



# Applying Universal Design Principles in Emergency Situations

## An Exploratory Analysis on the Need for Change in Emergency Management

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**Abstract.** The United Nations Convention on the Rights of Persons with Disabilities (CRPD) obligates States' to take all necessary measures to ensure the protection and safety of persons with disabilities in emergency situations. While these requirements represent one aspect of this article's aims, it also focuses on how another paradigm, universal design, can and should offer a useful approach to emergency situations and management. Referring once more to the CRPD, universal design is defined as the "design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design". Consequently, universal design should provide a valid framework for identifying and removing usability and accessibility barriers in emergency situations. Using a heuristic analysis, this article intends to offer a preliminary reflection on the following question: "To what extent can universal design principles be applied to emergency management situations?".

**Keywords:** Emergency management · Universal design · Accessibility · Disability · Emergency situations · Situational disability · Disability rights

## 1 Introduction

According to the United Nations Convention on the Rights of Persons with Disabilities (CRPD) and under international law, international humanitarian law, and international human rights law, States Parties have an obligation to take all necessary measures to ensure the protection and safety of persons with disabilities in emergency situations. Emergency situations can refer to a range of events that pose immediate threats to an individual's life, health, or property (Fitzpatrick 1994 in Kutty 2007) and may include, among others, armed conflicts, natural disasters, epidemics, or famine. From a disability rights perspective, emergency situations pose unique barriers both for persons with physical, sensory, cognitive or psychosocial disabilities as well as those with temporary or situational disabilities. Scholarship has conceptualized disability as the interaction between an individual with impairments, the activities with which they want to engage, and the environmental and attitudinal barriers that limit or prevent them from performing those activities (Shakespeare et al. 2006). Situational disabilities

describe the experience of persons with temporary forms of impairments. For example, a person experiencing sleep deprivation, due to jetlag or other causes, may experience a temporary cognitive impairment and as a result is situationally disabled. Other forms of situational disability, such as hearing impairments, may occur as a result of overexposure to sounds at loud volumes or visual impairments that occur when a person is exposed to smoke during a fire.

Accessibility is one of the primary aims of the disability rights movement, and has been enshrined in national and international legislation including the CRPD under Article 9 (Lid 2010). Under the CRPD, States Parties have an obligation to ensure access to, among other things, the physical environment, to information and communications technology (ICT), and to facilities and services open to the public. In other words, national governments have an obligation to ensure the accessibility of all relevant environments, systems, and services used in emergency situations for persons with disabilities. Article 9 of the CRPD goes on to state, in section 2(b) that accessibility includes the elimination of barriers that persons with disabilities may experience accessing “information, communications and other services, including electronic services and emergency services”. While these obligations for accessibility represent one facet of this article’s ambitions, another paradigm, universal design, provides a useful basis for considering situational disabilities. According to the CRPD, universal design refers to the “design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design”. As such, universal design provides a useful framework for considering the design of emergency management systems and may provide a basis for identifying and removing usability and accessibility barriers in emergency situations.

However, research has, only to a limited extent, examined the usability and accessibility barriers that persons with disabilities and everyone experiences in emergency situations (Christensen et al. 2007; Rowland et al. 2007; Kett and Van Ommeren 2009; Alexander et al. 2012) and has yet to fully examine the accessibility and universal design of emergency management systems and services (Rauschert et al. 2002; Kailes and Enders 2007; Malizia et al. 2008; Nick et al. 2009) This article aims to report on research-in-progress and to provide a preliminary and exploratory analysis of the application of universal design principles to emergency situations. The question this article asks is: “To what extent can universal design principles be applied to emergency management situations?”. Using a modified form of a heuristic analysis, this article poses an initial consideration of universal design in emergency situations, and concludes that, among other things, future practitioners could usefully integrate universal design principles in emergency management systems and services to ensure that persons with disabilities and everyone do not experience usability or accessibility barriers in emergency situations. In addition, this article recommends that future scholarship use a universal design framework for empirically examining the universal design of emergency situations from a social equality, human diversity, usability and accessibility, and participatory process perspectives.

## 2 Analytic Framework

### 2.1 Human Rights and Emergency Situations

Notwithstanding all the improvements in international rights protection since the Universal Declaration of Human Rights in 1948, national and international governments are not close to achieving an acceptable standard of conduct by States during internal conflict (Fitzpatrick 1994 in Kutty 2007). Research suggests that public emergencies pose a heightened threat of serious and systematic human rights abuse when States employ extraordinary powers to address threats to public order (Oraá 1992). In 1966, the UN adopted the International Covenant on Civil and Political Rights, which obligates States to notify the international community promptly when they suspend their human rights obligations during national crises (art. 41). Two criteria are central to the derogation articles in international human rights treaties: the presence of a public emergency threatening the life of the State, and the necessity to adopt emergency measures due to the exigencies of the situation (Fitzpatrick 1994 in Kutty 2007). Nevertheless, governments all over the world have declared states of emergency in response to a wide variety of crises, including political unrest, general civil unrest, criminal or terrorist violence, labor strikes, economic emergencies, the collapse of public institutions, the spread of infectious diseases, and natural disasters (U.N. Treaty Collection Database). The “Lawless” criteria for declaring a state of emergency, on the other hand, affirms that the threat must be present or imminent, exceptional, and a “threat to the organized life of the community”. As a consequence, even the threat posed by terrorist groups such as Al Qaeda seldom justify a declaration of emergency (Criddle and Fox-Decent 2010).

Scholars have suggested an agreement on four non-derogable human rights: (1) the right to life; (2) prohibition of torture; (3) prohibition of slavery; (4) prohibition of retroactive penalties for crimes (Fitzpatrick 1994 in Kutty 2007). To this list, the International Covenant on Civil and Political Rights adds three more non-derogable rights: the prohibition of imprisonment for breach of contract, the right to recognition as a person before the law and the right to freedom of thought, conscience and religion. Left apart the theoretical aspect, there appears to be no universal acceptance of any of these (Fitzpatrick 1994 in Kutty 2007). In the context of the aims of this article, research on human rights and emergency situations suggests that although States may suspend their human rights obligations, it is only under a narrow criteria of what constitutes a state of emergency. It is unclear, however, whether and to what extent obligations for accessibility constitute a non-derogable right for persons with disabilities.

### 2.2 State of the Art in Emergency Management

#### Decision Support Systems in Emergency Management

Technology has permeated every aspect of our lives, intertwining itself with the very fabric of our society (Schwab 2016) and bringing important changes and innovations, including widespread and broadly accessible internet, smaller, cheaper and more

powerful sensors, artificial intelligence and machine learning (Kuruczleki et al. 2016). This dramatic development naturally brings extensive efforts to apply these technologies to the design of systems for support of systematic risk analysis, decision support systems for operating crews during plant disturbances and accident control, and for support of the general emergency management organization (Andersen and Rasmussen 1988). Numerous analyses have demonstrated how investing in information technologies to a regional, national or international level may vitally improve the capacity to respond to disasters (Hamit 1997; Li and Yang 1997; Xu et al. 1996; Zhu and Stillman 1995).

In recent years emergency preparedness has become a prominent component in national contingency programs in order to improve public health and safety, and emphasis has been placed upon building computer-based decision support systems (DSS) (Chang et al. 1997). Especially now, emergency response organizations face complex and unpredictable events with high risk of catastrophic losses. To assist emergency response organizations in responding to these events, new models must be developed, and the traditional command and control structure of decision-making must be revised to accommodate greater flexibility and creativity by teams (Mendonça et al. 2001). A good decision support system for managing emergencies must be an integrated system, using most advanced computer and communication technologies and should contain strategic components such as a state-of-the-art Geographic Information Systems (GIS), sophisticated models for damage projections and appropriate models for the estimation of the evacuating population and their behavior (Tufekci 1995). Designing emergency response strategies is often complicated by the necessity of simultaneously considering large amounts of relevant data, applicable simulation models, computational speed, display resolution, and required spatial analysis (Chang et al. 1997), therefore in Tufekci's view a valid decision support system would not be merely a collection of processors. On the contrary, it would be a distributed computers and communication network interconnected with intelligence and in constant interaction with one another, like a multiagent architecture (Tufekci 1995). From a universal design perspective, DSS may provide new opportunities for securing the safety of persons with disabilities including persons with situational disabilities in emergency situations.

### **ICT in Emergency Management**

Communication in emergencies, especially among partner organizations, is crucial in order to make informed decisions under uncertain conditions and to engage individuals and communities in collaborative efforts to prepare for, respond to, and recover from disasters (Fleischer 2013). For these purposes in the last years, several information communication technologies (ICTs) have been introduced in emergency management at various levels (Shneiderman and Preece 2007; Jaeger et al. 2007a, b). The still emerging field of ICT in emergency management suggests that service providers continue to face challenges integrating ICTs with contemporary emergency management practices to improve performance and to strategically align ICT use with the needs and requirements of emergency management (Vogt et al. 2011). Adopting ICT in emergency management networks could lead organizations to a better understanding of their potential and to enhance communication and coordination between organizations,

strengthening their performance (Hu and Kapucu 2016). Nevertheless, few systematic empirical studies have investigated ICT utilization patterns in emergency management organizations and their potential for easing coordination and communication among those organizations (Bunker and Smith 2009).

Various ICT tools are currently utilized in emergency management both from organizations and local residents, such as geographic information systems (GIS) and global positioning systems (GPS) (Cutter et al. 2007; Vogt et al. 2011) and information systems that contribute to emergency managers' decision-making gathering and processing information (Carver and Turoff 2007). In times of emergency, GIS and GPS can allow organizations to receive satellite information and produce accurate location information about the affected areas and during evacuation procedures locate members of the community, in particular persons with disabilities, to better serve them and, potentially, save their lives (Hu and Kapucu 2016). ICTs can help improve information dissemination and reduce communication costs. When ICTs first started to boom in the 1990s, scholars called attention to integrating information technology into decision-making in emergency scenarios to help mitigate the high levels of complexity and uncertainty associated with such emergencies (Comfort 1993). While traditional radio and TV news remain crucial channels for emergency broadcasting and updates to the general public, the broadly accessible Internet and wireless technologies allow for new channels and methods of communication (Cutter et al. 2007). From a universal design point of view, ICT tools in emergency management may allow organizations to consider more accurately the complex variety of needs that arises in emergency situations.

### **Social Media in Emergency Management**

Disaster situations are non-routine events that result in non-routine behaviors. In times of disaster, people and organizations adapt and improvise (Wachtendorf 2004) to suit the conditions. While traditionally citizens affected by disaster situations relied on emergency officials and news media to provide them with information, in recent years social media has expanded access to information and increased the speed at which information can be distributed (Hughes and Palen 2012).

With growing access to the Internet, the pervasive adoption of mobile technology, and an explosion of social networking services, exponential amounts of socially-generated data are publicly available. For instance, users can share disaster-related information in real-time and seek support through their networks of users, which challenges the belief that emergency officials are the only legitimate source of information (Perng et al. 2012). Diverse social media platforms such as Twitter and Facebook have also been used to support grassroots participation by citizens in emergency management (Hughes and Palen 2012; Veil et al. 2011). Even emergency response organizations, which are strongly organized around locally- and federally-mandated protocols, adapt to accommodate the situation in terms of warning, rescue, and recovery (Sutton et al. 2008), especially since they face new demands by members of the communities to provide information through social media services (American Red Cross 2011). As a consequence of the pressure to incorporate information from the public into emergency response effort, the formal institutions of emergency management are shifting (Palen and Liu 2007). In the United States, the National Incident Management System (NIMS), specifies the structure and procedures for these formal response

organizations. Though questions of how and when to participate in the social media arena remain, many PIOs incorporate information and communication technology (ICT) into the public communication aspects of their work (Hughes and Palen 2012). Taken from a universal design perspective, including Social Media in emergency management procedures may crucially improve users' participation in dealing with extraordinary situations, while taking into account the variety of human necessities.

### **Disability in Emergency Management**

According to the U.S. Census Bureau, disadvantaged populations include persons with disabilities, elderly, indigent and illiterate, and cover more than 50% of the U.S. population. Given this demographic data, continuing to use the term "special needs" does a disservice to every group included and greatly weakens the chances of planning for specific needs and providing an effective, comprehensive response (Kailes and Enders 2007). Notably, disasters, terrorism and other emergency situations instantly increase the number of people with new disabilities and functional limitations, both as a physical or psychological consequence of the traumatic event and due to the environment's conditions. In addition, emergencies can intensify an individual's vulnerabilities and fears (Nick et al. 2009).

Disaster preparation and emergency response processes, procedures, and systems can be improved for the population as a whole by eliminating the use of a "special needs" category and integrating consideration of human diversity into the fabric and the culture of emergency management and disaster planning. As long as disability and other socially disadvantaged groups are viewed as unique or special, the system's existing inefficiencies and inefficacies will continue (Kailes and Enders 2007). Adopting the universal design perspective is therefore a necessity in order to overcome the term "special needs" and start considering population as a totality of different individualities, all deserving consideration.

## **3 Method**

Using a heuristic analysis, this article explores the relevant accessibility and universal design factors in emergency situations. Heuristic analyses are typically used to examine the usability of ICT user interfaces, especially regarding websites (Youngblood and Youngblood 2013; Bonastre and Granollers 2014) and this article aims to adapt the heuristic analysis approach to apply it as a framework for an exploratory analysis of human rights in emergency situations. In particular, the heuristic analysis will help frame the necessity for adopting universal design in emergency situations.

A heuristic evaluation or expert review of a web or mobile site, is based on a set of predetermined heuristics or qualitative guidelines often grounded on a set of ten criteria elaborated by Nielsen (1994):

1. Visibility of system status - The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
2. Match between system and the real world - The system should speak the users' language, follow real-world conventions, making information appear in a natural and logical order.

3. User control and freedom - Users often choose system functions by mistake and the system should support undo and redo.
4. Consistency and standards - Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
5. Error prevention - a careful design which prevents a problem from occurring in the first place.
6. Recognition rather than recall - Minimize the user's memory load by making objects, actions, and options visible.
7. Flexibility and efficiency of use - Allow users to tailor frequent actions.
8. Aesthetic and minimalist design - Dialogues should not contain information which is irrelevant or rarely needed.
9. Help users recognize, diagnose, and recover from errors - Error messages should be expressed in plain language, precisely indicate the problem, and constructively suggest a solution.
10. Help and documentation - Any information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Using a heuristic analysis, this article explores the application of three sets of universal design conceptualizations and sets of principles. The first set of principles comes from the originally definition of universal design set down by the North Carolina State University in the United States. The second set of principles comes a new definition of universal design posed by the WBDG Accessibility Committee, and the third set of principles comes from in a forthcoming article on universal design from a human rights lens (Giannoumis and Stein 2019).

## 4 Universal Design in Emergency Situations

### 4.1 Traditional Conceptualizations of Universal Design

As initially conceived, universal design focused on usability issues. "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Mace 1985). A working group of architects, product designers, engineers and environmental design researchers from the North Carolina State University established seven principles of universal design, with the aim to guide a wide range of design applications and disciplines and for educational purposes. The first principle is the equitable use, and states that the design must be useful and marketable to people with diverse abilities. The second principle affirms that the design should accommodate a wide range of individual preferences and abilities, while the third adds that it also must be simple and intuitive to use. The fourth principle asserts the importance of perceptible information: the design must communicate necessary information effectively to the user, no matter ambient conditions or the user's sensory abilities. To align itself to the fifth principle, the design should have a valid tolerance for error and minimize hazards and negative consequences of unintended actions. The sixth principle establishes the need of low physical effort, allowing the users to handle it comfortably and efficiently and with minimum fatigue. The seventh and last principle states the necessity for appropriate space and size for

approach, reach, manipulation and use of the design, regardless of users' body size, posture, or mobility (The Center for Universal Design 1997).

To adopt these principles in emergency management implies that the design of emergency procedures itself has to take into consideration equitable use and contemplate as many human characteristics as possible, in the smoothest way possible. One area to consider in an emergency situation, is the provision of clear information, which is exactly the focus of the fourth principle. Emergency response organizations are faced with complex, unpredictable events with the risk of catastrophic losses (Mendonça et al. 2001) and, therefore, applying the tolerance of error principle would accommodate greater flexibility and creativity by teams. The last two principles highlight the necessity to optimize the action for the lowest physical effort and the most appropriate size and space.

## 4.2 Universal Design as a Means for Social Inclusion

In the last ten years, the community of universal design practitioners have increased their attention on social inclusion issues and a new definition of universal design was posed by the WBDG Accessible Committee, Steinfeld and Maisel. It defined universal design as “a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation” (Steinfeld and Maisel 2012), making life easier, healthier and friendlier for all. In order to achieve said definition, Steinfeld and Maisel also indicated eight criteria for universal designing:

- *Body fit.* Accommodating a wide a range of body sizes and abilities
- *Comfort.* Keeping demands within desirable limits of body function
- *Awareness.* Insuring that critical information for use is easily perceived
- *Understanding.* Making methods of operation and use intuitive, clear, and unambiguous
- *Wellness.* Contributing to health promotion, avoidance of disease, and prevention of injury
- *Social integration.* Treating all groups with dignity and respect
- *Personalization.* Incorporating opportunities for choice and the expression of individual preferences
- *Cultural appropriateness.* Respecting and reinforcing cultural values and the social, economic and environmental context of any design project.

In this perspective, universal design provides a tool to develop a better quality of life for a wide range of individuals and to reduce the economic burden of special programs and services designed to assist individual citizens, clients, or customers while supporting people to be self-reliant and socially engaged. It also reduces stigma by putting people with disabilities on an equal playing field. While it would not substitute assistive technology, universal design would definitely benefit people with functional limitations and society as a whole. In the same way, tailoring emergency responses to the widest number of possibilities will reduce the need for specific, “special needs”, intervention (Kailes and Enders 2007).



### 4.3 Universal Design from a Human Rights Lens

The last set of criteria this article considers is elaborated by Giannoumis and Stein (2019) and, while recognizing universal design as crucial in promoting accessibility for persons with disabilities, reframes universal design as a means to promote substantive equality for everyone. The article acknowledges that universal design arises from the complex relationship between human rights, disability rights, and access to and use of technology and, consequently, the article argues that universal design can promote equality through four principles that shift the focus from universal design as an outcome to universal design as a process:

- *Social Equality*: a more structured approach for understanding universal design should use equality and non-discrimination as a reference point for implementing universal design in policy and practice. Such an approach would position universal design, similar to accessibility, as a mechanism for promoting equality.
- *Human Diversity*: universal design can ensure a truly universal experience by considering the barriers that people experience across all forms of disadvantage, as well as the complex, overlapping, and multidimensional barriers that exist at the intersection of multiple forms of disadvantage.
- *Usability and Accessibility*: taking into account access as an interdependent component of use extends universal design considerations from how the design is used, to include considerations on whether and to what extent it can be accessed.
- *Participatory Processes*: a set of principles for universal design should take into account user participation as an integral element in the design and development of ICT. (Giannoumis and Stein 2019)

Applying this set of criteria to emergency management implies a shift in perspective to truly consider universal design as a process instead of an outcome. Using this set of criteria universal design in emergency situations can move beyond the accessibility of specific user interfaces and environments to considering the equality of people across the diversity of the human experience when it comes to accessing and using emergency management systems and services. One of the key features of Giannoumis and Stein's (2019) approach, in terms of emergency situations, is the active and substantive involvement of all relevant stakeholders and their representative organizations in the design and development of these systems and services. This could take into account the experiences of, for example, persons with physical or psychological disabilities, women, students and youth, people from minorities, elderly, families and more. Each individual has different experiences and different needs regarding every aspect of life and approaching to ICT is no exception, especially extra-ordinary situations.

## 5 Conclusions and Future Work

According to the United Nations CRPD, States Parties have an obligation, to take all necessary measures to ensure the protection and safety of persons with disabilities in emergency situations. While these obligations for accessibility represent one facet of

this article's ambitions, another paradigm, universal design, provides a useful basis for considering situational disabilities that often occur in emergency situations. Universal design is defined as the "design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design". Hence, universal design offers a valuable framework for considering the design of emergency management systems and for identifying and removing usability and accessibility barriers in emergency situations. By means of a heuristic analysis, this article poses an initial consideration of universal design in emergency situations, and concludes that universal design principles could be usefully integrated in emergency management practices, to ensure that persons with disabilities, and everyone, do not experience usability or accessibility barriers in emergency situations. Furthermore, this article recommends a universal design framework for empirically examining the universal design of emergency situations from a social equality, human diversity, usability and accessibility, and participatory processes perspectives.

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