VSM Complexity Regulation Principles (Beer, 1979)**

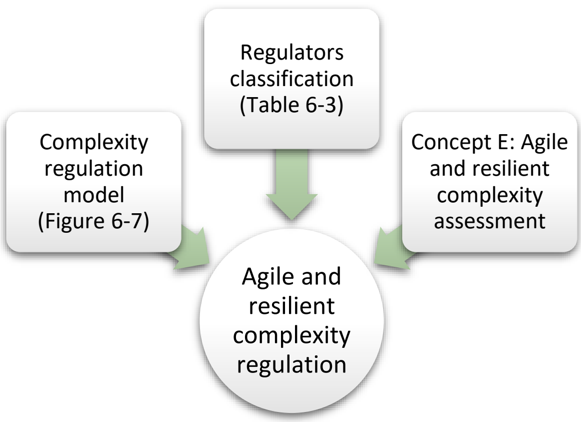
- Run independently
- Each function runs on a single type of complexity (Internal or External)
- Run in a predefined and single direction

**Proposed Complexity Regulation Principles**

- Run Jointly or collaboratively
- Both functions run on two types of complexity (Internal and External)
- Run on all communication channels and in both directions (inward and outward)

Combining the two novel models (regulators classification and complexity regulation) with Concept E (agile and resilient complexity assessment) leads to the novel Concept 3 – the agile and resilient complexity regulation. It is agile because it facilitates rapid and timely decision-making (classifications). It is resilient because it can deal with uncertainty and emergent complexities (the classification and the regulation models).

**Novel Concept 3: Agile and Resilient Complexity Regulation**



# 6.4. THE MODIFIED COMPREHENSIVE MODEL

This section introduces the changes made to the comprehensive model considering the outcomes of the discussion in this chapter - the overarching concepts 1, 2, and 3. These concepts resulted from a new understanding of the notion of boundaries and the associated systemic characteristic as discussed in Section 6.2, and the viable characteristics as discussed in Section 6.3. The new comprehensive model is called Agile and Resilient VSM (ARVSM). The development of this model in this chapter and the relevant findings are depicted in Figure 6-9.

**Figure 6-9: The Components of the Agile and Resilient VSM**

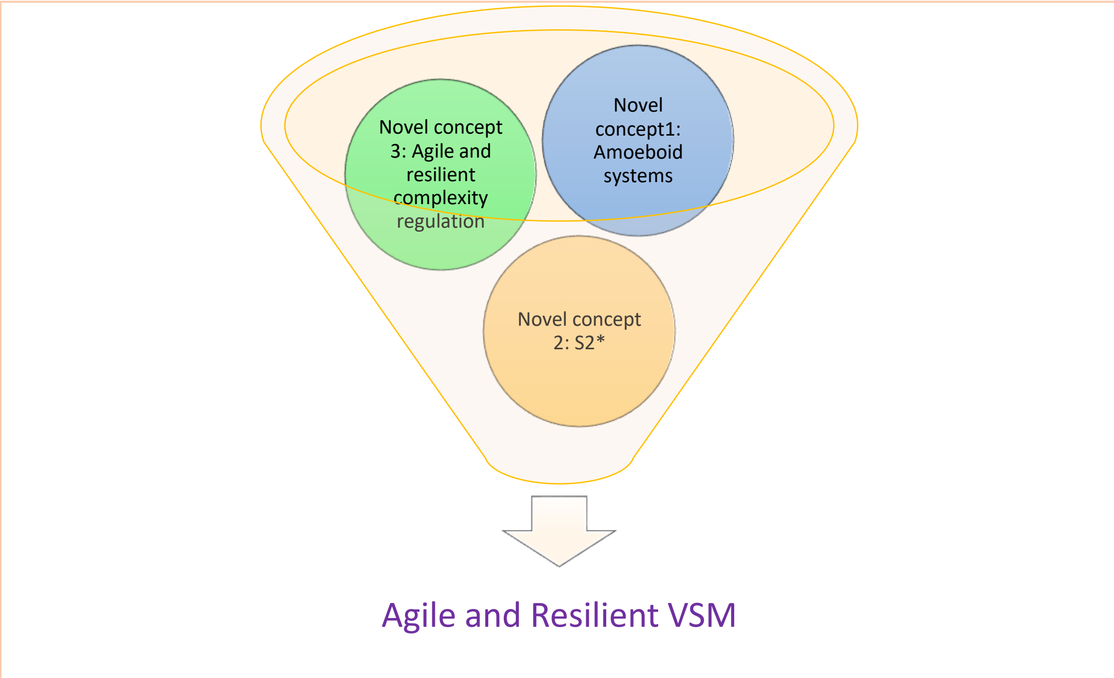



**Figure 6-10: The Modified Comprehensive Model – Agile and Resilient VSM During Disasters**

portrays the new model in two recursion levels. The changes in the boundaries characteristics are expressed with changing the circle shape of S1 in the VSM (Beer, 1979, 1985; Espejo and Reyes, 2011) into an amoeba shape in both recursion levels. As discussed, the findings showed that the system was amoeboid because of the enhanced permeability and the holistic relationship that the system had with the environment. The discussion has established that the boundary permeability involves allowing the environmental physical elements to timely access and exit the system according to the complexity management criteria. Thus, the shape of S1 and the embodying system is amoeboid and dynamic. The dashed part of the boundary expresses the filtering criteria according to which physical elements are allowed to cross the boundary. These criteria are based on Concept 3: the agile and resilient complexity regulation. The rest of the boundary is solid to show that the notion of boundaries as defined in the system thinking (Midgley, 1992; Mingers, 2006)still apply. This boundary still separates the system from its environment. Its permeability is managed and controlled.

**Another change in the model concerns the way by which the VSM is depicted in accordance with its environment. The system is now embodied in its environment as is in real life. Beer (1985) stressed that systems are embodied within their environment. However, the visual expression of this fact has not been introduced. This research acknowledges Checkland (1993) emphasis on the importance of visual representation of reality. Drawing the system inside its environment might have a psychological influence on the analysis. For instance, Figure 6-10: The Modified Comprehensive Model – Agile and Resilient VSM During Disasters**

makes it clearer that the system's identity is part of, and not separate from the whole's identity. The boundary does not extend to an external domain to acquire part of it as expressed in the proposed comprehensive model in Chapter 2. Rather, it is in a symbiotic relationship with the different co-inhabitants of its own larger domain. Metaphorically, this relationship is similar to that of the human digestive system with the healthy gut bacteria that inhabit it (Varela, 1986).

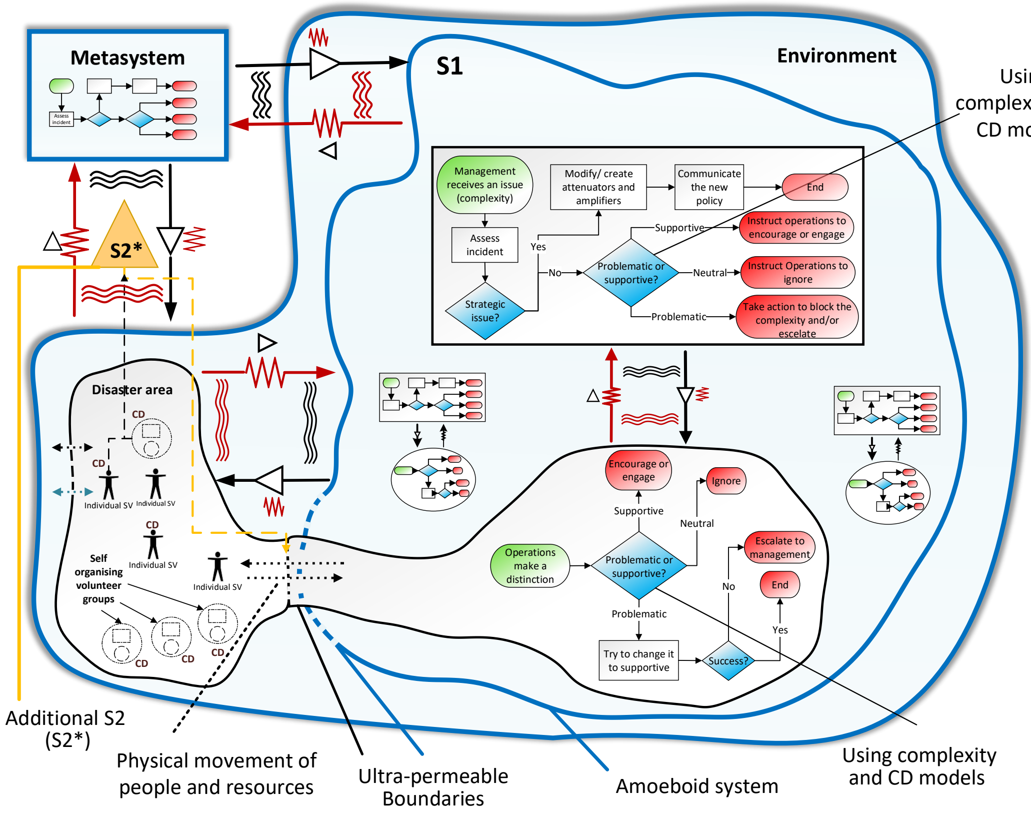
The second change was made to how the complexity regulation function is expressed. The modified model shows the proposed mutual connection between attenuation and amplification. This change applies to all communication channels in the system whether they are internal or external. It also shows the double effect of the regulation actions (the smaller symbols near the main attenuation and amplification symbols).

**The decision-making flowcharts in S1 and the metasystem were not changed from the original proposed model. The findings did not provide evidence that can refute these flowcharts, which are proposed examples of how the complexity and the CD models can be used. However, the clarity that was obtained from the findings and the discussion in this chapter required to make a reference to their functionality. As expressed in Figure 6-10: The Modified Comprehensive Model – Agile and Resilient VSM During Disasters**

, the S1 flowchart is designed for more autonomy and dynamicity in decision-making for operations while the metasystem flowchart is designed to produce strategic complexity management decisions.

The ARVSM is comprehensive because it embeds and expresses the discussed concepts and models. It visually communicates the novel contributions to the systems thinking and the VSM principles.

**Figure 6-10: The Modified Comprehensive Model – Agile and Resilient VSM During Disasters**




## 6.5. CONCLUSION

The chapter discussed the proposed conceptual models in light of the findings and the literature. Some conceptual propositions and models were improved to reflect the discussion of the findings.

The chapter concluded by introducing a model that enhances the VSM agility and resilience during disasters. This was called Agile and Resilient VSM (ARVSM). This model embedded the models and propositions that emerged conceptually and from the findings. These included the novel notions of amoeboid systems, the additional S2 function (S2*) and agile and resilient complexity regulation.

Nevertheless, it may be useful to provide managers with a practical guide of managing complexity based that is theoretically compatible with the new concepts and models This is beyond the scope of this research. However, a proposed guide is presented in the Appendix. The guide is called complexity engineering to distinguish it from Stafford Beer's variety engineering as presented by Espejo and Reyes (2011).

CHAPTER 7

# CONCLUSIONS

This chapter summarises the thesis structure and highlights the main contributions of this research (Section 7.2). Further, it discusses the new gaps that were identified after conducting this research (Section 7.3). Lastly, Section 7.4 presents the abstracts of selected potential research papers that are based on the contributions of this research.

## 7.1. SUMMARY

The research aimed at enhancing communities and systems' resilience to face the escalating number of disasters. It investigated how engaging SVs during disasters could contribute to enhancing resilience and reducing risk. Chapter 1 discussed this aspect and introduced the SV phenomenon. SVs' motives and their associated complexity during disasters were discussed.

Further, Chapter 1 explored the disaster response system, its structure, and characteristics. The SV phenomenon was approached from an operational perspective. This perspective was missing from the disasters and system thinking literature. Requests for operational solutions for the problem of engaging SVs in the response system exists in the disasters literature (e.g. Alexander, 2011). This research addressed this.

Chapter 2 started with exploring the notion of resilience. It defined the notion and discussed its meaning for organisations and communities during disasters. Section 2.2 concluded that an effective management of complexity is key for enhancing resilience. Accordingly, Section 2.3 discussed the notion of complexity, its generators and classification from a cybernetics perspective (Ashby, 1957; Beer, 1979). Further, it investigated the notion of variety that is used by the VSM to measure complexity. It questioned whether this measurement can enable the response system to handle SVs' complexity during disasters.

Section 2.4 discussed the VSM's merits and its suitability for this research. Then, it discussed the VSM's structure and its strategy for managing complexity for viability (Beer, 1979, 1985; Espejo and Reyes, 2011). To reflect on the context of this study, Sections 2.5 discussed the need for enhancing responders' resilience from a complexity management perspective. A complexity gap that might contribute to the overwhelmedness of responders and to threatening their resilience was identified. The section concluded that engaging SVs in the response system can be a way of enhancing responders' resilience and thus of closing this gap.

Section 2.6 discussed the reasons that might make the VSM inflexible and limited in regard to enhancing the resilience of systems during disasters. Gaps in the existing definitions of the notions of variety, complexity, variety engineering, and variety regulation were discussed. To close the identified gaps, the section introduced conceptual propositions and models that were argued to enhance the VSM effectiveness during disasters.

Chapter 3 discussed and justified the philosophy that underpins this research. It elaborated on the strategies that were used to sample the research cases studies and participants, and the methods that were used to collect and analyse data.

Chapters 4-5 presented the research findings that relate to answering research questions 1 and 2. Chapter 4 analysed the evolvement of the response system during simulations of a disaster response. The VSM and system thinking principles were the lenses that were used to analyse the structure, characteristics and the function of the system. The VSM lens was also used to analyse the complexity management practices of the system during its evolvement. Nonetheless, Chapter 5 focused on testing the validity of the conceptual propositions that concern classifying and managing complexity. Hence, this chapter presented the findings that relate to answering research question 3. Accordingly, it explored the data for complexity generators. It analysed the value of the classification of the generated complexity and the operational benefit of using such classification.

Chapter 6 discussed the proposed comprehensive model and its conceptual components in light of the finding and the existing literature. It discussed the systemic and the viable characteristic of the response system that contributed to its resilience and viability. Systemically, the notions of boundaries, identity, ethics, and holism were discussed. The section concluded by proposing the notion of Amoeboid Systems. For the viable characteristics, Section 6.3.1 discussed the implications of having an additional coordination function I the VSM on enhancing its resilience. This function was called S2*. Section 6.3.2 discussed the VSM complexity management principles in light of the research findings. New notions were proposed and merged in a notion that was called Agile and Resilient Complexity Regulation. Chapter 6 concluded by introducing a new model that was called Agile and Resilient VSM. This model merged the merits of all the proposed notions in the chapter.

## 7.2. CONTRIBUTIONS

The originality of the research contributions comes from the way resilience was approached within the VSM. The research revisited the core characteristics of viable systems to explore what could limit the disaster response system from achieving its potential resilience during disasters. Further, it investigated the traditional perception of complexity, the environment and the self. Mainly, the VSM was used to examine the complexity management practices of organisations during disasters and its impact on resilience and viability.

The novel knowledge that this research brings to the VSM and the system thinking works of literature is how to enhance the resilience and agility of viable systems during disasters. The research shows that this can be achieved by reconsidering the notions of variety and complexity, the principles of complexity regulation, the system’s boundaries and identity, the relationship with the environment, and by enhancing S1’ autonomy to make instant decisions. Further, the research brings a new understanding to the VSM literature of how multi-agency systems should be organised and managed during disasters. For the disasters literature, this research contributes to closing the gap of managing the risks that are associated with engaging volunteers in the official emergency system. The research reveals that it is operationally and theoretically possible to find solutions for these risks and that such solutions can contribute to enhancing the resilience of communities and emergency response agencies.

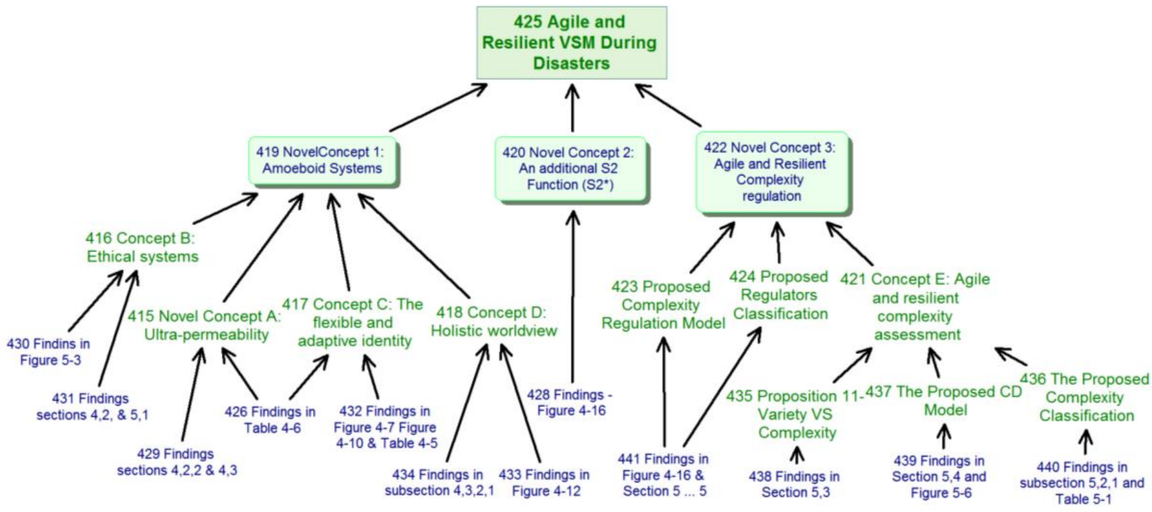
The contributions have practical implications. Decision-makers can benefit from the proposed models to make changes to their disaster response policies in regard to engaging communities during the response. This can apply to government agencies, NGOs and other organisations that may be involved in responses to disasters. The research suggests that adopting these models to engage communities can enhance their organisational resilience in the face of disasters. Furthermore, the findings of this research highlight key systemic pathologies (e.g. not having a single policy) that can hinder the effectiveness of multi-agency systems. Building on this learning, the research provides a novel insight on how to organise and manage multi-agency organisations in a way that maintains coherence, efficiency, effectiveness, and resilience. Although this research focuses on the disaster response systems, that are typically multi-agency systems, organisations in other sectors that need to work collaboratively in a similar structure can also benefit from the findings of this research.

The following subsections explain these contributions in more detail.

### 7.2.1. To the VSM

The overarching contribution to the VSM was the modified VSM model. This model was called the agile and resilient VSM (ARVSM) – see Figure 7-1 to learn how this research resulted in the development of the modified VSM. The findings and the conceptual discussion showed that ARVSM could enhance the resilience and agility of organisations during disasters. Further, introducing AVRSM has addressed the gap that Schwaninger's (2001) identified the need of thinking of viability beyond survival. The model facilitates a holistic worldview and enables organisations to thrive and be viable beyond survival. Moreover, it closes the gap that Espejo (2000) identified the impracticality of the notion of variety. The ARVSM was based on contributions to the systemic characteristics and the viable characteristics of the VSM. The systemic contribution was the novel concept of the amoeboid system. This will be discussed in the next subsection.

**Figure 7-1: The Development of the Modified Comprehensive Model and the Relevant Findings**




### *7.2.1.1. Contribution to the VSM Structure (S2*)*

The VSM (e.g. Beer, 1979, 1985) does not include a function to coordinate the environments' complexity in order to utilise it. This might not have been necessary for organisations during peacetime. Moreover, the existence of more than one operation role is contrary to viability according to traditional VSM (Beer, 1979). Thus, the VSM is not able to proactively engage in coordinating the environments' physical forms of complexity. The findings showed that having such a function can facilitate using external resources and consequently support the system's resilience. Thus, a new function (S2*) was proposed and incorporated into the VSM structure to make it more resilient during disasters. See Concept 2 and Figure 6-4 in subsection 6.3.1.3.

### *7.2.1.2. Contribution to VSM's Complexity Management*

Regarding the managerial characteristics, the research introduced the novel notion of the agile and resilient complexity regulation (Concept 3 in subsection 6.3.2.4). This notion resulted from identifying and closing three gaps in the VSM theory that could make the VSM less resilient and less flexible during disasters. These concepts are discussed next.

*Agile and Resilient Complexity Assessment*

The inability of the VSM to timely assess complexity was identified as a gap that hinders systems ability to achieve their potential resilience during disasters. Two sub-gaps were identified in the VSM theory.

The first gap concerned the inability of the VSM to distinguish between the potential and actual states of a situation. The VSM introduces the notion of variety as a measure of complexity (Beer, 1979). Espejo (2000) questions the practicality of using variety for managing complexity because of its large value. In the disasters context, Espejo's concerns are more relevant, yet for a different reason. The ability to distinguish and prioritise overwhelming complexity is key for timely decision-making and resilience during disasters. Conceptually, variety was argued in this research as unsuitable to meet these needs. The findings confirmed the validity of this argument. During the exercises, variety did not facilitate timely-decision-making and could not assist the system in isolating the actual states (see findings in Section 5.3). The contribution that closed this gap was the novel proposition that distinguished variety from complexity. The impact of this contribution on the VSM is that it does not consider variety as an absolute and valid measure of complexity as introduced by Beer (1979). Rather, it distinguishes between complexity and variety. The proposition defined complexity as the experienced and manifested states and defined variety as the potential states of a situation or a system (see Subsection 2.6.3).

This proposition can be useful for theory and practice. For theory, it develops the VSM with a model that explains where variety and complexity are generated, how they flow within the VSM structure, and who should be responsible for processing them. Further, it closes the gap that was identified in the VSM literature of the confusing use of the terms complexity and variety interchangeably as is seen in Schwaninger, (2006b) and Rios (2012). This is a novel contribution to the VSM theory because it contributes generalising the applicability of the VSM by making it more resilient during disasters. For practice, it enables the VSM user to decide when, where, how, and what to manage.

The second gap was the inability of the VSM to assess complexity before regulating it. The VSM argues that external complexity should be attenuated and internal complexity should be amplified (Beer, 1985). As such, the system may attenuate external complexity that can support its operations. Beer (1979) stresses that attenuation can result in losing opportunities. Similarly, the system might amplify internal complexity although it might damage its operations. The research argued that this approach could hinder resilience and might be counterproductive during disasters. The findings supported this argument and showed that the response system could enhance its resilience by accepting (not attenuating) and utilising selected complexity from the environment (SVs). To close this gap in the VSM, two novel propositions were introduced: the complexity and CD classification models. These models provided a tool to timely understand the nature of emerging complexity and the nature of its generators in an operationally useful way. The models make organisations more attentive to their environment and more accepting of using external complexity to enhance their resilience and improve their operations (see subsections 2.6.2, 2.6.3, 6.3.2.2, and 6.3.2.3). These model facilitate exercising more S1 autonomy as recommended by Beer (1979). Still, they do not sacrifice the system's cohesion and its control over the situation. Therefore, it can be argued that they contribute to enhancing the viability of the VSM.

*Complexity Regulators Classification*

The VSM literature (e.g. Beer, 1979, 1985; Espejo and Reyes, 2011; Rios, 2012) does not provide a tool to assess the regulatory actions. Rather the general principle is to encourage the amplification of the system's (or function) complexity and to attenuate external complexity (Beer, 1979). This rule does not acknowledge that some internal complexity can be problematic. Hence, amplifying such complexity can damage the system's resilience. Similarly, some external complexity can be supportive and hence attenuating it can result in losing opportunities (Beer, 1979) – also see discussion in subsection 6.3.2.4. The findings confirmed the existence of this gap. For instance, the findings showed that amplifying SVs' complexity was supportive of the system's resilience and viability (See Section 5.6). To close this gap in the VSM, a regulators classification model was proposed. This model classified attenuators and amplifiers to positive and negative regulators according to the nature of the complexity that they regulated (i.e. problematic or supportive) – see Table 6-3. Embedding this model into the VSM would allow decisionmakers to evaluate actions before applying them on the wider scale. In disasters, this can mitigate against disseminating bad decisions, and against blocking external opportunities, which can have serious consequences on viability.

<u>*Complexity Regulation Model*</u>

This model contributes to closing the gap of the indiscriminate and unassessed regulation of the VSM. It modifies the regulation functions in light of the previous contributions to VSM's regulation. The VSM Literature (e.g. Beer, 1979, 1985; Espejo and Reyes, 2011; Rios, 2012) does not suggest any relationship between the attenuation and regulation functions. Rather, it presents them as independent actions on either external or internal complexity. The findings suggest that there is mutual influence between these functions. Also, the findings showed that each regulation function was observed to act on both internal and external complexity (Section 5.6) in opposition to what the VSM suggests (e.g. Beer, 1979, 1985; Espejo and Reyes, 2011; Rios, 2012). The new model updates the traditional regulation function with the new learning – it suggests a close relationship between attenuation and amplification, that every attenuation action has amplification effect and vice versa, and that each function is applied on complexity that travels on any direction (towards or outwards the system) – see Figure 6-8. This was found to support the system's resilience by making informed and coordinated decisions.

### 7.2.2. To Systems Thinking

This research contributes to systems thinking by introducing the concept of amoeboid systems. This concept was formed by merging four concepts: Ultra-permeability, holistic worldview, adaptive identity, and Ethical systems– see Figure 6-2. Discussing the findings suggested that amoeboid systems need to incorporate these concepts to enjoy higher resilience during disasters.

The novel concept of ultra-permeability was developed to reflect the need for allowing environmental elements (e.g. SVs) to access and integrate into the system. Permeability was discussed in the systems literature to mean communicating, exchanging, and collaborating with stakeholders. Boundaries permeability was discussed in three theories: human activity systems (Checkland, 1983), open systems (Chick and Dow, 2005; Mingers, 2006), and boundary spanning (Hernes and Paulsen, 2003; Beechler *et* *al.*, 2004). However, the findings suggest that to achieve higher resilience during a disaster, systems need to go beyond the soft principles of permeability. The concept of ultra-permeability develops the existing definitions of permeability and facilitates achieving higher resilience by allowing the system to utilise external resources – see subsection 6.2.1.

The concept of holistic worldview (Senge, 1990; Checkland, 1999; Gharajedaghi, 2011) was included in the concept of amoeboid systems. As Concept D in subsection 6.2.4 states, systems need to perceive themselves as part of the environment to effectively exercise ultra-permeable boundaries. to embody new elements in the system, the system needs to appreciate the mutual influence of the actions and the potential mutual interest (e.g. resilience and viability) of elements of the whole.

The third concept is adaptive identity. The proposed Concept C states that adaptive identity is necessary for the system's cohesion and resilience when new elements enter the system during the repose to a disaster. The concept adopts Schwaninger (2006) and Jackson's (2003) assertion that human systems should not be rigid. Rather, they need to consider other identities and be willing to adapt their identity to achieve viability beyond survival. Schwaninger (2006) and Jackson's (2003) assertion is key for amoeboid systems since they integrate different element (e.g. SVs) that may have diverse identities. Organisations that have a strong and inflexible sense of identity can be more reluctant to engage with their environments. This is because having an open relationship can be perceived as threatening to the self-identity (Jackson, 2003). The findings showed that the tolerance that the response system had toward the CG made the CG more effective in evacuating residents before and after the officials' arrival (See subsections 4.2.1.2 and 4.2.2). This led to enhancing the system's resilience and viability.

Ethicality was also identified as an important concept for amoeboid systems. The discussion of the findings showed that system-in-focus's boundaries were subjective (see Proposition 3). Also, the discussion showed that ignoring the ethical factor when discussing and operating boundaries might lead to conflicts with environmental stakeholders (Midgley, 1992; Zakour and Gillespie, 2013). Hence, the concept of ethical systems (Concept B) was included as a component of the notion of amoeboid systems.

Discussions on the notions of boundaries, ethics, identity and holism exist abundantly in the system thinking literature (e.g. Senge, 1990; Checkland, 1999; Midgley, 2000; Paulsen and Hernes, 2003; Gharajedaghi, 2011). However, most of these discussions are conceptual. Case study research that analyses their collective implications is rare, particularly in the during disasters context. This research closes this gap by merging these concepts into one operational model. It presents them as interrelated and necessary notions to achieve resilience during disasters.

Lastly, these systemic contributions were embedded into the VSM. Hence, the operational value of these contributions was enhanced because it was represented in a viable organisational structure. This can encourage organisations to adopt a holistic approach to operations and address many of their concerns that might hinder their engagement with the environment or hinder granting more autonomy to their staff.

### 7.2.3. To the Disasters Literature

This research contributes to the disaster literature by proposing operational models to managing and engaging SVs during disasters. The SV phenomenon was discussed in the disaster literature by describing SVs' motives, their contribution to disasters, and the implications of their presence on the disasters response (Orloff, 2011; Barraket *et al.*, 2013; Shaw *et al.*, 2015; Twigg and Mosel, 2017). Although these publications can be informative, their operational benefit is limited. This gap is identified by the disasters scholars (Kahan, Allen and George, 2009; Alexander, 2011) but not much effort is made to closing it (Orloff, 2011). This was identified as an unaddressed gap in the disasters literature.

The research introduced a novel model that uses complexity management principles and the VSM structure (Beer, 1979, 1985) to guide organisations in managing SVs. It theoretically and empirically discussed how the response system can be modelled to utilise SVs complexity to enhance resilience and to maintain viability during emergencies. The research analysed two case studies where the engaging SVs was practically beneficial for enhancing the resilience of official responders.

Furthermore, the proposed model can contribute to enhancing communities' resilience. It was tested in coordinating SVs' activities, allowing them to benefit from officials' experience, and responding when an official response was not available. The case studies showed how the collaboration between communities and officials helped in early evacuation immediately after the impact of the disaster. This contributed to saving lives, reducing causalities, and saving resources. This could significantly enhance the community's resilience in the face of the disaster as was conceptually argued by (Orloff, 2011).

### 7.2.4. To Practice

This research informs counties that are developing their SV policies. Further, it informs decisionmakers in the councils, disasters response organisations, and policymakers on the government level. The research adopted an operational approach to analysing the response system and the SV phenomenon. This can help in planning for engaging SVs in future disasters, which can enhance the responders' resilience, the quality of the response, and communities' resilience.

The research addresses the requests that are made by international organisations, especially UNSDR, to find solutions that can engage communities during disasters. The premise is that this engagement would enhance communities' resilience and reduce the consequences of disasters.

Lastly, the findings of this research can inform businesses and organisations. Enhancing resilience by using the resources in the environment is not operationally and theoretically addressed. However, further research is needed to evaluate the feasibility of using the proposed models in organisations in different sectors during peace times or disasters.

# 7.3. NEW GAPS AND LEARNINGS

This section presents the new gaps that were identified as a result of conducting this research. These involve gaps in theory and in the research process.

## 7.3.1. In Theory

Complexity was distinguished from variety. While complexity was defined in this research as the manifested and experienced states, variety involved the potential states of a system or a situation. Hence, it was argued that complexity manifests only in the present and does not exist in the future. On the contrary, variety manifests in the future. The findings showed that this distinction can be operationally useful to make timely decisions and enhance systems' resilience. This was a contribution to the VSM's complexity engineering (Beer, 1979; Espejo and Reyes, 2011).

However, the time factor can have a higher influence on how these notions are defined. For instance, further analysis of these notions may include what happens to complexity and variety when they become in the past. Also, defining the 'present' and the 'past' can have operational implications. The duration of observation can be instant, a day, or a response period. This research did not cover the time factor in detail. Also, this aspect is not discussed in the VSM literature (e.g. Beer, 1979, 1985; Espejo and Reyes, 2011; Rios, 2012). This is the first identified gap as a result of conducting this research.

The second identified gap concerns the conceptual model of complexity and variety dynamics. The model argued that variety is only generated by S4 and processed by S4 and S5. On contrary, the model argued that complexity is generated and processed by the whole system. These arguments were consistent with the proposed definitions and with the roles of the VSM's five functions (Beer, 1985). This argument was made to be valid during the response to a disaster when S1 was overwhelmed by complexity. However, variety is conceptual and may happen in S1's brain without being observable. For instance, it was not clear during the exercises whether any of the response staff thought of the possible outcomes of SVs' actions. Such questions emerged after the data collection and analysis. This is a gap that can be covered by further research.

Lastly, these novel models were developed and tested in the disaster response context. This is an opportunity for further research to test these new models in different contexts and validate their usefulness for different types of organisations.

### 7.3.2. The Research Process

Although collecting data during the exercises involved three researchers, it was not possible to observe the system in its entirety. The exercises involved a large number of players who were operating in a wide area. For instance, the response system's functions were located in different locations (the FCP near the site, the SCG at the CC). Also, the S1 teams were spread over a wide area (e.g. two villages in E1 and several sites in E2). Hence, it was not possible for the researchers to exist in most of the locations during the short period of the exercises (8am-4pm). Moving from one site to another required using cars and was time-consuming. Hence, the researcher focused on what was considered the most important location to inform the research. Yin (2011) calls this gap in observation *"fluidity"* in complex settings (p. 144-145). Although attempts were made to mitigate this gap, observing the system's functions operating simultaneously could have provided a more-in-depth data on the factors that may influence complexity management.

In this research, data analysis started concurrently with data collection as advised by Charmaz (2008) and Yin (2011). However, a holistic and comprehensive analysis of the response system was only possible after collecting data from both exercises. This was because the data that were collected in those exercises were complementary. E1 focused on testing the CG-led response and the collaboration between the officials and the CG. The main player in the exercise was the FCP. However, E2 was entirely dedicated to testing the VRC process, including SV deployment. In real disasters, both aspects (the FCP and CGs, and the VRC and SVs) would be part of the response system. Hence, a complete model of the system could only be obtained after observing both exercises.

Consequently, the time invested in collecting data in CS2 was used to complete the picture that was partially provided in CS1. As such, it was not possible to fully develop the models from CS1 data and validate it in CS2. Further, the timeframe of this research did not allow for approaching new case studies that have live exercise plans. New case studies could have allowed the researcher to make specific observations on these findings. To mitigate this shortage, the analysis was conducted iteratively where data was revisited several times to confirm conclusions.

However, these limitations are opportunities for further research. To be more generalisable, each of these findings and contributions would need further testing in real-world situations (Hartley, 2004; Flyvbjerg, 2006; Creswell, 2009). Further research can contribute to the development of the proposed ARVSM model and the proposed sub-models and concepts.

## 7.4. RESEARCH PAPERS

This section presents the abstracts of three potential papers that are considered for publication. These papers build on the theoretical contributions that were made in this research. Following are the titles and the abstracts of these articles.

### 7.4.1. **Viability Beyond Survival During Emergencies:** A Holistic Perspective of Systems' Boundaries and Identity for Higher Resilience (EJOR)

The Viable System Model's (VSM) and the systems thinking definitions of systems boundaries and identity aim at maintaining the system's stability and thus viability. It is also a protective mechanism to protect the system and regulating the relationships with the environment. Open systems are said to be more resilient because their boundaries are permeable, meaning that they allow sharing of information and expertise with selected stakeholders. However, the traditional definitions of permeability and identity may limit systems potential to achieving their resilience during emergencies. Emergencies are complex and threatening situations that may require systems to adopt a holistic worldview. A holistic response to emergencies transcends the mere information sharing to engaging with the wider environment. This paper discusses the notions of boundaries and identity holistically for achieving higher resilience. The goal is viability beyond survival. This means providing organisations with the potential to stay in control during and thrive after major emergencies. A new definition of permeability is developed in this paper to enable systems to enhance their resilience during disasters by using the abundant resources that reside in their environment.

### 7.4.2. **Measuring the Complexity in Viable Systems:** A Reconsideration of Beer's Notion of Variety (EJOR)

The Viable System Model (VSM) uses the notion of variety to measure and manage the complexity of systems and environments. Variety is defined as all the possible states of a system. However, some scholars argued that the notion of variety can be overwhelming and sometimes unpractical. Further, variety as a numerical measurement of complexity may not be theoretically and practically informative. Theoretically, the notion of variety does not distinguish between the potential and actual states of a situation. The paper will argue that this may limit efficiency and resilience, especially during disasters. Practically, variety might be deceptive for decision-makers regarding the nature of the complexity that they face. This may lead to counterproductive decisions, especially when rapid decision-making is required. A novel conceptual proposition that distinguishes between variety and complexity is introduced in this paper. The distinction considers the potentiality and actuality factors. It proposes the characteristics of each notion based on several criteria. This proposition contributes to the VSM in three ways. First, it closes the theoretical gap of not distinguishing between potential actual states. Second, it can enhance the effectiveness and the efficiency of organisations that adopt the VSM complexity management approach. Third, this distinction can boost organisations' resilience during situations when rapid decision-making is required.

### **7.4.3. Complexity Management in Viable Systems:** A New Complexity Classification for Resilient Operations (EJOR)

The VSM's approach to managing complexity is based on attenuating external complexity and amplifying internal complexity. This aims at enabling the system to be in control by maintaining more complexity than that of its environment. However, the VSM does not advise users on the types of complexity that they need to regulate (attenuate and amplify). The paper argues that the operational value of the complexity classification that is introduced by some VSM scholars may be limited. The classification leaves decisionmakers to their own judgment, and may be confused, on what actions should be taken when they are faced with complexity. Lacking an operationally useful classification of complexity is a gap in the VSM. The negative implications of this gap can increase during emergencies when a rapid-decision making is required at the operational level. In such conditions, the dilemma of determining the best autonomy-control equilibrium in the system becomes more apparent. This is still an issue in the VSM. This paper introduces novel propositions that use four operationally-useful criteria to classify complexity and its generators. Theoretically, this closes the complexity classification gap in the VSM. It also contributes to the debate on how to safely grant more autonomy to the operation units. For the VSM, it contributes to enhancing the level of resilience that the VSM can offer in stressful situations. Practically, this classification can support operational units in making timely decisions. It also facilitates designing policies that can explicitly standardise the process of decision-making across the organisation.

## 7.5. SUMMARY

The research studied the systemic and viable characteristics of the response system. For the systemic characteristics, novel concepts were developed to close gaps in the theory that may hinder systems' resilience during disasters. For the viable characteristics, gaps in the complexity management concepts were identified. Novel propositions and models were developed that can enhance systems' resilience and viability beyond survival through an agile and resilient complexity management. The research concluded by stating the main contributions, potential research papers, and the gaps that were identified as a result of conducting this research. Further research can validate the findings and develop the novel models to contribute to enhancing the resilience of diverse types of organisations that operate in various contexts.

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## APPENDIX

# COMPLEXITY ENGINEERING FOR VIABILITY BEYOND SURVIVAL

Complexity engineering is a set of principles (or steps) to managing complexity. It is a development of variety engineering (Beer, 1979, 1985) and its steps that are explained by Espejo and Reyes (2011). The need for complexity engineering arises from the necessity to embed the new concepts and models that were discussed in the previous sections and to close the gaps that were identified in the traditional variety engineering. These gaps were identified when testing the VSM under the chaotic and stressing conditions of disasters. The term complexity engineering is used to (1) distinguish it from Beer's variety engineering and to (2) emphasise its focus on addressing complexity in light of the distinctions made between variety and complexity. Table A shows the difference between variety engineering and complexity engineering.

**Table A: Variety Engineering versus Complexity Engineering**

| Variety engineering | Complexity engineering |
|---|---|
| 1. The management produces detailed and fixed performance criteria and CD list | 1. Broad, flexible and adaptable criteria for managing complexity (it can be designed for a narrower context/environment). |
| 2. It supports a top-bottom approach to managing complexity | 2. It supports a recursive approach to managing complexity |
| 3. Not resilient when faced with new complexity | 3. Resilient and applicable to new and unpredictable complexity |
| 4. Process focused | 4. Focuses on maximising resilience |
| 5. Aims at viability | 5. Aims at viability beyond survival |

Complexity engineering proposes the following steps to manage complexity during disasters:

1- Agreeing on a purpose of managing complexity
2- Establishing performance criteria to achieve the Purpose
3- Assign responsibilities for complexities regulation
4- Creating policies
5- Regulating complexity

## Agreeing on a Purpose of Managing Complexity

This step is cognitive and is *led* by S5 (the organisation's brain). The decision-making process should involve different stakeholders to avoid any future conflicts that can disturb the complexity management operations. The aim of this step is to align activities and establish the foundation to work effectively and coherently. This alignment involves individual purposes (the meaning that individuals ascribe to their actions) and situational purposes that is the purpose of carrying out a shared task (Espejo and Reyes, 2011) in a selected area and time.

The purpose of managing complexity can be broad such as enhancing resilience, maintaining viability or achieving the system purpose (e.g. saving lives for emergency services and maintaining law and order for police). It can also have shorter-term goals such as reducing costs, be more effective, enhancing the quality of service, and protecting the organisation's identity. Analysing this purpose follows the *fractal* (or recursive) rules of analysing complexity (Hoverstadt, 2008). This allows S5 to use its recursion knowledge to decide on the most suitable level to be addressed.

This step is similar but not identical to Espejo and Reyes' (2011) step of assigning a purpose of the situation. In the latter, the focus is on making the numerous implicit purposes explicit and sharing them inside the organisation. Revealing purposes is a strategy to mitigate conflicts among departments (Checkland, 1999) when dealing with complex situations (Espejo and Reyes, 2011). However, in both case studies in this research, the official participants had a common purpose, which is to save lives and respond to the disaster. Yet, each agency exercised this purpose from their perspective. Eventually, the agency that had more authority could enforce its perspective on other agencies thorough controlling actions on the ground. However, complexity engineering requires an agreement on assigning a purpose to managing complexity. Although the purpose of managing complexity may be in some cases identical to the purpose of the situation, focusing on action (managing complexity) can have advantages. The former approach can lead to asking higher-level and inclusive questions such as why to respond, save lives, and maintain law? An answer to these questions can be: support communities' resilience and wellbeing. Having such purpose can lead to a different and more open understanding of how to manage complexity (e.g. SVs).

## Establishing Performance Criteria

For the previous step to be practical, performance criteria should be established. Espejo and Reyes (2011) use the criteria to help the management in identifying the CDs affecting the system's performance. Although this can be useful, it is not comprehensive enough to respond to the dynamicity of CDs in the social domain, especially during disasters. Two justifications exist for the latter claim. First, as discussed, the type of complexity that a single CD generates and the role it plays in relevance to the system can change continuously. Second, Espejo and Reyes (2011) did not clarify whether S1 or S3 (directly dealing with CDs) can be involved (autonomously or collectively) in selecting both the performance criteria and the CDs.

Deciding on the relevant CDs on the S5 level can negatively impact resilience in two ways. The first is the rigidity that a predefined CD list can suggest for S1. S1 cannot work beyond S5's instructions and thus to respond to emerging CDs. The second is a result of the latter. S1 may prefer to escalate the complexity and the CDs that are not in the list to avoid any liability of the consequences of the decisions they may take. This was evident in the findings. For example, when the fire officer in CS2 said that they would escalated many SV cases to their supervisors, who in turn escalated it to S5 to avoid liability. Hence, imposing rigid criteria on S1 by S5 can lead to intentionally or unintentionally having an autocratic type of management. Autocracy is a threat to viability and resilience (Beer, 1979) because it hinders making decisions at the closest function to where information is available (Rios, 2012).

Another benefit of having performance criteria is enabling reflection and improvement. The criteria provide operators with tangible and explicit means of evaluating their experience and improving accordingly. During disasters, the five VSM functions would refer to these criteria to learn whether their actions on complexity and CDs were successful.

What could be missing in Espejo and Reyes' (2011) approach is an explicit tool that enables robust decision-making in regard to defining performance criteria and selecting CDs. Complexity engineering uses the complexity and the CD models for this purpose. It also suggests that these models may be used by S1 to make decisions. This can contribute to solving the problem of escalation and liability because (1) it gives S1 the needed confidence and authority to make decisions and (2) it increases S5's confidence in S1 decision-making process. Thus, this proposed step enhances resilience and viability by authorising any function of the system to make timely and informed decisions according to flexible decision-making criteria, that are shared among all aspects of the system. This also contributes to solving the unaddressed Stafford Beer's reference to the subjectivity of the VSM and the control-autonomy paradox. It promotes using a more holistic lens when selecting and evaluating CDs.

Table B shows an example of the difference between using complexity engineering and variety engineering when deciding on the purpose and performance criteria when responding to a disaster.

**Table B: The Purpose and Performance Criteria in Complexity Engineering and Variety Engineering**

| Complexity Engineering | | |
|---|---|---|
| **The purpose of the response (S5)** | Criteria (holistic) | Implementation |
| **Support communities in the face of a disaster (customer-centred)** | Communities self-response is enabled | - % of SVs engaged<br>- % of problematic SVs addressed<br>- % of community members satisfied |
| | Reduce the impact of the disaster | - % of water flow reduction<br>- % of flooded houses cleared<br>- % of residents evacuated<br>- % of causalities are served |
| | Enhance the responders' capability | - % of voluntary organisations involved<br>- % increase in resources<br>- % trustworthy sources of information<br>- obtain knowledge of the situation |

| Variety Engineering | | |
|---|---|---|
| **The purpose of the response (S5)** | Criteria (narrow) | Implementation |
| **Respond to a disaster (self-centred)** | - Unexpected SVs not addressed<br>- Unexpected donations are not addressed<br>- New opportunities are not utilised | Cannot manage (or take responsibility for managing) unexpected complexity |
| | - % of water flow reduction<br>- % of flooded houses cleared | - % of water flow reduction<br>- % of flooded houses cleared |
| | - % of people evacuated<br>- % of causalities addressed | - % of people evacuated<br>- % of causalities addressed |

## Assigning Responsibilities for complexity Regulation

This is about defining the responsibility of different system's functions and stakeholders in terms of two aspects. The first is the responsibility for variety and/or complexity. The second is the scope of operations. Regarding the former, the complexity and variety flow model (Figure 2.6 in Chapter 2) can serve as guidance. It shows that variety is only generated by S4 and is processed by S4 and S5. On contrary, complexity is processed and generated by all CDs inside and outside the system. However, some emergent cases might require the system to assign a stakeholder or a VSM function to handle variety. For instance, assign the CG to simulate what can wrong in their village based on their local knowledge.

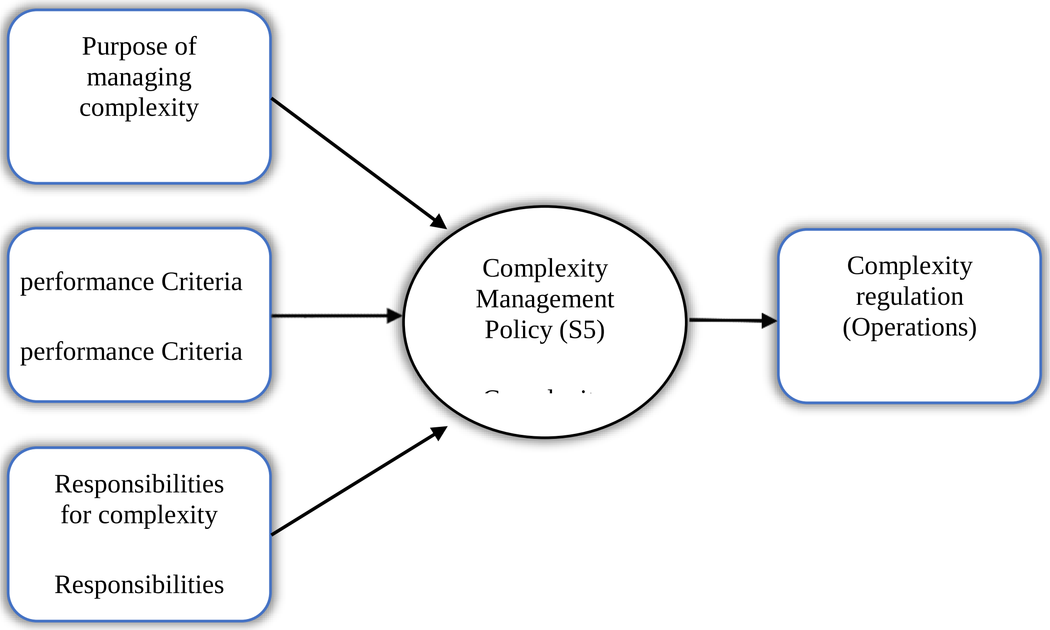
The scope of operations concerns the complexity load that each stakeholder has to manage. This step divides the responsibility of managing complexity according to complexity type, the source, or the geographic area where it is generated. For instance, the guidance may suggest that the community-generated complexity may be only processed by the official S1 units. Similarly, donations-related tasks can be assigned to SVs. Another example of the type of complexity is assigning the responsivity of managing supportive SVs to the CG.

## Creating Policies

The previous three steps for complexity regulation should be documented in a policy. Such policy formalises the roles of different stakeholders and defines liability. It clearly communicates the level of autonomy that each stakeholder enjoys and provides them with the means to exercise it (how and who to judge and regulate different types of complexity). However, these policies should not be very specific and detailed (vertically) as is commonly practised. Vertical detailing means having instruction to staff on conducting the activities all the way to the lowest recursion levels. This resembles a micromanagement practice that is not compatible with innovation, flexibility, adaption to change (Gharajedaghi, 2011), and thus resilient organisations.

Nevertheless, policies cannot cover all the emergent complexity that may face the system, especially during disasters. Even if this was possible, this would be an infinite document that staff cannot possibly remember or follow. Policies in complexity engineering should contain a set of general frameworks on how to make judgements in the light of the operations purpose and performance criteria.

**Figure A: The Policy Components in Complexity Engineering**



## Regulating complexity

This step is different from Espejo and Reyes' (2011) step of designing a set of attenuator and amplifiers. In complexity engineering, designing such sets is not exclusive to S5 nor does it suggest a mere in-advance planning. Regulating complexity is about executing operations by using the proposed complexity regulation principles (models). As such, different S1 units can have their own attenuators and amplifiers as long as they adhere to the policy, serve the purpose of the operations, and reduce the residual complexity that is escalated up the recursion scale. S1 can design these regulators during its operations in light of the emerging CDs and the complexities that they generate.