USING THE OPEN SYSTEMS PERSPECTIVE TO UNDERSTAND CRITICAL INCIDENTS

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Abstract

At the end of its Fall 2010 conference, the Academy for Critical Incident Analysis (ACIA) called for the development of frameworks that would aid in the study and analysis of critical incidents. This paper responds to that call. The paper answers the question, "is it possible to construct a framework that is generic enough to encapsulate the essential components observed in all critical incidents?" The paper utilizes the open systems perspective to develop a conceptual framework to help us delineate and understand critical incidents and how they evolve. The paper presents examples to substantiate arguments made about the framework. The chief example relied on for this purpose is Hurricane Katrina in 2005. Open systems is a good candidate to help our understanding of critical incidents because like critical incidents an open system is one whose component parts are so interrelated and interdependent that any change in one component produces simultaneous changes in other components and so alter the thing as a whole. The open systems perspective helps us to focus on the dynamical nature of critical incidents. In addition, open systems perspective helps us to consider the fact that there is no simple cause and effect relationship in critical incidents, but that there are multiple relationships, and simultaneous consequences throughout the critical incident system. A notable insight gained from utilizing the proposed framework is that critical incidents are non-linear in that the components within the system interact everywhere within the system in a non-random and patterned way. Therefore utilizing a holistic approach to studying critical incidents is essential to understanding these incidents. The paper ends by proposing a series of steps to guide application of the proposed framework.

Introduction

This paper addresses the question: is it possible to develop a framework generic enough to encapsulate the essential components that can be observed in all critical incidents? The author believes that this question is pertinent to the study of critical incidents today as scholars grapple with how to advance the field beyond just the study of critical incident cases. Developing conceptual frameworks that can later be refined, tested and proven or disproved will facilitate critical incident analysis and ultimately theory development. Conceptual frameworks identify a set of variables and the relationships that account for a set of phenomena (Ostrom, 1996). A framework will help us to understand the key elements of critical incidents and the relationships between and among these elements. This is an important step in theory building. According to Ostrom (2005), frameworks organize diagnostic and prescriptive research from which hypotheses are generated; they ask specific questions and make working assumptions about important elements and relationships. Frameworks also help us to show important relationships

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and assist the testing of these relationships. The utility of using the systems perspective in developing this framework is that it moves away from the reductionist, cause-and-effect model to a more holistic, non-linear study of critical incidents. This is a more meaningful approach to analyzing critical incidents.

The paper proceeds as follows. Section one outlines the methods used to develop the arguments for this paper. Section two presents the current definition and model-in-use of critical incidents and discusses the main ideas presented in them. Section three sketches the open systems perspective and discusses how it aids our understanding of critical incidents. Section four outlines the proposed framework, and discusses the key ideas and components of the framework using examples to elucidate arguments. Section five presents a series of steps that should be considered in the application of the framework. Section six concludes the paper.

Methods

The author of this paper uses the proceedings of the Summer and Fall 2010 critical incidents conferences and the critical incident conference of Summer of 2011 to develop a general framework for critical incidence analysis (Academy for Critical Incident Analysis, 2011a; 2011b' 2011c). The Summer 2010 conference focused on a case assessment of Hurricane Katrina as a critical incident, with emphasis on the displaced persons involved. The conference highlighted the multiple dimensions of critical incidents. The Fall 2010 conference focused on trying to articulate a coherent model of critical incident analysis and what factors would be significant. In the Summer of 2011, the conference's focus was 9/11 as a critical incident with special emphasis on the experiences of children who experienced 9/11 and as such highlighted the complexity of critical incidents. In addition, peer-reviewed articles from the first two issues of the *Journal of Critical Incident Analysis* provided information for the framework. The table below gives a sampling of the *Journal of Critical Incident Analysis* sources referenced and the information collected to help with crafting the framework.

Table 1: Select Articles from the Journal for Critical Incident Analysis

Author	*Source*	*Information Used to Develop Framework*
Kirby, E. (Fall 2010).	A Conceptual Model for Critical Incident Analysis. *Journal of Critical Incident Analysis*, 1(1):3-16	Definition of critical incident; Model of critical incident analysis; Types of critical incidents
Till, R. (Fall 2010)	Simulation in Interventions Using Agent Based Modeling. *Journal of Critical Incident Analysis*, 1(1):17-29	Definition of critical incident; Model of critical incident analysis; Actors in critical incident
Colvin, R. (Fall 2010)	Critical Incidents, Invisible Populations, and Public Policy: A Case of the LGBT Community. *Journal of Critical Incident Analysis*, 1(1):30-40	Trigger Mechanisms
Gad-el-Hak, M. (Spring 2011)	Large-Scale Disasters: Mechanistic Framework for Prediction, Control and Mitigation. *Journal of Critical Incident Analysis*, 1(2):105-160	Call for consideration of natural and man-made incidents as dynamical systems; Scope of critical incidents
Coates, D. (Spring 2011)	Disaster and Recovery: The Public and Private Sectors in the Aftermath of the 1906 Earthquake in San Francisco. *Journal of Critical Incident Analysis*, 1(2):161-173	Actors

The paper draws heavily on Hurricane Katrina as a critical incident that can be used to explain the model. With over 1,200 dead, more than 1.5 million people directly affected, and more than 800,000 displaced, it was the largest forced migration since the Dust Bowl migration in the 1930s (DHS, 2008). Additionally, there was over $52 billion in government funds to aid recovery efforts, as well as widespread private sector contributions. Hurricane Katrina resulted in unprecedented ecological and economic impacts, long term psychological impacts including PTSD, and changes in state and federal emergency management laws.

Critical Incidents: Definitions and Models in Use

A critical incident is defined as "a relatively brief occurrence involving injury, loss, conflict, discovery or change of significant proportion, usually unscripted and unanticipated, with the potential to alter existing societal norms" (Ochberg, et. al., 2007).

The pivotal elements of this definition are "change of significant proportion", "alter existing social norms" and "unscripted and unanticipated". Our understanding of critical incidents is defined by our experience of and reactions to them (Gill, 2007). A critical incident causes society or segments of society to stop and take stock – to reflect upon the incident, critically assess the incident, and engage with issues involved in the incident's occurrence, as well as question beliefs, attitudes and behavior (Kirby, 2010). Because there is reflection, large-scale change usually accompanies critical incidents. Critical incidents can also present significant global consequences. For example, the 1979 Three Mile Island nuclear meltdown that resulted in global changes in safety standards for nuclear power plants; the 2004 SE Asian earthquake and tsunami that revolutionized early warning systems applications in coastal communities; and Hurricane Katrina in 2005 resulted to sweeping changes in how we plan and prepare for natural

disasters as well as fundamental organizational changes to the Federal Emergency Management Agency, and better evacuation planning nationally (Bell, 2006).

Critical incidents are unanticipated and unexpected and often so improbable that we cannot even imagine them until they occur. The examples cited above bear testament to our inability to anticipate critical incidents. As a result, it is very difficult to plan for critical incidents. What can be done is to learn from them retrospectively and to put plans and mechanisms in place to mitigate the circumstances that originally led to negative critical incidents, or to facilitate those circumstances that led to positive incidents in the first place.

Although critical incidents are usually negative and traumatic in cause and consequences, they may also lead to positive and uplifting outcomes (Schwester, Dank, & Horning, 2008). In a positive manner, a critical incident would be a serendipitous discovery of a new program that revolutionizes organizational processes. The Civil Rights Movement of the 1960s constitutes a critical incident that resulted in a positive societal outcome especially for disadvantaged segments of the society. In addition, the creation of the World Wide Web is a positive critical incident in that it has completely reshaped the way we live and work, interact with each other, mobilize around issues, and has generally expanded the reach of information and knowledge in ways that could not have been imagined prior to its existence.

Critical incidents are not the same as natural disasters, although they can result from one (Kirby, 2010). The difference lies in the fact that critical incidents tend to follow a more nonlinear pattern of development in that it is sometimes difficult to pinpoint the disaster's beginning or end (Gill, 2007). Gill (2007) points out that: these events cascade and result in new incidents and impacts before they are finally resolved; and that there is a constant stream of new information that leads to renewed perceptions of threat. Critical incidents evolve exponentially, rather than geometrically. Their impacts quickly reverberate nationally or globally. They are not contained at the local level. These points are significant to the study of critical incidents because they highlight the fact that there is not a definite outcome, but multiple possible outcomes of one critical incident throughout its life. This is so because the incidents take unusual turns from the time of initiation (trigger) to stabilization and outcome. We take some time to process the evolving streams of information, understand what that information means, and then try to put them to use to assist with stabilizing the critical incident.

Further, because of their scale and unscripted nature, critical incidents are often associated with high levels of psychological anxiety and stress. Critical incidents often result in significant long term displacement and distress, even for people who do not live in close proximity to the event (Freudenburg, 1997). This was true in the case of Three Mile Island in 1979, and again in the 2004 SE Asian tsunami.

Conceptual Model

Kirby (2010) introduced a conceptual model designed for critical incident analysis based on the 2004 work of Ochberg, et al. This model, shown in figure 1, incorporates the event itself, the demands the event makes on political actors, the influences of policy on the actions taken by the bureaucracy and adhocracy, and the resulting tactics that are fed back into the incident (Goodman, 2008). As shown in figure 1, the political arena consists of interactions between the governors and the governed based on trust (Till, 2010). The bureaucracy and adhocracy consists of management and whatever responsibility they delegate to those who intervene to stabilize a critical incident (Till, 2010). Within the model, the media is shown to influence all other

elements described. The media presents a lens through which the critical incident experience is filtered and common understanding formed. The media therefore is a key player in critical incident analysis.

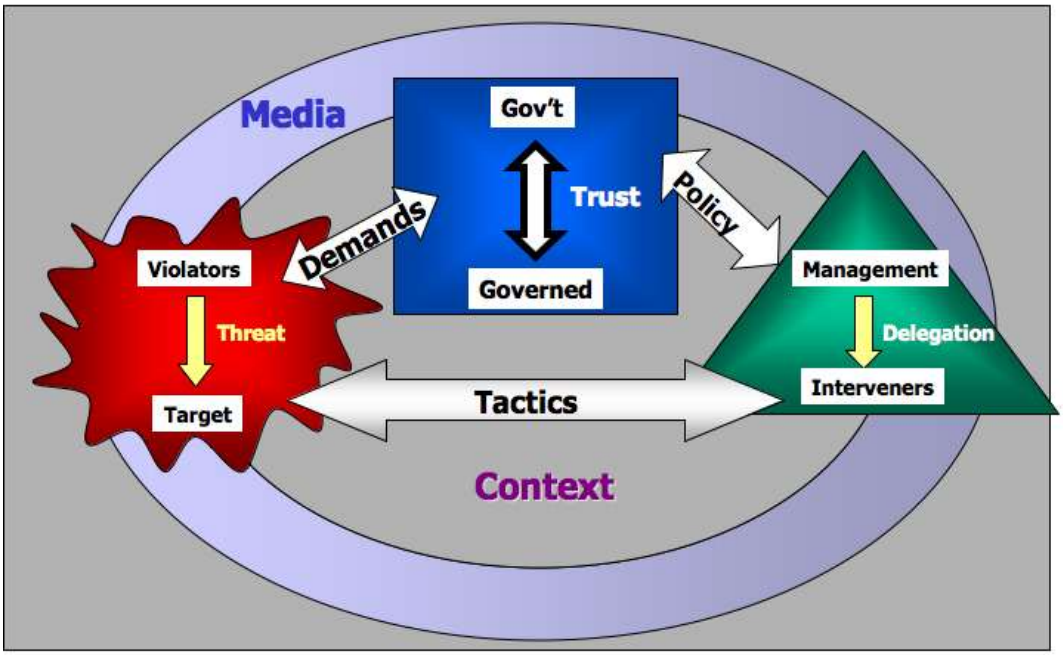

Figure 1: A Model for Critical Incident Analysis by Ochberg, Cinti, Goodman, Houk, Kirby, Lammers, Melia, Prior, & Taggart (2004).

From this initial model of critical incident analysis one can observe components that depict the various interactions that take place during a critical incident. For instance, during an incident government intervene both with the citizenry and with the managers and the managers interact with the interveners to bring the incident under control. The model in figure 1 presents two distinct groups of interactions that take place during a critical incident. Interactions that take place as the critical incident is initiated (interactions between violators and target in the red star-shaped block), and those that occur during response to the critical incident (i.e., those between the governors and the governed, governors and the managers, those between managers – interactions between the blue box and the green triangle). There are also interactions between all three color groups and the media that mediate all these domains during a critical incident. This model still leaves a pertinent question unanswered, how do we know how to identify and label an incident as a "critical incident?"

This author proposes that incidents labeled "critical incidents" can be understood using the open systems perspective. This perspective originated in biological science but has been widely applied in other areas of study in the social sciences including organization theory, chaos and complexity, political economy, computer applications, among others.

Open Systems Perspective and Its Utility for Critical Incident Analysis

To understand open systems, one must first understand what constitutes a system. A system is anything whose component parts are so interrelated and interdependent that any change in one, produces simultaneous changes in other components, and as such alters the thing as a whole (Tompkins, 2005). Examples of systems include the solar system, a thermostat, global economy, the human body, a rainforest, a city, etc. Each of these systems has component parts and processes that constitute its structure. Systems involve input and output of materials or energy that determine how they function. The various parts have functional and structural relationships between them that are nonlinear (Walonick, 1993). Although each component part can be analyzed independently, the utility of the systems perspective is that it helps us to understand whatever is being studied holistically to give a more accurate picture of how the component parts work together as a whole. The fundamental difference between a closed system and one that is open is that open systems *exchange* matter, energy and information with the external environment, closed systems do not.

The open systems perspective focuses on the "external environment and exchanges between the system and the environment so that systems can adapt and renew themselves and continue to grow or take on different states" (Tompkins, 2005, p. #). Environmental forces shape the structure and behavior of the (critical incident) system (Tompkins, 2005). A key consideration in the open systems perspective is the maintenance of equilibrium with the external environment. If the environment is turbulent, as in the case of critical incidents, then the system adapts to deal with rapid change. A calmer environment does not require this type of adaptation. Whereas closed systems' components deteriorate and are completely spent over time, open systems renew and reinvigorate themselves through access to resources from the external environment (i.e., *negative entropy*) and gets more complex and heterogeneous over time (Tompkins, 2005). Hence, the longer a critical incident continues, the more difficult it is to be contained or understood. As the incident evolves there are shifting coalitions of external participants contending to keep the critical incident under control through trial and error in most cases or to keep the momentum going in the case of positive incidents. It is these interactions that determine the outcome of a critical incident.

Bertalanffy (1968) observed that due to the importation of new resources into the open system, the path or outcome of that system is not determined by its initial condition, but by types of interactions that take place between components, and also between components and the environment. As a result, an open system's end state can be reached by any of multiple means (Bertalanffy, 1968). This principle is known as *equifinality*. Components within the system interact in a non-random and patterned way resulting in not one, but many paths to system outcome (Tompkins, 2005). The patterns of interaction in turn, give each system its unique identity which can then be studied.

An important principle of systems functioning is their reliance on continuous *feedback* with their environment (borrowed from the field of cybernetics as articulated by Norbert and Wiener, 1940s). In systems there is continuous throughput transformation of input (information, material, resources) into output or outcome through a feedback loop (Tompkins, 2005). Feedback controls or regulates the system. In the case of critical incidents information, policy action, behavioral change, response and other interventions constitute feedback. Systems experience both positive and negative feedback. Positive feedback will accelerate any change in a system and results in amplification of that change, rather than equilibrium. For example, if a

boulder is rolling downhill, positive feedback speeds up the downhill roll. In contrast, negative feedback reverses the change within the system and moves it to equilibrium. In the case of the boulder, the rolling would slow with negative feedback. As a result of feedback, these systems are viewed by open systems theorists as self–regulating, adjusting to the requirements of the external environment to achieve equilibrium.

Feedback allows for emergence (outcome) which results when independent parts of the system interact because they can no longer act independently, and begin to influence each other (Skytner, 2007). It is this relationship that gives the system its properties and behavior (Skytner, 2007). Because it is not easy to fathom the nuanced relationships that occur within a system, Beer (1979) encourages experimentation with a variety of interventions as well as attempts at discerning patterns of change, and the effects of those changes within an open system. This encouragement is especially applicable for critical incidents that are turbulent in nature.

The benefits of using the open systems perspective to understand and label critical incidents is that open systems allow for an alternative avenue to understand these phenomena outside of a simple cause and effect relationship, but rather to understand them in terms of simultaneous interactions. Using open systems thinking to develop a framework for critical incident analysis allows for the consideration of the dynamic nature of critical incidents.

Critical incidents operate in an input-process-output (or outcome relationship). Among the input components are the trigger that sets off a critical incident and the activating event that pushes the incident into critical mode. Process components are those activities that generally take place during the response to a critical incident. Herein lays the complexity of a critical incident. There are multiple responders from the community, including individuals responding to cascading series of causes and effects (some anticipated; many novel). There are also national and even international responders as the incident almost immediately overwhelms the local resources to cope with the incident. Each response relies on some other response. Each event responded to can potentially trigger other events, some of which are unanticipated (i.e., non-linear). Outcome components are demands from the governed class or citizens on the governors who employ tactics and policies to address the initial trigger, and the results of unfolding. Outcomes also involve measures instituted by communities as they understand more about what happened and try to improve. They also include changes by individuals, who having learned from the critical incident wonder what changes they can make, and later reflect these changes into individual actions. For instance, there are many individuals from the Lower 9th Ward in New Orleans who now volunteer to monitor the levee system (personal communication, June 12, 2010). Identifying the various components of a critical incident facilitates analysis. In order to be able to properly analyze a phenomenon, one first has to put a boundary around it. Utilizing the open systems perspective facilitates this boundary building.

In addition, ongoing case studies done through the Academy for Critical Incident Analysis (e.g., Virginia Tech shootings, Hurricane Katrina, 9/11 terrorist attacks) show other commonalities in all critical incidents. For instance, in our study of Hurricane Katrina several things were observed. First, there are always triggers to critical incidents -something causes or initiates a series of incidents leading to a critical incident – psychological issues with the shooter in the case of Virginia Tech; sheer volume of water from the hurricane putting pressure on the levee system in New Orleans, lack of preparation on the part of city and state leaders in the case of Hurricane Katrina; failure to take credible threats seriously in the case of 9/11, and a lack of understanding of terrorism threat prior to 9/11.

Second, if not properly managed, critical incidents escalate before they are stabilized. Improvisation, policy implementation and feedback are required by a network of interveners including government and citizens, but also the media, and non-government and private sector and individual actors to stabilize critical incidents. Third, critical incidents usually lead to policy changes. In the case of those critical incidents with negative outcomes there is greater regulation of behavior that are intended to detect and deter the actions that lead to the critical incident in the first place. In the case of critical incidents with positive outcomes, there are regulations to facilitate actions that resulted in that critical incident. Critical incidents usually lead to behavioral changes because of lessons learned.

The framework proposed in this paper highlights not only the input and process components, but also outcome components thereby presenting a more holistic way of studying and understanding critical incidents. The framework integrates a feedback loop to show the dynamic nature of critical incidents; they interact and exchange energy, information and resources with the environment, thus allowing critical incidents to be characterized as open systems.

Using the Open Systems Model to Develop a Framework for Critical Incident Analysis

What would a framework that is generic enough to encapsulate the essential components observed in all critical incidents look like? Figure 2 presents a critical incident as an open system that includes several interrelated components linked together in an input-process-outcome relationship informed and regulated by continuous feedback. The thick broken line around the components delineates the "critical incident." The activating event, responses and interventions, lessons and fundamental change leading to transformational changes in policy outcomes, community outcomes, and societal outcomes constitute the critical incident. Critical incidents do not lead to incremental change which results in that being outside the critical incident box.

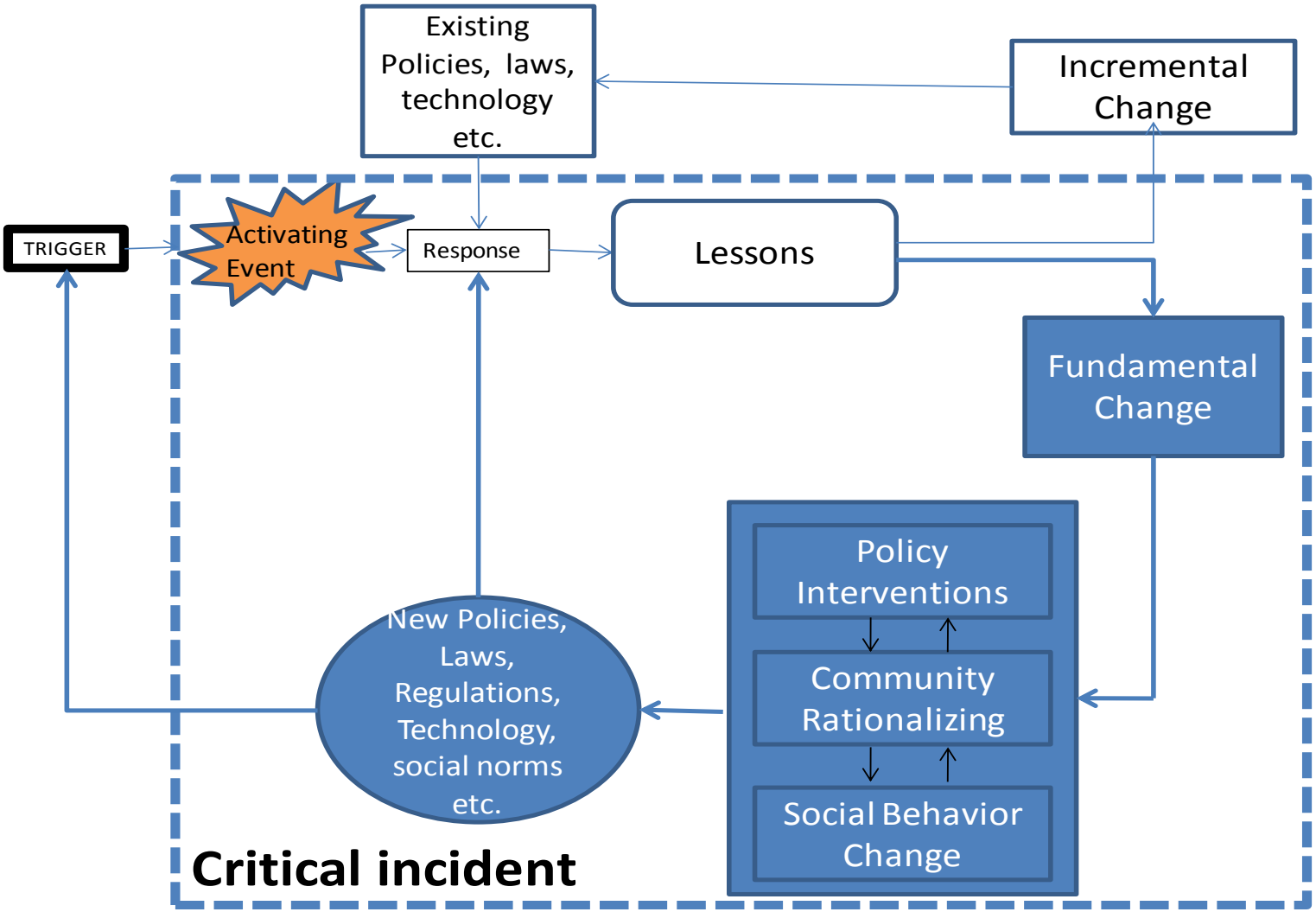

Figure 2: Framework for Critical Incident Analysis

Table 2 shows that the components involved in a typical critical incident can be grouped together into four distinct sets of components – (1) input components, (2) process components, (3) outcome components and (4) a feedback component. Also in the table in italics are the components depicted in the proposed framework in figure 2 as follows:

Table 2: Components Involved in a Typical Critical Incident

(1) Input components	**(2) Process Components**	**(3) Outcome Components**	**(4) Feedback**
Trigger - Natural - Technological - Social (Human) *Activating Event*	*Responses or Interventions* - Multiple causes and effects - Novel, intense, and changing circumstances - Governance systems -Actions, interactions *Community Rationalizing Learning*	*Fundamental Change*: - Behavior - Policy - Institutional - Individual	*Lessons Learned*

Key Elements of the Framework

Input Components

Input components are changes to the system that modify process components. Inputs are detectable changes in the critical incident environment that influence other activities in that environment. These components are described below:

Trigger

A trigger is the originating cause of an event or set of circumstances that result in a critical incident (Freudenburg, 1997). This could be a result of natural, technological, or human actions. Whether outcomes are negative or positive, triggers constitute the underlying instabilities that lead to a critical incident. In the case of Hurricane Katrina, the trigger was the sheer volume of water dumped by the hurricane. The water quickly inundated the levee system and led to its breach in several places.

Activating Event

An activating event is the tipping point (Gladwell, 2000) in a set of instabilities in the environment. An activating event is that point at which the trigger reaches critical mass, the boiling point in a set of instabilities in the environment, the point at which a trigger cascades into a rapidly changing set of circumstances that compels the actors to pay close attention to the rapidly changing and increasing scale of a situation. The levee breach during Hurricane Katrina was the activating event. The breach resulted in the flooding of the city of New Orleans, water contamination and the ultimate demise of over 1,200 people and property damage in the billions of dollars. This case is discussed in greater detail in the sections that follow.

Process Components

Process components are the set of actions that convert inputs into outcomes. Process components are transformative components. While process components are present in all critical

incidents, the interventions taken, actions and events that trigger new effects, policies brought to bear, actors, the way the community and individuals understand and react, and lessons are different in human, technological and natural incidents. The responses to critical incidents usually include novel approaches because the circumstances themselves are atypical or improbable.

Responses or Interventions

Interventions are actions taken to correct or ameliorate the impact/results of the activating event and its consequences. This action is taken by government (federal, state, local), NGOs, private sector agencies, communities and individuals. Because of the scale and the novelty of critical incidents, there are often international actors as well contributing technical expertise and unique resources and skills to the cause. Hurricane Katrina showed this argument to be true. Hurricane Katrina's costs outpaced those typically associated with a hurricane (Waugh & Tierney, 2009) – countries from Afghanistan to Yemen offered assistance of one kind or another. The Netherlands for instance sent dyke inspection teams, Germany sent water treatment specialists, China sent medical experts, the United Nations deployed experts from the High Commission for Refugees as well as those from the World Health Organization (CNN, 2005). In addition, whereas in normal disasters residents are evacuated within their home states, Hurricane Katrina evacuees were spread throughout the country – the volume of evacuees would overwhelm individual states and so had to be shared.

Moreover, an assessment of the timeline of response activities to Hurricane Katrina indicates that each response relies on some other response; that unanticipated events are an integral part of each critical incident, and that each event responded to can potentially trigger other events, most of which are unanticipated.

Timeline

On Sunday, August 28, 2005 at around 9:00 am New Orleans Mayor Ray Nagin issues a mandatory evacuation order for New Orleans on advice from National Hurricane Center Director Max Mayfield that category four storm Katrina heads for New Orleans (Drye, 2005; DeLozier, 2005). National Hurricane Center warns that the storm is potentially catastrophic indicating that some levees in the greater New Orleans Area could overflow their banks resulting in significant storm surge flooding (Drye, 2005); therefore residents in low lying areas are encouraged to evacuate. The Superdome and nine other shelters open to allow people in (DeLozier, 2005). Late Sunday night thousands of New Orleans residents were either unable to leave or chose not to (Drye, 2005). By noon on Sunday August 28, highways are packed, and the city activates contra-flow traffic system to allow for outgoing traffic only (DeLozier, 2005).

By 8:00 am on Monday, August 29, 2005 Mayor Nagin reports that the New Orleans levees have been breached and that water was flowing over the levees. By 11:00 am a major levee has failed in New Orleans dumping water through the 17th Street Canal; the city of New Orleans begins to flood (Drye, 2005). Throughout the day water continues to pour into New Orleans from breaches in the city's levees. The Superdome sustains damage to the roof and other areas of the building with about 10,000 people inside and the National Guard is called in (DeLozier, 2005). The breach was the point at which the trigger reaches critical mass, the boiling point in a set of instabilities in the environment. It is the point at which a trigger cascades into a rapidly changing set of circumstances that compels the important actors to pay close attention to a changing situation.

On Tuesday August 30, about 80% of New Orleans is covered in water; 20 feet in some places (Drye, 2005). FEMA stops volunteer firefighters with emergency experience from entering the city due to the insecurity of the city (DeLozier). There is an official call for anyone with boats to help in the rescue operation. The mayor announces that the city's pumps will fail by sheer volume and intensity of the water flowing into the city. Reports suggest widespread looting (DeLozier, 2005; Drye, 2005).

Wednesday August 31, Governor Blanco orders remaining residents in New Orleans to leave the city; however, there are no buses and trucks to carry out that order (Drye, 2005). Health and Human Services secretary declares federal health emergency throughout the Gulf Coast and sends in medical supplies and workers (DeLozier, 2005). Health related problems beginning to surface as a result of water-borne diseases, environmental pollution from chemicals, lead from petroleum, household pesticides and sewage mix in the cities (Shah, 2005). Buses start to arrive to evacuate about 25, 000 from the Superdome; 52,000 are in Red Cross shelters. By midday the water stops rising in New Orleans. Looting grows exponentially and the police are forced to focus on violence, looting, and carjacking rather than search and rescue (DeLozier, 2005). FEMA water rescue operations suspended because of gun fire (Drye, 2005; DeLozier, 2005). At the same time there is a breach in the London Avenue canal.

Thursday September 1, New Orleans mayor issues desperate SOS to federal government for help (e.g., no food for those seeking shelter in the Louisiana Superdome and the New Orleans Convention Center) (Drye, 2005). The New Orleans Convention Center was never listed in the New Orleans Comprehensive Response Plan as a shelter before its use. On September 2, the U.S. National Guard along with supply trucks arrives in New Orleans; Congress returns from recess, approves and President Bush signs a $10.5 billion in aid bill (Drye, 2005; DeLozier 2005). Friday September 2, President Bush tours the area and acknowledges the government's failure; more national guardsmen deployed to New Orleans. U.S and Europe tap oil and gas reserves as gas prices soar to approximately $3.00 per gallon because of refinery damage (DeLozier, 2005; CNN, 2005). There are explosions at chemical storage plant in New Orleans with resulting scattered fires (DeLozier, 2005). On Saturday September 2, 200 officers walk off the job in the New Orleans police force; two commit suicide. U.S. Labor Department announces $62 million in emergency grants for displaced workers. On September 4, Louisiana Governor Blanco declares state of public health emergency. Monday September 5, most of the gaps in levees closed; 500 New Orleans officers unaccounted for, some refiners restart production. Tuesday, September 6, less than 10,000 people still remained in New Orleans (Drye, 2005; DeLozier, 2005). Thursday September 8, $52 billion in aid approved by Congress to complement $10.5 billion already approved (DeLozier, 2005).

Hurricane Katrina also presented lasting environmental and psychological impacts. For instance Nina Shen Rastogi (2010) noted the high levels of toxicity five years after Hurricane Katrina, while psychologist Matthew Tull (2009) observed the increased severity of post-traumatic stress disorder in those who experienced the event, particularly among those with pre-existing psychiatric disorder. For these individuals there was greater risk of trauma from the event and from watching coverage of the event.

The timeline of events shows the complexity of critical incidents, their non-linearity, and their ability to quickly overwhelm the local, and sometimes even national, ability to cope. The timeline helps to validate the notion of *equifinality* articulated in the open systems perspective and also shows the influence that environmental factors pose for open systems.

Governance Systems

In this context, governance systems are mediating government or organizational mechanisms (local, national and international), as well as individuals (including volunteers) that respond to critical incidents. They comprise government offices and field offices at various levels of governance, organizations involved in service provision, or responsible for the event or circumstances leading to the critical incident, and non-governmental actors involved within the policy area of the critical incident. In the Ochberg et al. (2007) model of critical incident analysis (see figure 1), governance system specifically refer to government and its interaction with the governed. It is government that directs interventions to sort out or mitigate critical incidents. However, within the framework presented in this paper, governance must be understood in a wider context.

The idea of a government standing above society steering it has long been debunked by those who study networks and governance structures. These scholars (e.g., Agranoff & McGuire, 2003; Ansell & Gash, 2007; Kickert, Klijn, & Koppenjan, 1997; O'Toole & Meier, 2004) argue that governments, becoming aware of their limitations and the limitations of downstream implementation, have strategically retreated from their "public domain through privatization, deregulation, and decentralization strategies" (Kickert, Klijn, & Koppenjan, 1999). This argument has articulated what many had known for a while – the conventional view of governance with government steering from above was no longer relevant and had given way to a new governance paradigm. In this new paradigm there are self-steering mechanisms that ensured the smooth execution of policy by all kinds of actors involved in governance, not just government (Kickert, Klijn, & Koppenjan, 1999).

In critical incidents, there are diverse networks of actors involved in each stage of a critical incident, including those that remain engaged long after the critical incident has stabilized. Government agencies at various levels, private organizations including suppliers and contractors, citizens and voluntary groups, hospital and allied healthcare facilities, psychiatric services, and the media, among others, comprise the bulk of these actors involved in governance.

Community Rationalization

How the community comes to grips with the critical incident, the way they process the information and experiences, and the measures put in place to limit, in the case of negative outcomes, or encourage in the case of positive outcomes, the recurrence of similar events in the future at the community level are termed community rationalizing. Community rationalizing includes, but is not limited to, a collective sorting through of what happened and how to limit or encourage future recurrence.

The community includes the immediate community impacted, or it can involve a wider community such as a country, region, or the globe depending on the scale of the event and the number of people who are witness to the event. The 2008 global economic meltdown is one such example, although it started in the USA, it had implications for almost every citizen of the globe as to whether they were employed or not, government instituted austerity measures, and their overall personal lifestyle. The civil rights movement of the 1960s had far reaching impact: nationally in terms of who could access loans, what communities minorities could live in, what colleges minorities could attend, what social services could be accessed, minority representation in sporting events, government and so on. The movement also influenced those in other parts of the world who sought to redress civil injustices. The 1979 Three Mile Island nuclear meltdown changed not only nuclear safety regulations for power stations, but also changed how we plan for

possible meltdowns both in the USA and globally. No one was spared the images of these events, the constant commentary and expert analyses or the findings of technical panels on the issues. These are key influences on how individuals understand and respond to critical incidents.

Learning

Learning is a key component in critical incident analysis because of its importance in stabilizing a critical incident and to impact recurrence of the event. It is a continuous and ongoing process of capturing information, processing it and making decisions based on the information and knowledge garnered. Learning is the feedback that regulates the critical incident (open system) – it informs change and also helps us to codify knowledge.

Feedback

Feedback is the interactions of the various components of the system because they can no longer act independently. When they interact they start to influence each other (Skytner, 2007). It is this relationship that gives the system its properties and behavior. In this framework, lessons learned constitute the feedback loop. Lessons are learned throughout the critical incident. Some lessons are quickly applied, but others must be codified, and applied in planning and strategies for coping. These lessons influence policy, strategies for planning and response, risk reduction, individual behavior and so on.

Outcome Components

Outcome components can be observed and measured over the short, medium and long term from system interaction after the critical incident has occurred. Outcome components in the case of Hurricane Katrina include changes in policies in FEMA, changes in levee construction codes, changes in behavior of citizens in response to evacuation orders and changes in regulations, and so on. Outcome is used in this paper as opposed to output because output is more immediate. The outcomes of critical incidents are not necessarily immediately observed, they can arise over the medium to long term.

Change

Due to the scale, complexity, novelty and visibility of critical incidents, they are accompanied by change. The changes are profound or transformational and can be observed at multiple levels and at varying degrees.

Policy Change

Policy change usually follows a critical incident. Transformational change indicate new and sweeping legislation and regulations to affect actions that lead to the critical incident, significant increase or decrease in budgetary allocations, creation of new agencies organizational change, and so on.

A number of policy changes were initiated and passed based on lessons learned from Hurricane Katrina. The Department of Homeland Security (2008) outlined a few acts that apply to future federal emergency actions and also have implications for state emergency actions. They include: Title VI of P.L. 109-295 (H.R. 5441) the post Katrina Emergency Management Reform Act 2006; Security and Accountability for Every Port Act 2005 (SAFE Port Act); Pet Evacuation and Transportation Standards Act 2006; Federal Judiciary Emergency Special Sessions Act 2006; Student Grant Hurricane and Disaster Relief Act 2005; and John Warner National Defense

Authorization Act for Fiscal Year 2007. Of these statutes, the Post-Katrina Reform Act is notable for its long-term consequences for FEMA and other federal entities (DHS, 2008). According to the 2006 CRS report, the Act "reorganizes FEMA, expands its statutory authority, it imposes new conditions and requirements on the operations of the agency" (CRS, 2006). A number of emergency management functions were consolidated within FEMA, its status was elevated within the department, and was granted enhanced organizational autonomy. FEMA's Office of Gulf Coast Recovery was also set up as a result of Katrina.

Behavioral Change

Behavioral changes occur after a critical incident. For example, in the case of Hurricane Katrina, complex computer models created by scientists and engineers from Louisiana State University as well as studies carried out by scholars at the University of California at Berkeley show that "faulty design, inadequate construction or some combination of the two were the likely cause of the breaches to the levee system in New Orleans (Grunwald & Glasser, 2005, A1). Grunwald and Glasser (2005) note that: based on a national discussion of Flood Plain protection that ensued post Hurricane Katrina there is now routine maintenance of the flood plains; and, the Army Corps of Engineers has instituted a number of organizational changes to minimize the chance of levee breach after massive flooding. For instance maintenance practices, technology, frequency and process of monitoring, and the organization of those stakeholders focusing on the Louisiana levee system have improved. Prior to Hurricane Katrina communities around the country were negligent in terms of their preparedness for critical incidents (Bell, 2006).

Other Changes

Locally in New Orleans and around the country, Hurricane Katrina highlighted the role of mutual aid (Bell, 2006). Bell notes that approximately 38 states and 66,000 people responded to the incident. There is now a large New Orleans diaspora. People who had never left the community, let alone the state were uprooted, leaving family ties, cultural ties, church and other social fabric affiliation.

In addition, there is a large volunteer contingent of remaining residents in New Orleans who are active in monitoring the levees and in holding accountable those whose job it is to maintain the levee system.

Nationally, Hurricane Irene in 2011 illustrated how seriously people take the threat of a pending hazard and the importance they place on preparation and on heeding evacuation orders. Days prior to Irene's impact, all along the Eastern Seaboard emergency plans were put into effect, and there were mandatory evacuation orders. Some cities enforced state of emergency to ensure law and order were maintained and shelters were set up. These types of preparedness plans bear testament to the institution of lessons learned during Hurricane Katrina.

When the right lessons are learned there is sweeping or transformational change at one or multiple levels. When lessons are partially learned, only incremental changes are made.

Application of the Model

This section provides insights on how scholars and researchers wishing to test the model may do so. To reiterate, open systems framework is proposed as a tool for evaluating what incidents are critical incidents – how do we delineate and understand them. It is hoped that these steps to the model's application will help other scholars wanting to test the framework and fine

tune it over time. This approach has been used by scholars in the past to guide the application of a proposed framework. For instance, Margaret Polski and Nobel-laureate Elenor Ostrom (1999) used this approach when they developed the Institutional Analysis and Development Framework (IAD),

A number of steps should be considered in the application of the proposed framework. The steps are as follows:

Step one: Define what is meant by critical incident.
The definition-in-use of a critical incident is very broad and leaves a lot to interpretation. This provides the flexibility to categorize incidents as they occur. Recall that critical incidents are unscripted and unanticipated. As such, the definition should not be so rigid as to box in researchers and other scholars who in the future need to identify and analyze critical incidents.

Step two: Identify the trigger and the activating event.

There are multiple triggers of critical incidents. Triggers may be natural, technological or human (social). The activating event is usually different from the trigger and can be the result of anything, but it is a specific point in time (i.e., a pivotal moment). Identifying the trigger and the activating event will help with the classification of the critical incident.

Step three: Identify and analyze the cause-and effect chains throughout the critical incident, but especially in the interventions (Response stage).

One method that can help with this analysis is the Fishbone analysis that provides a structured way of effects and the causes that lead to these effects (Gupta, 2010). First, note the types of interventions. Second, label these interventions as either "novel" or "routine" and "large scale" or "small scale". This will assist to differentiate the incident from an ordinary disaster. Descriptions placed on the incidents by the media and experts will aid this determination. Critical incidents display no-linear patterns because of the multiple and varying causes and effects throughout the individual critical incident. These causes and consequences in turn influence outcome(s).

Step four: Identify, evaluate and label the impacts.

Secondary research, such as content analyses and interviews, will aid with this activity. Superlatives used in these descriptions are a good indicator of the nature of an incident – critical incident or routine event. In addition, estimates of destruction, social impacts, deaths, and so on will provide a good picture of impacts. Note that multiple primary and secondary impacts will be observed nationally and internationally.

Step five: Analyze what feedback mechanisms apply.

In social systems like critical incidents, learning is a good indicator of a feedback mechanism because one is able to see its expression in the changes that take place. Note that changes take place at multiple levels. This means that we must first define what is meant by learning and then deconstruct the multiple levels and meanings.

Step six: Determine outcomes.

Analyze national and local policy outcomes, community and local outcomes, and global outcomes separately. These include changes in value systems, sweeping policy overhauls, and

changes in community norms. These activities present a challenge because of our ability to quantify changes such as value system changes but are a critical step in delineating a critical incident. However, carefully defining what each change means will greatly aid this process. Note that multiple primary and secondary outcomes will be observed locally, nationally and internationally. Because they are usually not readily evident, it might be difficult to delineate secondary outcomes of a critical incident.

Step seven: Determine the level of the analysis to be done.

An important consideration is at what level – local, national, international – can the framework be applied. The cases relied on as examples all took place in a local context (all incidents are local); however, the scale and unprecedented nature soon gave them national and international significance. For the sake of analysis, one must be able to put a boundary around a critical incident. This is easier done at the national as opposed to the global level because impacts and outcomes become unwieldy and difficult to associate with a particular critical incident. Within that level there are multiple units of analysis – who are the actors and their relationships throughout the critical incident (See Till, 2010) – responders and types of responses, resource needs and suppliers, impacts, and types of change that resulted.

There are collaborative strategies that could allow for critical incident analysis at a global level, for instance multiple case study analysis (see Tellis, 1997; Yin 1994, 2009). Multiple case study approaches improve validity and builds some reliability in the findings.

Conclusion

The open systems perspective presents a dynamic framework that encapsulates the essential components that can be observed in all critical incidents. The open system perspective facilitates a more holistic understanding of critical incidents and will therefore facilitate a more complete understanding of critical incidents.

More specifically, there are several benefits of using the open systems perspective to propose a framework for critical incidents. First, it allows an alternative avenue to understand this phenomenon outside a static cause-and-effect relationship. Open systems thinking allows us to see simultaneous patterns of interactions, rather than limiting us to sequential interactions that cause-and-effect models permit. Because one can observe simultaneous interactions, one can also observe the non-linear patterns of relationships that occur in critical incidents. Open systems perspective also helps us to see that not all relationships involved in critical incidents are proportional in that a small trigger can have tremendous consequences and vice versa.

Second, unlike static models that only allow us to study critical incident components in discrete segments, those utilizing systems thinking allow us to study them together, thus affording insights into their nuances of the relationships and interdependencies as the critical incident progresses.

Third, open systems perspective allows us to understand that a critical incident's end state can be reached by any of multiple means (Bertalanffy, 1968) because components within the system interact in a non-random and patterned way. This interaction results in not one, but many paths system outcome (Tompkins, 2005). As such, one needs to tackle critical incidents on multiple strategic fronts using multiple interventions and with multiple actors.

Fourth, because of the unscripted and unanticipated nature of critical incidents, learning lessons as the critical incident unfolds is important. How one applies what one learns impacts the

outcome of the critical incident system in the short and medium term. Learning and applying lessons will also reduce the likelihood of negative outcome or increase the likelihood of positive outcomes as a result of similar activating events in the future. It is therefore important to capture important lessons, document them, incorporate lessons learned in policies and programs to understand and benefit from critical incidents.

The proposed framework has the potential to aid our understanding of critical incidents. This framework must now be tested and refined. The steps proposed to the framework's application are tentative, and many of the steps can be applied simultaneously rather than sequentially. These steps can be refined over time. Refinement, as Sabatier (1999) reminds us, will facilitate the development of a clear and logically coherent and interrelated set of propositions or approaches to critical incident analysis.

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