PHOENOMIA WITHIN THE NATIONAL FIRE INCIDENT REPORTING SYSTEM: PRACTICES OF RESOURCE DEPLOYMEMNT AND SAFETY CONCERNS FROM 1998-2014 IN THE AMERICAN FIRE AND EMERGENCY SERVICES

By

DAVID J. YONKO

Bachelor of Applied Science in Emergency Management

Arizona State University

Tempe, Arizona

2015

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 2018

PHOENOMIA WITHIN THE NATIONAL FIRE INCIDENT REPORTING SYSTEM:

PRACTICES OF RESOURCE DEPLOYMEMNT AND SAFETY CONCERNS FROM

1998-2014 IN THE AMERICAN FIRE AND EMERGENCY SERVICES

Thesis Approved:

____

Thesis Adviser/Chair: Dr. Brienen, Marten

____

Committee Member: Dr. Wu, Tristen

____

Committee Member: Dr. Chang, Ray

____

ACKNOWLEDGEMENTS

The dedication of this thesis is to the all firefighters that have perished during the line of duty along with the actively serving firefighters in the American fire and emergency services along will firefighters serving throughout the world. This dedication of this thesis also acknowledges the late great innovative author Fire Chief Alan V. Brunacini (retired). I fully appreciate the expertise and guidance throughout this research study process from my thesis chair/advisor Doctor Brienen, Marten along with committee members Doctors Wu, Tristen and Ray, Chang. Additional acknowledgement, all the fire and emergency management administration program faculty of Oklahoma State University, family, and individuals that have mentored or supported me throughout my professional and academic careers.

Acknowledgements reflect the views of the author and are not endorsed by committee members or Oklahoma State University.

Name: DAVID J. YONKO

Date of Degree: MAY, 2018

Title of Study: PHOENOMIA WITHIN THE NATIONAL FIRE INCIDENT REPORTING SYSTEM: PRACTICES OF RESOURCE DEPLOYMEMNT AND SAFETY CONCERNS FROM 1998-2014 IN THE AMERICAN FIRE AND EMERGENCY SERVICES

Major Field: FIRE AND EMERGENCY MANAGEMENT ADMINISTRATION

Abstract:

Humans usually thrive within the social ecological system (SES) until an emergent fire begins to consume structures in the built environment and in some cases become injured or deceased. The Bronfenbrenner (1979) social ecological system (SES) model is the foundation to create an emergent-social ecological system (E-SES) model comprised of four sub-systems. First, the macro-sub-system consists of the national incident management system (NIMS). Second, the meso-sub-system consists of fire department policies. Third, the exo-sub-system consists of the national fire incident reporting system (NFIRS. Fourth, the micro-sub-system consists of firefighters and civilians). Utilizing the quantitative methodology for the statistical analysis of nine hypotheses will determine if relationships exist amongst any variables. This thesis also discusses the concepts for reducing or eliminating additional unsafe conditions during operational fire incidents, which contribute to both firefighter and civilian casualties. The major finding from within this study is that the infrequent utilization of the incident command system (ICS) for either small or large emergent building fire incidents, this will in fact contribute to both firefighter and civilian casualties.

Keywords: American, Deployments, Fires, Fire Department, Resources, Professional, Mixed, Volunteer, Hazardous Materials, Chemical, Biological, Radiological, Nuclear, Explosives, Safety.

TABLE OF CONTENTS

Chapter Page

LIST OF MODELS

CHAPTER I

INTRODUCTION

Historical Significance of Fire and Humans

Since the early 20th century urban populaces of the United States (US) have been concerned with fire damaging residential, commercial, and industrial structures within the built environment. These urban populations were also concerned with personal injury, death, damaged homes and possessions, all due to the instance of building fires. As a result, the formation of volunteer fire companies provides civilians with fire protection and suppression. Presently, professional fire departments or fire districts provide fire and emergency services (i.e. fire prevention, protection, suppression, hazardous materials mitigation, specialized rescue, and emergency medical services) for the modern urban inhabitants. The sub-urban populaces of the US naturally rely on either professional and/or mixed fire departments/districts to provide fire and emergency services. Comparatively, the rural populaces of the US naturally rely on mixed fire departments (i.e. an aggregation of both professional and volunteer firefighters) or volunteer fire departments (i.e. un-paid firefighters) to provide fire and emergency services.

Emergency Management Concepts and Fire Terminologies

Emergency Management Concepts. The first concept, *emergency management* entails the development and implementation of policies that foci on the mitigation of hazards, preparedness, response to, and recovery from disaster events. The second concept, *hazard or risk*, entails dangerous human interactions with either natural (e.g. metrological, hydrological, geological, or ecological phenomenon) or un-natural (e.g. instances of building fires, hazardous substances releases, failure of engineered structures or human induced terrorism). These dangerous human interactions have the potential to transform into life-threatening events resulting in significantly negative outcomes (Burton, Kates & White, 1993; Cutter, 2001; Lindell et al., 2006). The definition of *disaster* utilized within this thesis simply entails any natural or un-natural hazard event that produces overall societal dysfunction and collapse of the built environment. (Schenker-Wicki, 2009).

Fire Concepts. The most prevalent fire terminologies utilized throughout this thesis have originated from the American fire and emergency services. The first concept, *fire-related injury*, any case involving an injured individual (e.g. the community or firefighters) through exposure to a fire causing, injury form natural or accidental origins, involving fire suppression, rescue of individual(s), or egress from the hazard of fire. The second concept, *fire-related death*, any occurrence involving a fatality of an individual due to fire exposure, involving in fire suppression, rescue of individual(s), or egress from the hazard of fire along with the death of an individual(s) within one year of injuries caused via fire. (Cornell, 2015). The third concept, *operational fire incident* consists of all events occurring within an active fire-ground (i.e. the beginning of an incident up until the termination of the incident. The fourth concept, *exterior fire suppression approach* is a defensive fire attack on a structure (Brunacini 1985, 2001, 2002) of both stationary structures (e.g. buildings) and portable structures (e.g. vehicles, waste containers or mobile homes). The fifth concept, *interior fire suppression approach* is an offensive fire attack on a structure (Brunacini 1985, 2001, 2002) of both stationary structures (e.g. buildings) and portable structures (e.g. vehicles, waste containers or mobile homes). The sixth concept, *transitional fire suppression approach* (NIOSH, 2018) consists of quickly utilizing the exterior fire suppression approach (e.g. projecting a strait stream of water from the nozzle of the fire hose into an exterior window or door showing active fire, then transforming to the interior fire suppression approach to attempt search and rescue of injured occupants).

Theoretical Social Frameworks

Social Ecological System. For the purpose of explaining social phenomenon in-depth, Bronfenbrenner's (1979) social-ecological system (SES) theory model shows how two organisms depend on each other for optimal survival (e.g. civilians rely on firefighters for survival). This social-ecological systems (SES) consists of vast overlapping sub-systems, these typically consist of interactions between resource units, users, and governance systems. Comparatively, these interactions produce different outcomes between the SES and the mechanisms of the sub-systems. Schroon and Cox

(2011) determined that the SES is prone to experience multiple disturbances and organisms (i.e. humans) within the SES must be adaptable to absorb, withstand, or resist any disturbances (e.g. humans experiencing emergencies or disasters). (pg.1). Kraseny and Roth (2010) mention that societies should provide educational programs for the purpose of preparing for large emergencies or disaster incidents.

Emergent Social Ecological System. Adopting the SES model provides the foundation for creating an emergent-socio-ecological system (E-SES) model. The E-SES entails the following four sub-system elements. The first element, the NIMS-ICS functions as the macro-system overall, analyzing this system allows for in-depth explanation of probable factors. The second element, the exo-system consists of fire policies (e.g. federal, state or local fire prevention, safety, fire and hazardous materials response and suppression) and fire standards of the national fire protection association (NFPA). The third element, the meso-system consists of the national fire incident reporting system (NFIRS) building fire cases from years 1998 thru 2014. The fourth element, the micro-system consists of firefighters protecting the civilians in the US.

The main objective of this thesis is to determine what factors contribute to the injuries or fatalities of fire and emergency services members (i.e. firefighters). The reviewing of the existing fire science literature clearly indicates gaps in the areas of safety, reduction of additional firefighter risks, hazardous materials, NIMS-ICS utilization frequencies of fire departments to prevent both firefighter and civilian casualties during operational fire incidents. Completing this study this will empirically identify the factors that contribute to the effect of firefighter or civilian casualties during active structure fire incidents. Identifying these factors may show variations between professional, mixed, volunteer fire department unit response times. The research problem statement: fire department utilization frequencies of the NIMS-ICS in the US contributes to the phenomena of both firefighter and civilian casualties during operational fire incidents.

CHAPTER II

REVIEW OF LITERATURE

The Macro Sub-System of NIMS

The macro-system of NIMS consists of comprehensively flexible components for effectively managing incidents ranging in scalability (e. small to large). Historically, the US Congress voted in the homeland security presidential directive five into action on February 28, 2003, this directive mandates all four levels of government to adopt the NIMS. The NIMS is the foundation for managing all types and magnitudes of emergent incidents; the national response framework (NRF) consists of federal policies for incident responses. Interestingly, any state or local government receiving grant funding from the federal government (e.g. DHS, FEMA) for attaining fire and emergency management resources, the organization becomes automatically mandated to abide by the guidelines in the NIMS. (Jensen and Youngs, 2015). These elements from NIMS automatically mandate these state and local entities to self-report their compliance levels, the absolute minimum is for the government entity to eventually become fully compliant. (Jensen and Youngs, 2015). The focal elements of NIMS involves mitigating or preventing, preparing, responding, and recovering from major emergencies, terrorist attacks, or significant disasters. (Jensen and Young, 2015). Mostly, these incidents begin as smaller emergencies (e.g. residential building fires) with the potential to grow into larger (e.g. hurricane hazard agent destroying the built environments of multiple localities of a couple of states within a region of the US) complex incidents. Way and Yuan (2014) mention that most types of emergencies possess multiple unknown elements, such as, the uncertainties involving medical mass casualties, firmness of time burdens, lack of resources, large-scale bearing of damages, and overall infrastructure failure. The type of incident tends to dictate how one requires additional resources, as the scalability of incident escalates to an enormous scale (i.e. multiple area disaster) requires the utilization of emergency operations center (EOC).

The EOC allows for multiple agencies to collaborate and communicate in a unified fashion with each other during an enormous incident. The EOC acts as a gateway for the field IC(s) to obtain a variety of resources from multiple local and/or state agencies for the disaster incident, each representative from each responsible agency relays staffing and equipment availabilities. (Slepow et al., 2007). These emergency response personnel typically provide crucial information to one another through portable radio systems, in most cases these agencies participate in unison. In addition, disasters of large magnitudes require vast types and quantities of resources and in some cases these resources may be unavailable. The lack of resources can prevent the incident commander from completing critical tasks quickly (i.e. within seconds or minutes). (Way and Yuan, 2014). Slepow et al. (2007) further mentions that once an emergency transformed from a small incident into a large-scale disaster, one needs to be aware of local level (i.e. county or municipal) emergency response protocols. Public safety administrators rely on intra-agency assistance to coordinate infrastructure stabilization (e.g. electricity, telecommunications, transportation, and water departments). These public safety administrators utilize the NIMS for the purpose of unifying communications, information management, resource management and maintenance. (Jensen and Young, 2015). The three key concepts for effective disaster communication of vital information requires the utilization of the public information officer from the incident command staff, multi-agency coordination system, and an accurate public information system. (Anderson et al. 2004). Lester and Krejci (2007) mention that the NIMS prompts government agencies to establish standardized communication, unify the preparedness process (i.e. certifications, plans development, and trainings), a joint information system to disseminate unified messages, and establish a national integration center to guide coordination. The national integration center recommends that all four levels of government should utilize the NIMS as a 'joint and collaborative system' for response to emergencies or disasters quickly and adequately. (Lester and Krejci, 2007). This NIMS also provides guidance for public safety administrators (i.e. fire and police chiefs or emergency managers) to mitigate natural or un-natural hazard agents (e.g. or un-natural hazard agents during a disaster. These public safety administrators collaborate and coordinate in unison with all four levels of government (i.e. local, state, tribal, and federal) to prepare for responses to incidents and post disaster recovery operations. These incidents require the establishment of self-reliable infrastructures, multiple experts and massive involvement of personnel, high demand of quick information for stakeholders and eliminating conflicts of interest amongst stakeholders. (Chen et al. 2008), (Way and Yuan, 2014).

ICS Component of the NIMS. The utilization of ICS mainly involves local government fire departments or fire districts for the stabilization of both smaller or larger emergency incidents (e.g. portable or fixed structure fires). The federal and state government fire agencies also utilize ICS as well for the smaller or larger emergency incidents. These fire agencies/departments unify with other fire agencies/departments and law enforcement to operate as a comprehensive incident command system. Historically, the NIMS adopted the fire-ground command system (FGCS) which allows for the management of structure fires and all other types of incidents. (Brunacini 1985, 2001, 2002). The Phoenix, AZ fire department originally created the FGCS under the leadership of Chief Brunacini during the 1970's then later changing from the FGCS into the incident management system during the 1980's. Simultaneously, the FIRESCOPE group in the state of California created the ICS in the 1970's for organizing and deploying firefighting resources to combat wild-land fires in southern California. (Jensen and Youngs, 2015; EMSI, 2017). The FIRESCOPE group created both the multi-agency coordination system (MACS) and the wildland ICS for the purpose of unifying wildland fire personnel and managing wild-land fire incidents as an organized approach. (EMSI, 2017).

The modern ICS includes multiple components to control and adequately manage an emergent incident of any scale. These ICS components assist the incident commander and their command support staff depends on the polices or procedures of each fire department. This command support staff activation is for larger emergent incidents, these command support staff consist of an operations, planning, logistics, investigations and finance section chiefs. The incident commander coordinates with the supporting staff of chief officers for assigning units of company officers and their firefighters to specific branch(s) or division(s). (Lindell et al., 2006). Rake and Njå (2009) found vast differentiations between an experienced incident commander verses an inexperienced incident commander. Experienced incident commanders and safety officers increase the overall safety of fire officers and firefighters operating in an emergency incident.

The most frequent type of fire department responses involves residential building fires, this necessitates increasing one's familiarity with choosing the safest tactical fire suppression method(s) for effective incident stabilization. Furthermore, each individual's (i.e. firefighters) experiences with certain types of incidents vary greatly. For example, a 'routine' house fire tends to be far from routine, this is due to different experiences amongst firefighters throughout the structure fire incident. (Brunacini; 1985, 2001, 2002). Brunacini (2002) also mentions that if most of the fire service members think that when the department receives another fire call it will be the same as all the previous fire calls; this type of thinking may prompt an increase of firefighter injuries or fatalities. (pg. 7). The main objectives for an incident commander include foci on life safety (e.g. safety of firefighters to search for and rescue inhabitant(s)), stabilization of the incident (e.g. fire suppression or identification and mitigation of hazardous materials) and limiting property damages (e.g. protection of other buildings from extending fire with H2O projection from a fire hose nozzle) while operating from either a mobile or stationary location within an operational fire incident perimeter. In addition, the command staff and general staff consists of specific sections and divisions to manage incidents thru means of managing personnel and controlling tasks throughout incidents. Some incidents have the potential of transforming from a small-scale emergency into a large-scale emergency incident, the large-scale incidents tend to require assistance from other agencies (e.g. automatic or mutual aid agreements between fire department(s)).

The research of Lindell et al. (2006) indicates that fire department systems should pre-establish a glossary of standardized terminologies for the users of the ICS; this allows for like-minded decisiveness amongst the fire and police departments throughout emergent incidents. The author also mentions that inter-fire department mutual aid agreements allows for sharing multiple types of vital resources. (pg. 27). For example, a local fire department or district system typically provides residents with EMS and transport to the closest most appropriate hospital. An officially established mutual or automatic aid agreement clearly acts as an external support mechanism for other fire department /district systems to respond in to other localities. These official fire department systems mutual or automatic aid agreements further allows for establishing the utilization of the ICS, this allows for functionality, compatibility and backing throughout an emergency incident. (Lindell et al., 2006). Jensen and Youngs (2015), Mathews (2004) suggest that all emergency responders must be familiar and utilize the same terminologies to avoid confusion within the incident command's operational structure to reduce the occurrences of additional stressors. (Pg. 2). In sum, Chang (2017) suggests further investigating the ICS component in-depth for the analysis of practicum utilizations (e.g. experiences of fire and emergency services managers during an active emergency or disaster type of incident).

Exo Sub-System of Fire Policies

Limited empirical studies of fire policies exist, most of the research conducted since the 1970's era in the US revolves around two specific studies. America Burning (1973) report and the fire department deployment modeling from Walker's (1979) study. The investigational report titled as America Burning originated from the national fire prevention and control committee of the US congress extensively pinpointed the effects from frequent fire incidents in the American society, mainly in the urban localities. (AB, 1973). Interestingly, during this era, the authors of this report calculated that fires contribute to 6,200 fatalities along with 100,000 injured persons annually, this also includes firefighters. (AB, 1973). As a result, the US Congress formed the national commission on fire prevention and control; this special committee determined that multiple fire prevention issues existed throughout urban America during the early 1970's. The first issue, Walker's (1979) comprehensive study portrays that the national fire problem clearly contributed to human suffering along with the loss of human life and property. The second issue, the quantity of fire related fatalities and vast property losses (e.g. 12,000 fire related fatalities and 300,000 injuries) within the US, these injuries were higher than all other major industrialized nations of the world. The third issue, compromised public health and safety involved about 50,000 individuals, prolonged hospitalizations, and three billion dollars of property damages annually from fires. The fourth issue, the overall economic totality from fire destruction in the US during 1974 is roughly 11,000,000,000 billion dollars per year. The fifth issue, the federal government deemed to assist all tribal, states, and local governments to substantially reduce overall fire losses through means of fire prevention and suppression by local fire departments. The sixth concern, the fire service localities and the federal civil defense program in cooperation should benefit all stakeholders thru means of reducing the US fire problem.

Consequently, the US House committee of national fire prevention and control determined that potential barriers might limit the fire prevention policy implementation. The first barrier, indifferences between Americans regarding that building owners lack concern for the fire and life safety of the buildings occupants. The second barrier, not undertaking new research to discover new findings to reduce the fire-related concerns. The third barrier, several societies lack adequate fire prevention codes for buildings. Most fire departments in 1974 apply roughly 95 cents of revenue from every dollar for operating costs, applying the remaining five cents for fire prevention activities. (House, 2017). In addition, the special committee of fire prevention and control persuaded congressional members to enact the federal fire prevention and control act of 1974 (Public Law 93–498) for reducing the loss of life and property within the US society. The main goal of this federal government policy is to improve the national fire prevention and control guidelines for all levels of government to then establish community programs for educating residents. In addition, when a local government fails to regard the time-frame of practices for new policies or programs seems to affect the crucial economic and social changes overtime. (Brienen, 2007).

In the US, the modern fire service depends on the federal policies of emergency management to mitigate, prepare, respond and recover from either an emergency or a disaster ranging in scalability. The first federal fire laws of the US originate from the federal fire prevention and control act of 1974 (Public Law 93–498), the overall purpose of this law is to reduce losses of life and property thru improving fire prevention and control programs. This law seems to be based from the tenth amendment of the US constitution in 1787 portraying that: “the powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people” (GPO, 2017, pg.1). These incidents tend to rely on the polices of the federal government (i.e. US House of Representatives and Senate), and non-profit associations (i.e. the NFPA). For example, White House (2017) digital document portrays that municipalities must provide parks and recreation services, police and fire departments, housing services, emergency medical services, municipal courts, public transportation service, and public works (i.e. street and sewer maintenance, street cryptograms). (pg.1). In modern times, the previously implemented constitutional tenth amendment of 1787 seems to imply that local fire departments must be able to fund and provide fire prevention, fire suppression and emergency medical services to all individuals of a locality. The implementation of the fire and emergency services volunteers’ policy consists of: Protecting Volunteer Firefighters and Emergency Responders Act of 2014. This federal counteracts the existing internal revenue service classifying volunteer firefighters as professional personnel for tax coding purposes. (GPO, 2017b).

NFPA History and Standards Influencing Policy. The NFPA originated in Boston during the year of 1896, a group of business specialists from various backgrounds came together to exchange ideas concerning the lack of adequate fire codes and fire standards across the US. This group of specialists further collaborated to mitigate the discrepancies found in the fire sprinkler system design and installation standards. This contributed to unreliable sprinkler systems across the US, this prompted the creation of a unified standard for the fire sprinkler system installation guidelines (i.e. NFPA 13 standard for installing sprinkler systems). The establishment of IFSTA in 1934 provides the fire service with training materials developed and authenticated thru the IFSTA members from the fire service is to then improve firefighting in a safe manner as technology evolves over time. (IFSTA, 2017).

The modern NFPA operates as an international non-profit membership-based group, the primary focus of the NFPA is to decrease the global fire problem, reduce all hazards, and increase the value of life expectancy thru means of research, education or training, and societal groups agreeing on fire codes and standards. The quantity of NFPA codes and standards have increased over the past century, these evolving codes and standards bring up-to-date the expanses of fire safety overall. Currently, the NFPA provides stakeholders the opportunity to implement some or all the 300 fire codes (e.g. fire codes for commercial, industrial, and residential facilities/structures) and standards (e.g. professional and volunteer fire department administration, operations, safety, and training). The NFPA research into the phenomena of fire produces the required data for producing relevant educational fire safety programs and materials for civic members to appreciate. (NFPA, 2017).

The specialized federal policies and standards for hazardous substance releases or CBRNE incidents includes NFPA standards and the federal occupational safety and health administration (OSHA) policies. The federal policy of OSHA 29 code of federal regulations (CFR) 1910.120 entails hazardous waste operations and emergency response; the NFPA 472 standard on competence of responders to hazardous materials/weapons of mass destruction incidents; third, NFPA 1991: standard on vapor-protective ensembles for hazardous materials emergencies; fourth, NFPA 1992: standard on liquid splash-protective ensembles and clothing for hazardous materials emergencies; NFPA 1994: standard on protective ensembles for first responders to CBRN terrorism incidents. The policies and standards throughout this section allows for key government stakeholders to adopt new laws or amend existing laws.

Fire Department Unit Response Times and Civilian Casualties. Response times of fire department units vary when comparing urban or sub-urban to rural response times. The contributing factors for civilian casualties typically result from the overall distance and speed of travel to an incident. Walker (1975) clearly states that travel time entails the span of time between the deployment of the emergency unit and the arrival of the emergency unit on the incident scene. The utilization of the Dormont et al., (1975) deterministic location models allows for fire department administrators to analyze travel time statistics, hazards, fire incidences, traffic conditions, and time of day within an ethnographic area(s) of the locality. The times for any specific response may be function of many variables in addition to the distance traveled. In addition, Walker (1975) utilized stop watches and odometer readings from the emergency units (i.e. fire companies) to measure the travel times. Meanwhile, determining that that travel time factors had an insignificant effect on the emergency unit responses. Interestingly, the maximal coverage model of Daskin (1983) entails the focus on emergency unit coverage opposed to relying on emergency unit response time means. These standards help determine adequate coverages impartiality opposed to focusing on the total efficiency of the emergency unit.

Swersey (1994) mentions that if fire administrators utilize the p-median optimization model to determine fire station locations, this limits the maximum travel distance to specific locations. In addition, the author suggests that fire administrators pin point fire stations locations via mapping the current and tentative sites on a map. This is based on the data from determining peak fire resource deployment frequencies and the localities current or potential fire hazards. (Swersey, 1994). In the 21st century, the emergency response environment is comprised of subtle fundamentals (i.e. station location, time and distance of travel) (Kowalski and Vaught, 2001). These fundamentals influenced the establishment of the current NFPA 1710 standard for the deployment of fire resources (i.e. fire apparatus) to incident scenes within four minutes 90 percent of the time. (CFAII, 2003). Furthermore, the creation of the fire department effectiveness model

(FDEM) provides fire administrators (i.e. fire marshals, building plans reviewers, and civil engineers) the ability to calculate the fires: heat release rates, heat fluxes, ceiling temperatures, fire temperatures, and source diameters in conjunction with fire department units suppressing the fire. The fire administrators may also utilize the fire department response model (FDRM) to estimate the response times for each fire units via calculating the quantity of dispatch time, preparation time, and travel time. (Bénichou et al., 2002).

The modern fire locations modeling tends to be based from vintage fire station locations of the 19th century, which influences the building of modern fire stations. The vintage and modern fire stations seem to meet or exceed the fire department unit response times. These modern firefighter units require an on-scene time of five minutes opposed to the slower vintage horse drawn fire apparatus responses to fires. (AFAC, 2004). The research of Claridge and Spearpoint (2013) emphasize the importance of portraying what the elements for fire department unit response times. The first element, involves the distance traveled by a fire apparatus (i.e. engine, ladder, rescue, or specialty vehicles) to a specific structure from the closest available fire station. The second element, the miles per hour traveled. The third element, the initial notification time of the incident. The fourth element, the overall time for firefighters to mount the fire apparatus to respond to an alarm. The fifth element, the fire units availability status (i.e. in quarters or available on the radio) for incident responses. In comparison, the fire services in Ontario, Canada procedures for fire protection coverages involves (e.g. time in-route, time on scene, and specific distance) selecting appropriate fire station locations. The Ontario, Canada fire service typically arrives on scene to an incident within three minutes in the central urban areas. The on-scene time requirement for fire apparatus responses to the border of an urban area is five minutes and the on-scene time requirement for rural area fire apparatus responses is typically 8 to 10 minutes. (AFAC, 2004; OFMO, 2012). Finally, most local fire departments choose new locations for fire stations based on a five minute or less response time. Also, fire apparatus availability and the duration of time required to reach specific fire incidents will influence the response times overall. (NFPA, 2017). The NFIRS concentrations involve current and future concerns of fire and life safety problems within the populace.

The Meso Sub-System of NFIRS

NFPA 901 Standard. The establishment of the NFPA 901 standard takes place during the year of 1963, this resulted via formulating a committee of designated individuals to then create a uniformed system for reporting fire incidents within the US. This standard encourages fire departments to utilize pre-set definitions for classifications (i.e. numerical sets) to report fire protection data (i.e. fire departments incidents). The NFPA 901 standardization contains a dictionary of fire terminologies and related numerical codes. In modern time, the USFA NFIRS 5.0 platform assists fire departments to adequately plan and manage emergency response operations for firefighters to perform fire control and fire prevention activities effectively. Firefighters and fire officers utilize the USFA-NFIRS 5.0 platform for managing fire department apparatus, personnel, and resources. This NFIRS shows how the local government fire departments respond to structure fires, hazardous materials, EMS, and various types of specialized rescues (e.g. building collapse, high angle, or water rescues). Firefighters tend to consider these types of incidents as 'routine' in the sense that standard responses to incidents require the utilization of specific equipment. (Quarantelli, 1987). These responses rely on the scientific modeling for deploying fire department resources.

Fire Resources Deployment Modeling. The deployment of fire department resources depends on three core factors: factor one, allocation of funds; factor two, funds provide attainment of fire apparatus and portable equipment; factor three, staffing of fire stations to respond in the fire apparatus to various types of emergencies. Claridge (2000) portrays that building fires in Australia clearly involve applying the fire brigade intervention model (FBIM) to quantify fire brigade response times. These fire response times begin when one notifies the alarm room of an incident (i.e. fire department dispatch center). The FBIM entails the aggregation of fire station locations, fire department resources availability, and the functional ability of a buildings fire safety systems to reduce the spread of fire. It is evident that when an available fire department resources quickly commits and responds to the scene of a building fire to stabilize an incident, thus reduces the loss of life and property. (Claridge, 2010). The main objective in Swersey's (1994) research study was to develop a set covering model for determining the minimum number of fixed units required to meet the demand of emergent calls from residents requesting the services of the fire department. In addition, the overall goal of the fire department is to make best use of unit coverage for the locality. The utilization of a set covering model tends to lack pin pointing the uncovered sectors within the locality. The travel time of fire units clearly fluctuates and involves a multitude of variables (i.e. topography, weather condition, roadway design and vehicle traffic density). (Buckley et al., 2000).

Micro-System of Firefighters

Fire Department Classification. The micro-system consists of fire and emergency services members from various ranks that operate in unison as a hierarchical system. These fire service members consist of: 1,160,450 firefighters protecting an estimated 320,090,857 million individuals residing in localities of the US during the year of 2015. Typically, these members serve in either professional, mixed, or volunteer fire departments. The NFPA defines the following types of fire departments: professional (i.e. 100 percent of the fire department consist of career members), majority professional (i.e. 51-99 percent of the fire departments consist of professional members), majority volunteer (i.e. 1-50 percent of the fire departments consist of career members), volunteer (i.e. 100 percent of the fire department consist of volunteer members). (NFPA, 2017; USFA, 2017). In 2015, an estimated 29,727 fire departments serve the inhabitants in the localities throughout the 50 United States. The typology quantity of fire departments consists of: 2,651career; majority of career 1,893; majority volunteer 5,421; and volunteer 19,762. Interestingly, of these 29,727 fire departments in the US around 13,500 departments provide EMS with basic life support (BLS); 4,617 fire departments provide advanced life support (ALS) and roughly 11,610 fire departments do not possess the capabilities to offer EMS. (NFPA, 2017).

Classification of Professional Firefighters. The classification of professional firefighters consists of individuals compensated by either local, state, federal, or tribal government with retirement pensions and health benefits (i.e. medical-mental, dental, vision and death insurance). In some cases, private corporations provide fire and emergencies services for local civil populaces. These professional firefighters tend to spend about 33 percent of their life serving the public over the time span of about 20-years. The beginning of a firefighter's career clearly relies on the acceptance from the existing group of firefighters of the fire department. Myers (2005) mentions that the assimilation of a new fire department member involves mutual acceptance (e.g. the new individual accepts the responsibilities of the firefighter position) then the organization officially accepts the new firefighter. (Myers & Oetzel, 2003; Myers, 2005).

Classification of Volunteer Firefighters. The unpaid firefighter consists of an individual trained and certified as firefighter I and II or untrained individuals lacking accredited firefighter certifications. The definition of a volunteer firefighter from the US Congress consists of: a qualified volunteer provided unpaid services to individuals, proprietors shall not consider volunteer members as compensated employees. (GPO, 2017b). In addition, Eltz (2015) defines volunteer firefighters as nonpaid individuals performing firefighting actions (i.e. responding to structure fires, vehicle crashes and various hazardous situations). These volunteer firefighters encompass 70 percent of the fire and emergency services in rural communities. In contrast, the remaining 30 percentile consists of professional firefighters protecting mainly urban or sub-urban communities. (NFPA, 2017; US census, 2017). Ironically, any type of firefighter (i.e. volunteer or professional) clearly risks his or her life to prolong civilian life(s); these accepted risks involve additional physiological, emotional or social stresses. (Eltz, 2015).

Firefighter Rank and Title. While there has been mass utilization of hierarchical system for managing firefighters or various ranks and titles dissimilar from one another. The adoption of McBride's (2016) extended hierarchy theory provides provisions for individuals (i.e. firefighters) to obtain familiarity with the social system layers (e.g. layers of different fire service ranks and titles). Interestingly, the components in McBride's (2016) hierarchy theory originated from the general systems theory. (Salthe, 1985; Wilby, 1994; Allen, 1996; McBride, 2016.). These social layers (i.e. fire department member rankings) directly involves social influence from higher levels of societal groups down to the lower levels (e.g. social influences originate from the chief down to fire officer then down to the individual firefighter). (McBride, 2016). McBride (2016) portrays that each social influence level involves social clusters that foci on ethos, determination, responsibilities, guidelines, and devotions. Social cluster information flexibilities permit information sharing throughout the cluster (e.g. the incident commander communicates task completions on an operational emergency scene). In addition, McBride (2016) also mentions that the top of a hierarchical level focus on information integration, which allows for one to decide when or what resources need distribution. (McBride, 2016). (McBride, 2016) suggests how to control the constraints on communications structures, along with how complex systems function. (pg. 1). Hierarchical dualism levels of communication structure consist of: the first level, hierarchy and social groupings within each level become separated by boundaries; the second level, complexities within systems are due to build ups in the networks from the interrelating elements. These interrelating networks tend to transform into innovative networks over time. For example, the ICS hierarchy automatically operates from the lowest level (i.e. a firefighter or company officer) initially, as time moves forward in the emergent incident operations requires top-level fire administrators (i.e. battalion, deputy, assistant or fire chief) in the hierarchy to safely manage the personnel on the emergency scene. (McBride, 2016).

Firefighter Training. The published standards from the NFPA and the IFSAC provide guidance for fire service administrators to provide personnel with trainings. Myers (2005) indicates that high reliability organizations (HRO's) tend to not focus on socialization as the main training mechanism for maximizing the proficiencies of the members. In contrast, the author found that fire department trainings pressure member reliability, which then increases the trust between members of this high-risk profession. (Weick, 1987, 1995; Weick & Roberts, 1993; Myers, 2005). Eltz (2015) mentions that the delivery of fire department trainings for members should focus on the federal occupational safety and health guidelines for active emergency incident operations. The training frequencies and effectiveness vary greatly between fire departments for safety awareness and practice techniques in high-risk emergency scenes.

Firefighter Safety Practices. The nature of suppressing fires in commercial or residential buildings involves a multitude of variables (i.e. age, capacity, dimension, geometrical shape, and condition of the building) that contribute to unsafe conditions. Buckley et al., (2000) found that quantitative estimating of firefighting operations exposes various safety related issues (e.g. dissimilar structural typologies) in the

Australian fire service. In addition, this clearly revolves around the concern of individual or multiple firefighter(s) attempting additional risks during the operational fire scene (e.g. consciously non-conforming to existing standard operating policies or guides). This may lead to dislocated or trapped firefighter(s) in a commercial or residential building.

Unsafe Conditions and Risks of Injury. The previous research of Hallmayer et al., (1981) and Kowalski and Vaught (2001), portray that senior firefighters with many years of experience have an undesirable tendency to interpret risks differently overall. Remarkably, the study of Preuss and Schaecke (1998) found that the experienced senior firefighters stress originates during highly complex rescue operations (e.g. standard or special operations involving traumatic injuries or fatalities of individuals and incidents involving children clearly contribute to increasing stress on firefighters overall). The fire organizations viability relies on adequate safety management and worker practices, which consists of different influences on valuing safety practices within the individual fire organizations. (Pessemier, 2012). Interestingly, Pessemier (2012) also found a significant difference between professional and volunteer firefighters regard for their fire organizations operational guidelines for utilizing important safety objectives during fire incidents. For example, when safety polices lack clarity firefighters may experience more injuries. The NFPA (2016) study of firefighter injuries data portrays that during the years of 2012 thru 2014 volunteer firefighter injury rates of 52 percent are in fact higher when compared to the lower professional firefighter injury rates of 42 percent.

CHAPTER III

METHODOLOGY

Research Objectives

Based on the current literature, it shows that ICS implementation and the type of fire department (i.e. professional, volunteer, and mixed) could change the deployment procedures for firefighter responses to emergent incidents. The literature reviewed in the previous chapter indicates gaps in the current research that lack emphases on firefighter or civilian casualties due to either frequent or infrequent utilization of the ICS. Therefore, this study intends to empirically identify the factors that may or may not contribute to the effect of firefighter or civilian casualties during active structure fire incidents. Identifying the factors that contribute to fire department utilization frequencies of the ICS will either prompt or prevent the identification and analysis of hazardous materials. The identifying of the factors contributing to variations in unit response times may indicate vast differences between the three dissimilar types of fire departments. Additionally, identifying the factors that contribute to increases in firefighter or civilian casualties within volunteer fire departments opposed to professional or mixed fire departments. Thus, the unit of analysis in this study is fire department(s). The research problem statement: fire department utilization frequencies of the NIMS- ICS in the US contributes to the phenomena of both firefighter and civilian casualties during operational fire incidents.

Operational Research Questions and Hypotheses

RQ1: Do the correlations among firefighter death, firefighter injury, civilian death, civilian injury, and hazardous materials identification change after control for ICS utilization?

RH1: Fire departments that frequently utilize ICS for active structure fire have lower firefighter fatalities compared to fire departments that infrequently utilize ICS.

RH2: Fire departments that frequently utilize ICS for active structure fire have lower firefighter injuries compared to fire departments that infrequently utilize ICS.

RH3: Fire departments that frequently utilize ICS for active structure fire have lower civilian fatalities compared to fire departments that infrequently utilize ICS.

RH4: Fire departments that frequently utilize ICS for active structure fire have lower civilian injuries compared to fire departments that infrequently utilize ICS.

RH5: Volunteer Fire departments have higher firefighter fatality rates compared to professional and mixed fire departments.

RH6: Volunteer Fire departments have higher firefighter injury rates compared to professional and mixed fire departments.

RH7: Volunteer Fire departments have higher civilian fatality rates compared to professional and mixed fire departments.

RH8: Volunteer Fire departments have higher civilian injury rates compared to professional and mixed fire departments.

RH9: Volunteer Fire department have longer response times compared to professional and mixed fire departments.

The overall point of producing these nine research questions and hypotheses is to then perform statistical testing of the variables to determine if relationships exist between the independent variables (IV's) and the dependent variables (DV's).

Quantitative Approach

Data Source. Statistical analysis allows for an in-depth explanation of the characteristics found within the American fire service and the NFIRS data set from 1998 thru 2014. Simply, fire department members utilize stationary or portable computers with USFA-NFIRS 5.0 software to then enter vital fire, hazardous materials, specialized rescues or EMS incident data. The fire department transfers the fire data to their appropriate state fire marshal office, which is digitally stores the fire data for future transfer to the USFA's NFIRS. Predominantly, the USFA's national fire data collection center NFIRS database includes roughly 75 percent of the annually reported fires. Also, the modular design of NFIRS outlines ease for the user, this captures the data that describes an incident in-depth. (USFA, 2018b). Furthermore, the descriptive work of Stevens (1946, 1951) portrays that one can utilize categorical variables (i.e. nominal, ordinal, interval and ratio) for measurement accuracy. The commonly occurring variable throughout the rest of this thesis is nominal, this allows for classification by type. In addition, this nominal variable tends to be the highest level of measurement for typing (e.g. ethnographic locations, distance, vehicles, names, labels, organizations). (McCune, 2009; Eye and Niedermeier, 1999). The nominal variables within the NFIRS data will most likely transform into various classes of data sets for additional scientific investigative purposes.

Measures. This research requires utilization of a secondary data source retrieved from USFA's national data collection center, this source consists of building fire incidents within the NFIRS data ranging from the years 1998 thru 2014. The USFA utilizes collected data over a three-year period to then establish means via trend analysis or moving means from at least five or additional years to determine any linear changes in the data. In addition, the USFA perform data validity checks for the national estimates of the U.S. fire statistics. The statisticians of the national fire data center check for missing modules, null values, large outliners, duplicate values, fire departments utilization of NFIRS 5.0 version, along with invalid codes or values excluded from NFIRS. (USFA, 2018). For example, NFIRS requires the utilization of either an electronic or paper incident form to indicate if the responding fire unit(s) self-reported the incident command (code 81) had occurred as either the primary action (i.e. most significant action taken by the fire department) or had taken an additional action(s). This also includes the identification and analysis of hazardous materials (code 41) as an additional action.

the data set created from the larger 1988-2014 NFIRS data set excluded the 344 Fire Department, City of New York (FDNY) firefighter fatalities due to the world trade center terrorist attack on September 11th, 2001. The main contributing factor for these 344 firefighter fatalities is from traumatic crushing injuries after the world trade center buildings one and two. (USFA, 2001). Also, the NFIRS also excluded the 8927 FDNY firefighters injured on or after September 11th, 2001. (Zeig-Owens et al., 2018). This research study requires recomputing variables (e.g. renaming and recategorizing variables from existing variables to new variables) from within the massive NFIRS data sets. Recategorizing variables required the utilization of the Microsoft Access program. Specifically, requires the regrouping of fire department identification with each respective state government, creation of new fire department types from values to professional, combination, or volunteer; primary or additional actions taken or not taken, fire department identification of hazardous materials, and new fire department response times.

Unit of Analysis. The unit of analysis (i.e. performing levels of observations in NFIRS) of this study is fire departments, in which span country-wide providing fire suppression and emergency services to the populace. The NFIRS data consists of incidents reported; therefore, the original NFIRS data aggregation is based on state identification numbers and fire department identification numbers. The sample includes only the fire departments that have at least 204 incidents response within the time span of 17 years. Therefore, on average, at least one fire incident occurred within their jurisdictions every month. In contrast, fire departments with less than 204 responses to fire incidents over the time span of 17 years, in consideration, these fire departments are inactive for this study. This research utilizes the following variables to test the research questions and hypotheses: (1) firefighter fatalities, (2) firefighter injury, (3) civilian fatalities, (4) civilian injuries, (5) ICS utilization, (6) hazardous material identification and analysis, and (7) fire department type, (8) fire department unit response time. First, *firefighter fatalities* entail human(s) experiencing traumatic bodily injury(s) that becomes fatal during an active fire incident or within a year from an incident. Second, *Firefighter injury* entails a traumatic human bodily injury that occurs during an active fire incident or within a year of an incident. Third, *Civilian fatalities* consist of non-fire service individual's traumatic bodily injury leading to death. Fourth, *Civilian injuries* consist of non-fire service individuals injured during an active fire incident. Fifth, *ICS utilization* is a dummy variable *(1= at least 50% of the incidents utilized ICS; 0= less than 49% of the incidents utilized ICS).* Utilizing ICS for any given incident involves one fire department member (i.e. firefighter, fire company officer, or chief fire officer) establishing oneself as the incident commander to manage the active fire incident (e.g. residential and commercial building fires). Sixth, according to NFIRS 5.0 complete reference guide, *Hazardous material identification and analysis* consists of air-reactive substances, flammable or combustible liquids, flammable gases, corrosive substances, explosive substances, organic peroxide, oxidizing substances, radioactive substances, toxic substances, unstable substances, or water-reactive substances; mixture irritant or strong sensitizer generating immense pressure via exposure to heat, or decomposition. Seventh, *fire department type* is a categorical variable (*1= mixed; 2= professional; 3= volunteer*). This variable is recoded using the NFIRS data. Fire departments consisting of both volunteer and professional firefighters are coded 1. Fire departments that only have professional firefighters are coded 2. Fire departments that only have volunteer firefighters are coded 3. Eighth, fire department *unit response time* consists of the geographic area in which a company (i.e. team) of firefighters ranging from two thru six firefighters respond to an emergent incident (i.e. structure fire, hazardous materials release or fire, specialized rescue, and EMS).

Analytical Methods. The analytical methodology for RQ1 requires the utilization of partial correlation testing to measure the strength and direction of a linear relationship between two variables; this further requires controlling the effect of single or additional variables. The utilization of a correlation matrix allows for examining and naming additional variables within sections and sub-sections of NFIRS data sets. (Voelkl and Gerber, 1999). The analytical methodology for RH1 thru RH4 requires the utilization of Levenes test to determine if equal variance exists across the groups of tested variables. The utilization of t-tests allows for the comparison of two means within the data set. The analytical methodology for RH5 thru RH8 requires the utilization of one-way analysis of variance (ANOVA) allows for comparing between groups of means (e.g. comparing groups of three or more means) along with estimating the variance to further determine if the means are significant different or not.

CHAPTER IV

RESULTS

Statistical Testing of the Variables

Descriptive Statistics for Continuous Variables. The descriptive statistics for the continuous variables consists of six different values (Table 1). *Variable one*, firefighter injuries consists of a mean value of 13.52 with a standard deviation of 193.460 based on a sample size of N=5679. *Variable two,* firefighter fatalities consists of a mean value of 0.03 with a standard deviation of 0.27 based on a sample size of N=5679. *Variable three*, civilian injuries mean value consists of 15.64 with a standard deviation of 72.23 based from a sample size of N=5679. V*ariable Four*, civilian fatalities mean value consists of 2.84 with a standard deviation of 10.44 is based on the sample size of N=5680. *Variable Five*, hazardous material identification and analysis mean value consists of 6.10 with a standard deviation of 41.21, which is based on the sample size of N=5680. *Variable six*, fire department unit response times mean value consists of 7.21 with a standard deviation of 2.3, which is based on the sample size of N= 5680.

Table 1. Descriptive Statistics for Continuous Variables

Variables	Mean	Std. Deviation	N
Firefighter Injuries	13.52	193.460	5679
Firefighter Fatalities	.03	.27	5679
Civilian Injuries	15.64	72.23	5679
Civilian Fatalities	2.84	10.44	5679
Hazardous Material Identification and Analysis	6.10	41.21	5680
Fire Department Unit Response Time	7.21	2.3	5680

Descriptive Statistics for Categorical Variables. The descriptive statistics for categorical variables consists of two different values (Table 2). *Variable seven* consists of the fire department utilization frequencies of the ICS: value 1=frequent ICS utilization for 5 percent of the fire incidents and value 0=infrequent ICS utilization for 97 percent of fire incidents with a standard deviation of .17, which is based on the sample size of N=5678. *Variable eight*, consists of the fire department types: Professional value = 38%, Mixed value = 27% and Volunteer value= 35% with a standard deviation of .76, which is based on the sample size of N= 3022.

Table 2. Descriptive Statistics for Categorical Variables

Variables	Percentages	Std. Deviation	N
ICS Utilization	Frequent ICS Utilization: 3% Infrequent ICS Utilization: 97%	.17	5678
Fire Dept. Type	Professional: 38% Volunteer: 35% Mixed: 27%	.76	3022

Testing of Hypotheses

RQ1. This first research question requires the utilization of zero-order correlation and partial correlation analysis to determine relationships between firefighter injuries, firefighter fatalities, civilian injuries, civilian fatalities, action taken 41 (i.e. hazardous materials identification and analysis), and ICS 50 cutoff (i.e. frequent or infrequent utilization of the ICS). The zero order correlations in fact show that ICS 50 cutoff is significantly correlated with all the firefighter injuries and fatalities along with civilian injuries and fatalities variables. However, controlling for the ICS 50 cutoff, the correlations remain unchanged when controlling for fire department utilization or non-utilization of the ICS and hazardous materials identification and analysis. In turn, have no impact upon the correlations between firefighter or civilian injuries and firefighter or civilian fatalities.

Table 3. Correlations Among Hazardous Material Identification and Casualties Variables*

	Firefighter Injury	Firefighter Fatality	Civilian Injury	Civilian Fatality
Zero-order Correlation	.18	.41	.42	.47
Control for ICS Utilization	.18	.41	.42	.47

*The correlations are all statistically significant at .01 level

RH1. The results supported RH1 (*fire departments that frequently utilize ICS for active structure fire have lower firefighter fatality compared to fire departments that infrequently utilize ICS).* The Levene's test results suggest the variance between two groups are not equal (F=7.80, p <*.01*). The data shows mean values of firefighter fatality between the fire department that utilize ICS frequently and infrequently are significantly different ($t_{(7836)}$ =-7.52, p < .01). Table 3 shows the firefighter fatalities mean value of fire departments that frequently utilize ICS is .00. The firefighter fatalities mean value of fire departments that infrequently utilize ICS is .03.

Table 4. The mean value of firefighter fatalities between 1998-2014

Fire Dept. Type	Mean	Std. Deviation	N
ICS Frequent	.00	.00	272
ICS Infrequent	.03	.31	7837
($t_{(7836)}$ =-7.52, p < .01)			

RH2. The results did not support RH2 (*fire departments that frequently utilize ICS for active structure fire have lower firefighter injury compared to fire departments that infrequently utilize ICS).* The Levene's test results suggest the variance between two groups are equal (F=1.08, *ns*). The data shows mean values of firefighter injury between the fire department that utilize ICS frequently and infrequently are not significantly different ($t_{(8107)}$ = -.69, *ns*).

RH3. The result supported RH3 (*fire departments that frequently utilize ICS for an active structure fire have lower civilian fatalities compared to fire departments that infrequently utilize ICS).* The Levene's test results suggest the variance between two groups are not equal (F=4.45, $p < .01$). The data shows mean values of civilian fatality between the fire department that utilize ICS frequently and infrequently are significantly different ($t_{(478.37)} = -3.90$, $p < .01$). The civilian fatalities mean value of fire departments that frequently utilize ICS is 2.04. The civilian fatalities mean value of fire departments that infrequently utilize ICS is 2.87.

Table 5. The mean value of civilian fatalities between 1998-2014

Fire Dept. Type	Mean	Std. Deviation	N
ICS Frequent	2.04	3.05	272
ICS Infrequent	2.87	9.41	7837
($t_{(478.37)} = -3.90$, $p < .01$)			

RH4. The result supported RH4 (*fire departments that frequently utilize ICS for an active structure fire have lower civilian injuries compared to fire departments that infrequently utilize ICS).* The Levene's test results suggest the variance between two groups are not equal (F=5.54, $p < .01$). The data shows mean values of civilian injuries between the fire department that utilize ICS frequently and infrequently are significantly different ($t_{(619.31)} = -5.20$, $p < .01$). The civilian injuries mean value of fire departments that frequently utilize ICS is 9.25. The civilian injuries mean value of fire departments that infrequently utilize ICS is 15.86.

Table 6. The mean value of civilian injuries between 1998-2014

Fire Dept. Type	Mean	Std. Deviation	N
ICS Frequent	9.25	17.03	272
ICS Infrequent	15.86	65.83	7837
($t_{(619.31)}$ = -5.20, $p < .01$)			

RH5. The results did not support RH5 (*Volunteer Fire departments have higher firefighter fatality rate compared to professional and mixed fire departments*). The ANOVA test results suggest that the firefighter fatality rate is not significantly different among volunteer, mixed, and professional fire departments ($F_{(2, 3018)}$ =.14, *ns*).

RH6. The results did not support RH6 (*Volunteer Fire departments have higher firefighter injury rate compared to professional and mixed fire departments*). But the ANOVA test results suggest that the firefighter injury rate are significantly different among volunteer, mixed, and professional fire departments ($F_{(2, 3018)} = 94.21$, $p < .01$) (Table 7). Professional fire departments' mean injury rate of firefighter injury is .013; mixed fire departments' mean injury rate of firefighter injury is .010; and volunteer fire departments' mean injury rate of firefighter injury is .006. The professional fire departments have the highest firefighter injury rate.

Table 7. The mean of firefighter injury rates between 1998-2014

Fire Dept. Type	Mean	Std. Deviation	N
Professional	.013	.015	1144
Mix	.010	.012	820
Volunteer	.006	.010	1057
$F_{(2, 3018)} = 94.21$, $p < .01$			

RH7. The results did not support RH7 (*Volunteer Fire departments have higher civilian fatality rates compared to professional and mixed fire departments).* The ANOVA test results suggest no differences among volunteer, mixed, and professional fire departments ($F_{(2, 3019)} = .30$, *ns*).

RH8. The results did not support RH8 (*Volunteer Fire departments have higher civilian injury rates compared to professional and mixed fire departments*). But, the ANOVA test results suggest that the civilian injury rate are significantly different among volunteer, mixed, and professional fire departments ($F_{(2, 3019)} = 275.4$, $p < .01$) (Table 8). Professional fire departments mean rate of civilian injury is .023; mixed fire departments mean rate of civilian injury is .015; and volunteer fire departments' mean rate of civilian injury is .007. The professional departments have higher civilian injury rates.

Table 8. The mean value of civilian injury rates between 1998-2014

Fire Dept. Type	Mean	Std. Deviation	N
Professional	.023	.020	1144
Mix	.015	.016	820
Volunteer	.007	.011	1058
$F_{(2, 3019)} = 275.4$, $p < .01$			

RH9. The results do in fact support RH9 (*Volunteer Fire departments have longer response times compared to professional and mixed fire departments*). The ANOVA test results suggest there are differences among volunteer, mixed, and professional fire departments on response time ($F_{(2, 3019)} = 804.51$, $p < .01$). Professional fire departments average response time is 5.38; mixed fire departments average response time is 6.67; and volunteer fire departments' average response time is 9.51. The volunteer fire departments do in fact have higher response time.

Table 10. The mean value of fire department response time rates between 1998-2014

Fire Dept. Type	Mean	Std. Deviation	N
Professional	5.38	1.86	1144
Mix	6.67	2.59	820
Volunteer	9.51	2.87	1058
$F_{(2, 3019)} = 804.51$, $p < .01$			

CHAPTER V

DISCUSSION

The results from testing the nine hypotheses clearly indicate many important findings from the tested variables within the NFIRS data set, these variables showing further support or disprove the existing theories directly related to the fire and emergency services. These results also include the various factors that directly influence unsafe events within each of the analyzed incident cases, the multitude of unknown variables clearly influences outcomes of incidents. Furthermore, this feat is impossible due to the extra time required to pin point every possible variable that exists within the time and spaces of earth, more specifically within the US. (Einstein, 1916). Harman (1960) and Bollon (2002) portrays that factors seem to be hypothetical constructs (Nunnally, 1978), humans decipher if these factors are in fact reality or just imagination from within the subconscious. Since multiple events take place throughout building fire incidents one must decipher probable factors, which is based upon reality and critical thinking (e.g. imagining situational outcomes of the building fire incident). The following sections will clearly portray what resulted from statistically testing the nine variables from within the NFIRS data sets (i.e. descriptive statistics, independent sample t-tests, and ANOVA) clearly shows in-depth explanations of the phenomenological factors.

Fire Department Utilization Frequencies of ICS and Firefighter Casualties

Firefighter Fatalities. The results from RH5 indicate that firefighter fatality rates are not significantly different among volunteer, mixed, and professional fire departments. Although, the results from RH1 indicate that the fatalities of firefighters are in fact due to the infrequent utilization of the NIMS-ICS. Investigating these fatal outcomes for professional and volunteer firefighters along with firefighters from mixed fire departments will reduce or eliminate the unsafe conditions (i.e. firefighter committing higher-risks). Kunadharaju et al. (2011) highlights the overall implications for nearly all non-fire and emergency service organizations is the complete avoidance of the high-risk situations. The highly risky activities of suppressing fires and rescuing of trapped humans (i.e. civilians) during incidents. In contrast, the principal work activity of firefighting clearly requires hazard engagement, which is usually further complicated by extreme time burdens. These time burdens clearly effect the safety planning process that includes multiple procedures for increasing one's safety acuity, thus limiting the risk exposures of the employed individuals within an organization. (Rasmussen, 1997; Reason, 1997; Kunadharaju et al. 2011). Most firefighter fatalities resulted from cardiovascular injury (e.g. physiological stressors triggering heart problems) or failure (e.g. extreme physiological stressors triggering cardiac arrests) during active fire incidents. (Fahy, 2005; Kales et al., 2003, 2007; Hodous et al., 2004; Kunadharaju et al., 2011).

This study is providing deeper insight into the problem of firefighter fatalities, showing some of the principal factors contributing to these fatalities is important for the purpose of enhancing the overall survivability for fire service members. The enhancement of firefighter survivability is dependent on the collaboration amongst the national institute of occupational safety (NIOSH), national fallen firefighter's foundation (NFFF) along with the NFPA and the USFA. The NIOSH investigates all reported fire service fatalities cases to explain the core factors that contribute these fatalities. Interestingly, the NIOSH investigated roughly 213 firefighter fatalities over the span of five years (i.e. 2004 to 2009) leading into roughly 1200 safety enhancements to further improve the overall safety practices for fire service members. During the data analysis process the four most notable operational fire incidents with at least four or more fire firefighter LODD's consists of: (1) Charleston nine, firefighter LODD's (2) West ten, firefighter LODD's (3) Worcester six, firefighter LODD's (4) Houston four, firefighter LODD's. First, the nine Charleston, North Carolina firefighter LODD's transpired within a commercial furniture showroom/warehouse building during the June 18, 2007 year, which resulted from an overall disorientation from other fire company members resulting in expelling of all air from the SCBA tank during the interior fire suppression attempt. Second, ten volunteer firefighter LODD's consisting of five firefighters from the primary response fire department from the town of West, Texas along with four firefighters from three other mutual aid volunteer fire departments. These LODD's transpired during a fertilizer manufacturing building fire, which then an explosion of roughly 50 tons of ammonium nitrate occurred twenty minutes after the first arriving engine company. Third, six professional firefighters LODD's occurred in Worcester, Massachusetts during

December 3, 1999. These LODD's resulted from progressive disorientation within a six-story maze-like building interior during an interior fire suppression-search and rescue attempt of two homeless people along with fire extension. Fourth, a commercial building fire in Houston, Texas during the May 31, 2013 year then resulted in four professional firefighter LODD's, which occurred during the collapse of the restaurant roof. These four operational fire incidents include unsafe actions of members further leading to the occurrence of firefighter LODD's. The NIOSH prescribes that the IC must perform accurate accountability of all members along with close integration communication and establish an independent safety officer for the entirety of the incident. Also, the IC or independent safety officer appoints an engine, rescue or ladder company as the rapid intervention team (RIT) for emergency rescue of compromised firefighters. The NFFF provides support to fire departments with pre-incident planning support and training for possible firefighter line of duty deaths. Post fatality a chief-to-chief link allows for retrieval of technical assistance for fire department members and family members. (Firehero, 2018). In addition, the organization collaborated with various fire and emergency services to then establish an objective to reduce on-duty injuries or fatalities by roughly 25-percent over a span of 5 years. The attempt of increasing safety awareness during operational fire incidents is important, yet a difficult feat for an incident commander to effectively reach all members involved with completing several tasks. Kunadharaju et al. (2011) mentions that some organizations safety objectives depend on primary operational objectives (i.e. effectiveness, efficiency, and monetary control) opposed to accepting safety as a common cultural practice. In addition, the first logical explanation for compromising these safety objectives during an operational fire incident is due to firefighters experiencing 'burn-out' (i.e. physiological or psychological human stress) across the fire service. The second logical explanation, some of the individual firefighters experiencing 'burn-out' consists of: compromised verbal or physical communication to the IC concerning unsafe practices on the operational fire incident, improper or non-utilization of SOP's for individual personal protective equipment or how to perform tasks safely appears to contribute to firefighter injuries or line of duty deaths (LODD's) overall. It seems that most fire policies or procedures change when a tragic event unfolds during an operational fire incident. Individuals from various ranks and titles (i.e. chief level fire service administrators down to the company level officers and firefighters) experience an adverse effect within the fire department. Post firefighter fatalities events, senior fire administrators collaborate to initiate the policy changing process for improving the safety actions of members department-wide. Most of these senior fire administrators must emphasize implementing or amending safety policies prior to LODD's opposed to the post fire incident analysis of the LODD showing the most probable implications for the risks contributing to fatal firefighter(s) outcome. The extensive combinations of variables will in fact lead up to either a decrease or increase for the probability of firefighter(s) increasing self-risk, thus prompting the consequential risks (e.g. actions or inactions leading to a fatal outcome) during an operational fire incident. Overall, the data of Prati et al., (2013) demonstrates that firefighter's selfchoices become quite limited because the American fire service will clearly continue to operate under the structured public safety hierarchy (i.e. highest rank down to the lowest rank). Another self-choice limitation of firefighters is achieving reduction of risks reduction is that both the public safety hierarchy allows for curtailing members from committing unsafe act(s) through enforcing the span of control (i.e. managing 5-7 members per fire officer) element of the NIMS-ICS. In this case firefighter non-self-choice of firefighters also seems to reduce risk acuity post exposure to the various risks opposed to an individual possessing self-choice of volunteering for high-risk activities (e.g. non-fire service organizations). These conclusions can also generalize as to what risk elements the individual firefighter observes during the operational fire incident, the determined self-risk level of each firefighter will continue to fluctuate. This fluctuation of self-risk will clearly depend on an organizations frequency of utilizing the ICS to then limit the quantity of firefighter injuries or fatalities presently and in future years.

Firefighter Injuries. The results from RH2 indicated that fire departments utilizing ICS frequently or infrequently are not significantly different. Although, the results of RH6 shows that professional firefighters experience more injuries during operational fire incidents in comparison to volunteer firefighters, the professional firefighters tend to experience quite noticeably more fire incident responses due to the large urbanized areas of the US. These urban or sub-urban fire department's will continually respond to all types of fire incidents ranging from small structure fires (i.e. garbage containers or vehicles) to large structure fires (i.e. residential or commercial buildings, wild-land urban interface, and fires involving hazardous materials) will continue to endure exposures to extra risks throughout fire incidents. Lue and Wilson (2017) state that unsafe conditions consist of both physical and social elements of safety.

ICS Utilization for Smaller Residential Building Fires and Larger Commercial or Industrial Building Fires

The vast majority of the 9.1 million building fire incidents analyzed in this study involve private civilian residences and some commercial or industrial buildings. The results clearly indicate that the frequent utilization of the ICS will in fact limit of prevent the phenomena of firefighter fatalities along with civilian injuries and fatalities. The most probable factor for limiting or preventing firefighter fatalities during smaller (i.e. residential) or larger scaled (i.e. commercial or industrial) building fires incidents either currently or in the future will require fire departments to frequently utilize the NIMS-ICS. This requires the IC and safety officer of the command staff to control and manage the identities of each firefighter and their respective fire unit number (e.g. 3-6 firefighters assigned to engine 1 or ladder 1 for a 12, 24 or 48-hour shift) for task tracking and firefighter retrieval purposes. The fire departments utilization of the NIMS-ICS will in fact continue to reduce or prevent the phenomena of civilian injuries or fatalities currently and in the future. The main factor contributing to the reduction or prevention of these civilian injuries or fatalities is through an IC establishing a search and rescue task force team. This allows for the quick retrieval of civilians during either smaller scaled residential building fires with higher quantities of incidents or larger scaled commercial or industrial building fire with lower quantities of incidents.

Hazardous Materials Identification with ICS Utilization Affecting Firefighter and Civilian Casualties

The testing of these five variables (i.e. fire department utilization of the ICS, firefighter injuries, firefighter fatalities, civilian injuries, and civilian fatalities) show the importance of identifying and analyzing if hazardous materials exist upon arrival to the fire scene. the most probable factors involve non-certified personnel in hazardous material awareness or operations levels. The current and future members of fire departments' must continue an acute awareness of CBRNE exposure risks. More specifically, the overall exposure risks to either weaponized chemicals, biological organisms, intentional or unintentional nuclear or radiological releases, and small or large explosive devices. The most plausible concept to further reduce CBRNE exposure risks involves arranging trainings for the purpose of familiarizing professional, mixed and volunteer fire department members encountering the different typologies of hazardous situations. Gabor and Griffith (1980) highlights the importance of performing adequate assessments of the industrial companies' complexes producing hazardous chemicals along with storage container type, size and locations. The identifying factors for hazardous materials consists of the following three factors. *First*, the quantity of buildings storing chemicals and closeness to the human populace. *Second*, hazardous materials transport via railway or roadway. For example, portable hazardous structures (i.e. railcars, light-heavy motorized vehicles with or without trailers) will experience failures from time to time, thus leading up to the unwanted releases of substances. More specifically, rail car container failures will continue to involve immense releases of hazardous substances in the form of either aerosols, gases, liquids, or solids within the human and ecological systems. Glickman and Rosenfield (1984) highlights the implications for the venting of the liquid types of hazardous substances (i.e. raw, sweet or refined crude oil, propane, and liquified natural gas), vapors (i.e. anhydrous ammonia, chlorine, ethylene oxide, hydrogen fluoride, or sulfur dioxide) along with the release of volatile solids from railcars. *Third*, predicting the most probable types and severity of chemical releases from stationary structures located within counties or municipalities. For example, geo-spatial locations of either non-portable structures (i.e. buildings storing hazardous substances) or portable structures (i.e. railcars, light-heavy motorized vehicles with or without trailers) transporting hazardous substances will continue to be anywhere within a rural, sub-urban, or urban area of a locality. Perry and Lindell (2003) highlights that corporations producing and storing hazardous materials within buildings will continually experience consequences when releases occur, which then require fire department special operations resources (i.e. hazardous materials response teams). The occurrence of building fires involving hazardous substances releases (i.e. clandestine drugs, bio-chemical, explosives labs or large containers with unidentified substances) incidents involving private civilian residences will continue to require the deployment of fire department specialized resources.

The overall frequency and probability of these residential building fires (i.e. single-family houses or low-rise multiple family buildings) involving ignited hazardous materials continues to stay moderate. This is due to the fact that most single-family houses store unknown qualities of small sized containers storing hazardous substances. In comparison, large commercial or industrial building fires involving ignited hazardous materials will most likely be less frequent with immense consequences to the human and ecological system all together. The frequency of responses to incidents involving either unknown or known types of hazardous materials releases will continue to affect the built environment of humans along with an overall threat of ecological collapse (e.g. the release of hazardous substances adversely affects multiple species).

The current and future concerns for both the human and ecological systems is the threat of hazardous substance release in the rural areas of the US. The majority of these rural areas require hazard protection from volunteer fire departments that will continually require special operations resources (i.e. specialized rescue or hazardous materials response teams with technicians) for mitigation purposes. Although, in some instances, the volunteer fire departments units with firefighters certified as hazardous materials operations level or at least awareness level of certifications will at least have the capability of performing the identification of hazardous substances upon arrival to emergent incidents. These firefighters possessing operations or awareness level of hazardous materials must participate in annual re-certification trainings; for the purpose of familiarization for any changes with types of substances along with tactical mitigation.

Fire Department Frequencies of ICS Utilization Limiting Civilian Casualties

Fatalities of Civilians. The application of the Blaikie et al. (1994) pressure and release (PAR) model allows for determining and monitoring the risks that create the human vulnerability along with the various processes that threaten the overall populace. This outcome shows the crucialness for fire departments to establish appropriate response times for fire apparatus units to respond quickly (e.g. arrive to an incident within five minutes) to increase survivability of trapped humans within an active fire incident. Throughout time the modern built environment of humans will continually experience delayed responses from fire departments, these compromised fire department responses to active fire incidents directly contribute to fire suppression factors (i.e. variable(s) contributing to fire suppression delays). These fire suppression factors entail the managing of the overall fire condition process (i.e. fire growth and spread leading up to suppressing the fire) along with the occurrence of substantial issues. Furthermore, the evidence of various factors effecting fire suppression during an incident consists of: (1) ignition, (2) fire or smoke spreading, (3) overall incident complexity, and (4) existence of hazardous conditions. (FEMA, 2017). Anderson and Ezekoye (2018) highlights the implications for missing data is clearly a direct result of non-capturing of the geo-spatial data entailing the covered populaces, the fire department's accounts for and then reports all fire incidents involving civilian injuries or fatalities. Kunadharaju et al. (2011) also highlights the re-occurring issues concerning inadequate personnel and the non-establishment of the ICS within the volunteer fire departments. In addition, the identification of eight sections consisting of: medical/fitness, training, staffing, risk assessment, accountability, rescue, task awareness, and SOPs. These eight sections clearly revolve around reducing or eliminating unsafe actions during the operational fire incident along with factoring under-resourcing, inadequate preparation for an unsafe event, inadequate utilization of ICS protocol, and lack of personnel readiness through training evolutions.

Civilian Injuries. This study also provides deeper insight into the problem of civilian casualties, in this case mainly the fatalities share a positive relationship with the response times of volunteer and professional fire department units to building fires. The contributing factors of civilian fire fatalities will continue to involve both non-vulnerable (i.e. self-sufficient humans) and vulnerable human (i.e. self-deficient) populaces. Most of these smaller ethic groups mostly inhabit the geo-spatial urban and sub-urban along with inhabiting some rural areas within society. These vulnerable social groups continually experience higher exposures to fire risks within the urban areas in comparison to rural areas of the human built environment. The logical explanation is that most of these humans reside within the older US building stock, this will continually increase the probability of the small ethnic populace groups to experience instances of fire. The findings of Lue and Wilson (2017) will therefore have serious implications for the variable consisting of individuals from smaller ethic groups within the populace will in fact continue to experience fires in their homes. Post fire incidents, these smaller ethic groups will involve assistance from non-government organizations (i.e. mainly the

American Red Cross). The continuing concern among fire and disaster scholars and the members of the American fire and emergency services is the visual-auditory and language deficits of humans. These human deficits also contribute to decreases or absence in fire safety awareness (e.g. failure to contact 9-1-1 for fires or other types of emergencies), in turn this contributes to delays in deploying fire department units to active fire incident locations.

The continued foci of fire departments administrators are to utilize data tracking programs in a digital computing sense, this allows for data scrutiny and statistical testing of variables later. Each respective state must in fact mandate all fire department's to then implement and utilize the USFA- NFIRS to enhance the life safety of humans via risk reduction practices (i.e. community fire and self-safety awareness programs). Anderson and Ezekoye (2018) highlights the implications that comparing future NFPA and NFIRS data sets differentiations will repeatedly exist because of some fire department's not reporting fire incident data to the NFIRS. The concern amongst some fire incident data analysts is simply the 30 percent of fire department's non-reporting of incident data to the NFIRS overall, this clearly shows that some of the civilian casualties will remain stagnantly un-aggregated into the NFIRS. In addition, the ongoing concern for both the academic fire and disaster sciences along with practical (i.e. the fire and emergency services) is the known correlation between tangible items (e.g. various types of ignitable furniture) dependent variables and the independent variable consisting of civilian fatalities phenomenon's. Similar to the aged building stock contributing to human fatalities the overall age, condition, dimensions, and fire resistivity of materials (i.e. particular amount of time and ignition temperature) will dictate the overall survivability for humans.

Volunteer, Professional, and Mixed Fire Departments Rates of Firefighter Casualties

Fatality Rates of Firefighters. In general, the test results of RH5 suggest that the firefighter fatality rates are not significantly different among volunteer, mixed, and professional fire departments. However, there will always be firefighters from all ranks concerned with the possibly of experiencing fatal outcomes during an operational fire incident. Kunadharaju et al. (2011) highlights the overall implications for nearly all non-fire and emergency service organizations is the complete avoidance of the high-risk situations. The highly risky activities of suppressing fires and rescuing of trapped humans (i.e. civilians) during incidents. In contrast, the principal work activity of firefighting requires hazard engagement, which is usually further complicated by extreme time burdens. These time burdens clearly effect the safety planning process that includes multiple procedures for increasing one's safety acuity, thus limiting the risk exposures of the employed individuals within an organization. (Rasmussen, 1997; Reason, 1997; Kunadharaju et al. 2011). Investigating these probable anomalies amongst the fatal outcomes will clearly lead to an overall reduction or elimination of unsafe conditions (i.e. higher-risks within a human's surroundings) during the operational phase of incidents that clearly contribute to phenomena of firefighter fatalities. Most firefighter fatalities resulted from cardiovascular injury (e.g. physiological stressors triggering heart problems) or failure (e.g. extreme physiological stressors triggering cardiac arrests) during active fire incidents. (Fahy, 2005; Kales et al., 2003, 2007; Hodous et al., 2004;

Kunadharaju et al., 2011). The fire departments throughout the world and more specifically across the US along with the fire and disaster science community must keep emphasis on investigating the contributing factors leading to these fatal outcomes. The fire departments throughout the world and more specifically across the US along with the fire and disaster science community must keep emphasis on investigating the contributing factors leading up to these fatal outcomes.

Injury Rates of Firefighters. The test results of RH6 show that the firefighter injury rates are significantly different among professional, volunteer, and mixed fire departments. The professional fire departments have the highest firefighter injury rates, this is due to the fact that most professional fire departments experience much higher quantity of annual emergency responses in comparison to mixed or volunteer fire departments. The most probable factors contributing to these firefighter injuries is the larger urban densities of human populaces ranging in age along with mental and physical heath of civilians requiring the assistance of fire and emergency services for various types of emergent medical, fire, hazardous materials or specialized rescue incidents. The data set retrieved from the NFIRS shows that the five largest quantity of firefighter injuries during the 1998 thru 2014 years consists of: First highest, 14025 injuries consist of FDNY firefighters. Second largest, 1430 injuries consist of firefighters from the Columbus, OH fire department. Third largest, 1327 injuries consist of firefighters from the Chicago, IL fire department. Fourth, 1122 injuries consist of firefighters from the Minneapolis, MN fire department. Fifth, 1110 injuries consist of firefighters from the

Worcester, MA Fire Department. Most firefighter injuries will most likely continue to occur during the fire suppression phase of the building fire incidents.

Professional, Mixed, Volunteer Fire Departments Unit Response Times

Professional Fire Department Units. In modern time, the focus of stakeholders entails the utilization of scientific and mathematical modeling to determine the optimal location within an urban area along with the type and quantity of resources required for quick responses to emergency incidents (i.e. fires, medical emergencies or specialized operations of hazardous material or technical rescue teams). Kunadharaju et al. (2011) highlights the implications of focusing on under-resourcing leads to phenomenon within an operational fire incident. These professional fire department’s will continually need adequate funding from the public tax base to obtain proper resources for deployments to incidents opposed to under-funded professional fire department’s deploying limited resources to incidents. Kunadharaju et al. (2011) highlights the implications for under-resourcing leads to phenomenon within operational fire incidents; the specific details and circumstances seem impossible for absolute clarification for any under-resourcing.

Mixed and Volunteer Fire Units. Taken together, this data demonstrates that when comparing the mean response times for urban fire departments, sub-urban mixed fire departments’ and the rural volunteer fire departments shows dissimilarities between the mean response times within the US. The complexities involving the factors that directly contribute to variations in the individual fire unit response times. One of the contributing factors for mixed fire department unit response times involves the dissimilar social constructs between the mixed and volunteer fire departments. The perceptual dissimilarities amongst volunteer firefighters and professional firefighters influences the overall cultures. Gonzalez (2002) highlights the consequences for volunteer fire department's continually utilizing the theoretical apprenticeship training process that consists of a non-scientifically based trained journeyman, which in turn train the inexperienced individuals on quite basic fire suppression tactics. The non-scientific based fire suppression training seems to lack emphasis on the basic fire suppression techniques (i.e. projecting water onto fires) along with basic medical first aid. Some volunteer fire departments require these non-scientifically trained apprentice(s) (i.e. fire cadets) to respond to various types of complex emergent incidents (i.e. structure fires, hazardous materials, advanced emergency medical treatment or specialized rescues of individuals). These emergent types of incidents require certified firefighters with advanced training to further mitigate a complex incident. The professional individual fire service members tend to possess a variety of certifications (e.g. firefighter I and II, hazardous materials operations or technician, technical rescue technician, EMT or paramedic), which provides adequate levels of service to society.

The quick deployment of available fire department resources clearly affects the overall response times of the tested variables (i.e. ICS and civilian casualties) along with the factors that contribute to the overall outcome. Most of the professional fire departments deploy resources (i.e. firefighters and fire apparatus) from various existing fire stations throughout a locality to active fire incidents (i.e. building fires) opposed to un-staffed volunteer fire stations delaying the deployment of fire department resources to fire incidents. The main concern for volunteer fire department resource delays is awaiting the response confirmation from each volunteer firefighter, these immediate responses to incidents will continually increase the existing risks. These individual volunteer firefighters will in fact continue to respond from various points within the locality in personal vehicles to the volunteer fire station. The most probable factor for safer volunteer fire department response policies is to shift from a volunteer fire department into a professional fire department requires monetary resource allocation. The most probable action is to convince the members of the homeland security committee increase the supplemental funding from the US congress or to request additional funds from within the local county or town tax base. The data of Simpson and Hancock (2009) shows that the focus of the stakeholders in the US during the 1970's was on urban fire station locations opposed to rural geographic areas. Wilson et al. (2011) highlights the implications that the further the fire department unit distance of travel and the reduced quantity of on-duty specialized rescue teams contributes to the continuation of pro-longed arrival times for the first arriving engine companies along with special operations units in the rural counties of the US.

CHAPTER VI

CONCLUSION

Application of the Emergent Socio Ecological System Theory

The application of Bronfenbrenner (1979) SES has in fact allowed for the creation of the E-SES for explaining in-depth the phenomenological factors in the American fire and emergency services. The four sub-sections from the existing SES allowed for creating the four sub-sections of the E-SES that consist of the NIMS macro-sub-system, the fire department policies meso-sub-system, the NFIRS exo-sub-system, and the firefighter micro-system). Utilizing these sub-sections has further explained the dependency of humans (i.e. civilians) on firefighters for their survival upon the emergence of an incident that involves building fires, hazardous situations, or medical complications. The statistical analysis of the NFIRS data set has clearly shown various factors that contribute to the phenomenological outcomes within the American fire and emergency services. These outcomes clearly consist of several variable combinations in which dictate the phenomena within the operational fire incidents, analysis of the NFIRS data has shown the importance of: firefighter safety awareness, identifying hazardous materials, initiating the utilization of ICS, civilian fire risk reduction, community outreach support programs for the small groups of vulnerable individuals, and public fire safety education programs.

Validity. The major concern in this research is the overall validity of the research design and methods utilized for this study enforces these important findings. Empirically, the validity of these findings represents the phenomenon within the SEST (i.e. the 50 US) and the four sub-systems (i.e. the macro NIMS; the meso, fire department policies; the exo, NFIRS; and the micro, firefighters). In addition, all missing data from within the NFIRS was recoded to variables for the purpose of excluding either missing or inaccurate data entries from fire department personnel. These inaccurate data entries into the NFIRS consists of both the non-probable response times of 0 minutes or the response times exceeding 90 minutes. Creating a new variable in the SPSS program, version 25, allowed for excluding the missing data within this NFIRS data set, this prevented skewed data. The obtainment and testing of these 9.1 million individual fire incident cases confirms that the sample size is in fact representative of the defined populace. (Seliger and Shohamy 1989).

Research Limitations. The limitations within this research consists of missing data, the lack of time required to test every variable or possible combinations of variables, the inability of controlling the exact time and space, along with the specific size and the total time the operational fire incident persists. The data from within the NFIRS is obviously quite massive yet lacks an ability to differentiate between residential, commercial or industrial types of building fires, the existing incident type structure fire code is 111 for all building fires. The utilization of the incident number data and the US census data would allow for GIS plotting of the fire incident address to determine the type (i.e. residential, commercial, or industrial) and the quantities of each one. Most of the content within this study is considerably unbiased in comparison to prior analytical research experiencing either unintentional bias (e.g. systematic errors distorting the measurement process or reducing data misconceptions) or intentional bias (e.g. misapplication of the data contributing to lingering effects).

The inclusion of every single scientific journal article or dissertation somewhat relevant to this study could have created an overabundance of content for the readers (i.e. scholars or non-scholars) along with unnecessary citations for the literature unrelated to the fire and disaster sciences. For Example, the exclusion of the non-fire-based EMS provider population from this analytical study is mainly due to the simple fact that these individuals are not members of either professional, mixed, or volunteer fire departments. This study clearly necessitated the quantitative approach to perform statistical analysis of the immense NFIRS data set. The fire department incidents analyzed throughout this study consisted mostly of residential types of building fires along with minimal commercial or industrial fire incidents. The further analysis of all probable variables for factoring in each structure fire causation would clearly require an inclusive statistical analysis of the excessive combinations of variables, along with completely identifying any unobserved or unmeasured variables. (Bollon, 2002).

Public Fire Policy Recommendations. The reviewing of current fire policies literature is quite vague overall, more specifically, the lack of fire policy research studies is concerning for federal, state, and local governments. The creation, introduction, and passing of a federal firefighter certification and safety act would mandate all fifty states of America, sovereign nations, U.S. territories and commonwealth's. This standardization would also mandate that both professional and volunteers obtain and maintain their fire certifications (i.e. firefighter I and II, hazardous materials awareness and operations). Subsequently, in the year 2001, the USFA mandated that all fire departments requesting federal grant funding will then need to demonstrate continual utilization of the NFIRS for 12 months prior to submitting grant funding requests. In opposition, the USFA will need fire departments to demonstrate the utilization of both the NIMS-ICS and NFIRS for a minimum of six months. Furthermore, due to the concerns of hazardous materials releases amongst county or municipalities will continue to effect humans (i.e. civilians) and the ecological system entirely. Policy amending for zoning of commercial or industrial hazardous substances complexes along with the railroad transporting of hazardous substances. Also, mitigating these various types of hazardous substances requires emergency operations planning with other emergency responder organizations, for the creation and implementation of emergency operations plans, which require annual reviews.

Recommendations for Future Research. Future research should examine similar phenomena from within this research study along with extracting future data sets from the vast USFA-NFIRS data base. One could utilize mixed, quantitative (e.g. descriptive or statistical correlational analysis), or qualitative methodology (e.g. interviews and observations of the American fire and emergency services) to analyze other types of phenomena within the NFIRS. Also, it would be more beneficial to all humans to explore the following units of analysis: First, combination fire department members (i.e. both volunteer and professional members) certification levels and instances of injury comparison. Second, USFA grant programs for resource attainment or scientific studies. Third, fire departments that require firefighters certified as advanced life support providers may prolong the lives of injured firefighters or civilians during operational fire incidents compared to basic life support or emergency medical responder certified members. Four, incident commander education levels and critical thinking. Five, comparative analysis of fire department's training frequencies and topics covered along with determining what percent of volunteer fire departments have members certified as firefighter II, hazardous materials operations and EMT-B. Six, testing variations in fire department resource deployments. Seven, frequency of unintentional table top exercises occurring during firehouse meals and the contribution to self-knowledge base. Eight, comparison of fire department safety program training between the smaller or larger sized fire departments and instances of firefighter injuries or fatalities. Nine, comparison of fire department safety policies between dissimilar duty shifts (i.e. 12 or 24-hour shifts, shift rotations, and time off duty) and the instances of firefighter injuries from fatigue. Ten, how new technology can improve the overall safety and health via reducing the cancer risks amongst firefighters of the modern world. This investigative study has shown the contributing factors for the variety of phenomena throughout the American fire and emergency services. One should continue to focus indefinitely on the practices of safety for improving the survivability of both firefighters and civilians; while continually serving the public with compassion, modesty, and devotion.

References

AB (1973) United States Fire Administration, America Burning. Retrieved from https://www.usfa.fema.gov/downloads/pdf/publications/fa-264.pdf on 09/11/2017

Anderson, Austin and Ezekoye, Ofodike A. (2018). Exploration of NFIRS protected populations using geocoded fire incidents, Fire Safety Journal, Volume 95, 2018, Pages 122-134, ISSN 0379-7112, https://doi.org/10.1016/j.firesaf.2017.11.013. (http://www.sciencedirect.com/science/article/pii/S0379711217306938)

Australasian Fire Authorities Council, AFAC (2004). Fire Brigade Intervention Model (version 2.2). Melbourne.

Bernard, Thomas J; Paoline, Eugene A; Pare, Paul-Philippe. (2005) General systems theory and criminal justice, Journal of Criminal Justice, Volume 33, Issue 3, 2005, Pages 203-211, ISSN 0047-2352, http://dx.doi.org/10.1016/j.jcrimjus.2005.02.001.

B.J. Hommes. (2005). Evaluating conceptual coherence in multi-modeling techniques, in: J.

Cornell Law School. (2015). Retrieved from https://www.law.cornell.edu/cfr/text/34/668.49 on August, 20, 2017.

Blaikie, P., T. Cannon, I. Davis, and B. Wisner (1994) At Risk: Natural Hazards, People's Vulnerability and Disasters. First edition. Routledge, London.

Bollen, K. A. (2002). Latent variables in psychology and the social sciences. *Annual review of psychology*, *53*(1), 605-634.

Bronfenbrenner, U. (1979). The ecology of human development: Experiments by design and nature.

Brunacini, A.V. (1985). *Fire command*. Quincy MA: National Fire Protection Association.

Brunacini, A.V. (2001). *Fire command,* 2nd ed. Quincy MA: National Fire Protection Association.

Brunacini, A.V. (2002). *Fire command: The essentials of IMS*. Quincy MA: National Fire Protection Association.

Bigley, G. and Roberts, K. (2001) 'The incident command system: high-reliability organizing for complex and volatile task environments', The Academy of Management Journal, Vol. 44, pp.1281–1299.

Buckley, G., Bradborn, W., Edwards, J., Terry, P., & Wise, S. (2000). The Fire Brigade Intervention Model. *Fire Safety Science*, *6*, 183-194.

Burton, I., Kates, R. & White, G.F. (1993). *The environment as hazard, 2nd ed.* New York: Guildford Press.

Campbell, R. Fire Technol (2018) 54: 461. https://doi org.argo.library.okstate.edu/10.1007/s10694-017-0692-9

Chaiken, J. M., Ignall, E., & Walker, W. (1975). Deployment Methodology for Fire Departments.

Chang, H-H. (2017) 'A literature review and analysis of the incident command system', Int. J. Emergency Management, Vol. 13, No. 1, pp.50–67.

Claridge, E. and Spearpoint, M (2013) New Zealand fire Service Response Times to Structure Fires, Procedia Engineering, Volume 62, 2013, Pages 1063-1072, ISSN 1877-7058, http://dx.doi.org/10.1016/j.proeng.2013.08.162.

Commission on Fire Accreditation International, Inc., CFAII (2003). Creating and Evaluating Standards of Response Coverage for Fire Departments (4th ed). Chantilly, VA. Public Entity Risk Institute.

Corman, H., Ignall, E. J., Rider, K. L., & Stevenson, A. (1976). Fire casualties and their relation to fire company response distance and demographic factors. *Fire technology*, *12*(3), 193-203.

Coyne, J. A. (2009). Why evolution is true. New York: Viking

Cutter, S.L. (2001). *American hazardscapes: The regionalization of hazards and disasters.* Washington, DC: Joseph Henry Press.

Dormont, P., J. Hausner and W. Walker (1975). Firehouse Site Evaluation Model: Description and User's Manual, Report E-1618/2, The Rand Corporation, Santa Monica, CA, June.

D.T. Halpin, K. Siau (Eds.), Information Modeling Methods and Methodologies, Idea Group Publishing (IGP), Hershey PA, USA.

Eltz, B. J. (2015). *Comparative analysis of risk: Volunteer versus career firefighters within a community fire department* (Doctoral dissertation, Capella University).

EMSI (2017). History of ICS. Retrieved on 08/14/2017 from http://www.emsics.com/history-of-ics/

Einstein, A. (1916). The foundation of the generalized theory of relativity. *On a Heuristic Point of View about the Creation and Conversion of Light 1 On the Electrodynamics of Moving Bodies 10 The Development of Our Views on the Composition and Essence of Radiation 11 The Field Equations of Gravitation 19 The Foundation of the Generalised Theory of Relativity*, *22*, 22̃.

Eye, A. v., & Niedermeier, K. E. (1999). *Statistical Analysis of Longitudinal Categorical Data in the Social and Behavioral Sciences: An Introduction with Computer Illustrations*. Mahwah, N.J.: Psychology Press.

Fahy, R.F., 2005. U.S. Firefighter Fatalities Due to Sudden Cardiac Death, 1995–2004. National Fire Protection Association, Quincy, MA.

FEMA (2017) National Fire Incident Reporting System 5.0 Edition. Retrieved from https://www.fema.gov/media-library-data/20130726-1859-25045-1555/nfirs__crg_07_2010.pdf on 10/19/2017.

Firehero (2018). The National Fallen Firefighters Foundation. Retrieved from https://www.firehero.org/about-us/ on 02/20/2018.

Gasaway, R. B. (2008). *Fireground command decision making: Understanding the barriers challenging commander situation awareness* (Order No. 3310697). Available from ProQuest Dissertations & Theses Global. (230704335). Retrieved from http://argo.library.okstate.edu/login?url=https://search-proquest-com.argo.library.okstate.edu/docview/230704335?accountid=4117

Goldfarb, T. (1997) 'Putting the incident command system in perspective', Fire Engineering Magazine, Vol. 150, January, p.64.

Goldstein, E. (2010). *An investment in public safety: Do DHS Assistance to Firefighters Grants lead to a reduction in first responder injury rates?* Georgetown University.

Gonzalez, M. M. (2002). *Factors related to line -of -duty injuries to firefighters in a metropolitan fire department* (Order No. 3078439). Available from ProQuest Dissertations & Theses Global. (305553625). Retrieved from http://argo.library.okstate.edu/login?url=https://search-proquest-com.argo.library.okstate.edu/docview/305553625?accountid=4117

Government Printing Office. (2017a). GPO Conan. Retrieved from https://www.gpo.gov/fdsys/pkg/GPO-CONAN-1992/pdf/GPO-CONAN-1992-10-11.pdf on August, 21, 2017.

Government Printing Office. (2017b). PROTECTING VOLUNTEER FIREFIGHTERS AND EMERGENCY RESPONDERS ACT OF 2014. Retrieved from https://www.gpo.gov/fdsys/pkg/CRPT-113hrpt360/pdf/CRPT-113hrpt360.pdf on 12/05/2017.

Hanley, T. (1990) 'A different view of the incident command system', Hazard Monthly, Vol. 10, pp.1–2. Harrald, J. (2006) 'Agility and discipline: critical success factors for disaster response', The ANNALS of the American Academy of Political and Social Science, No. 604, pp.256–272. Hatch, M. (1997) Organization Theory, Oxford University Press, UKHarman

Haynes, Hylton (2016). National Fire Protection Association, US Volunteer Firefighter Injuries 2012-2014. Retrieved from https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics/Fire-service/osvolunteerfirefighterinjuries.ashx?la=en on 04/27/2018

Haynes, Hylton and Mollis, Joesph (2015). National Fire Protection Association, US Firefighter Injuries 2014. Retrieved from https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics/Fire-service/firefighterinjuries2015.ashx?la=en on 04/27/2018

HH. (1960). Modern Factor Analysis. Chicago: Univ. Chicago Press

House Legal Counsel, Government. (2017). http://legcounsel.house.gov/Comps/FIREPREV.PDF

IFRCND. (2014) Disaster management. http://www.ifrc.org/en/what-we-do/disaster-management/. Accessed 5 Sept. 2014

IAFF (2017). IAFF Training Programs: HazMAt Courses. Retrieved from http://client.prod.iaff.org/#page=hazmat_training programs on 10/13/2017.

IFSTA (2017) About IFSTA. Retrieved from https://www.ifsta.org/about-us

Johnson, J. B., Reynolds, H. T., & Mycoff, J. D. (2015). *Political science research methods*. Cq Press.

Karter, Michael and Molis, Joseph (2013). National Fire Protection Association, US Firefighter Injuries 2012. Retrieved from https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics/Fire service/FirefighterInjuries2013.ashx?as=1&iar=1&la=en&hash=44EB860BF63AC4F77DDA00400EFD73D311D1041F on 04/27/2018.

Karter, Michael and Molis, Joseph (2014). National Fire Protection Association, US Firefighter Injuries 2013. Retrieved from https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics/Fire service/FirefighterInjuries2014.ashx? as=1&iar=1&la=en&hash=96A6DDC5C40DB835FCB6A30181D5CF727C1FE55C on 04/27/2018.

Kales et al., 2003, S.N. Kales, E.S. Soteriades, S.G. Christoudias, D.C. Christiani Firefighters and on-duty deaths from coronary heart disease: a case control study

Environmental Health: A Global Access Science Source, 2 (2003), p. 14

Kales et al., 2007, S.N. Kales, E.S. Soteriades, C.A. Christophi, D.C. Christiani. Emergency duties and deaths from heart disease among firefighters in the United States

The New England Journal of Medicine, 356 (12) (2007), pp. 1207-1215

Krasny, M. and Roth, W. (2010). Environmental education for social–ecological system resilience: a perspective from activity theory. *Environmental Education Research*, 16(5-6), pp.545-558.

Kowalski, K. M., & Vaught, C. (2001). The safety and health of emergency workers. *Journal of Contingencies and Crisis Management*, *9*(3), 138-143.

Kunadharaju, Kumar, Smith, Todd D. Dejoy, David M. (2011). Line-of-duty deaths among U.S. firefighters: An analysis of fatality investigations, Accident Analysis & Prevention, Volume 43, Issue 3, 2011, Pages 1171-1180

Lynch, S. M. (2013). *Using statistics in social research: A concise approach*. Springer Science & Business Media.

Lindell, M. K., Perry, R. W., Prater, C., & Nicholson, W. C. (2006). *Fundamentals of emergency management*. Washington, DC: FEMA.

Leslie, P., & McCabe, J. (2013). Response Diversity and Resilience in Social-Ecological Systems. *Current Anthropology, 54*(2), 114-144. doi:10.1086/669563

Lue, E., & Wilson, J. P. (2017). Mapping fires and American Red Cross aid using demographic indicators of vulnerability. *Disasters*, *41*(2), 409-426.

McBride, N. (2016) The Application of an Extended Hierarchy Theory in Understanding Complex Organizational Situations: The Case of FIReControl. Syst. Res, 33: 413–436. doi: 10.1002/sres.2350.

McCune, S. (2009). Practice makes perfect statistics. Retrieved from https://ebookcentral.proquest.com

M.S. Aini, A. Fakhrul-Razi, M. Daud, N.M. Adam, R.A. Kadir. (2005). Analysis of royal inquiry report on the collapse of a building in Kuala Lumpur: implications for developing countries, Disaster Prevention and Management pp.55–79

Murray, A. T. (2013). Optimizing the spatial location of urban fire stations. *Fire Safety Journal*, *62*, 64-71.

Myers, K., & Oetzel, J. G. (2003). Exploring the dimensions of organizational assimilation: Creating and validating a measure. Communication Quarterly, 51, 438-457.

Myers, K. K. (2005). A burning desire: Assimilation into a fire department. *Management Communication Quarterly*, *18*(3), 344-384.

Neal, D. and Phillips, B. (1995) 'Effective emergency management: reconsidering the bureaucratic approach', Disasters, Vol. 19, No. 4, pp.327–337.

Neal, D. and Webb, G. (2006) 'Structural barriers to using the national incident management system', Learning from Catastrophe: Quick Response Research in the Wake of Hurricane Katrina, Institute of Behavioral Science, University of Colorado at Boulder, Boulder, Colorado, pp.263–282.

National Fire Protection Association NFPA (2002). Hazardous Materials Response Handbook, 4th ed, National Fire Protection Association, Quincy, M: 2002.

NIOSH (2018). Transitional Fire Attack Research. Retrieved from https://www.nist.gov/el/fire-research-division-73300/firegov-fire-service on 04/03/2018.

Nunnally JC. 1978. Psychometric Theory. New York: McGraw-Hill

Office of the Fire Marshal Ontario OFMO. (2012). Fire Station Location. Office of the Fire Marshal Ontario. Online Queen's Printer for Ontario. Cited: 04/07/2012. http://www.ofm.gov.on.ca/en/Fire%20Service%20Resources/Public%20Fire%20Safety%20Guidelines/04-87-13.asp. PFSG 04-87-13.

Pessemier, W. L. (2012). *Developing a model for the analysis of organizational culture: An application to safety culture in three municipal fire departments*. University of Colorado at Denver.

Perry, Ronald W. (2003) "Incident management systems in disaster management", Disaster Prevention and Management: An International Journal, Vol. 12 Issue: 5, pp.405-412, https://doi.org/10.1108/09653560310507226

Popper, K. S. (1992). The logic of scientific discovery. New York: Routledge.

Popper, K. (2005). *The logic of scientific discovery*. Routledge.

Preuss, G. and Schaecke, G. (1998), Firefighters Exposed to Psycho Mental Stress and Hazardous Work Situations, Poster Session I: Stress in Different Occupations, Work, Health and Stress 1999 Conference, Institut fuÈr Arbeitsmedizin der Freien UniversitaÈt Berlin.

Quarantelli, E.L. (1987). What should we study? *International Journal of Mass Emergencies and Disasters, 5*, 7-32.

Quarantelli, E.L. (2002) ‘The questionable nature of the incident command system’, in Oleary (Ed.): Here is a Statement about the Incident Command System, University of Delaware, Disaster Research Center, Newark, DE.

Rasmussen, J. (1997) Risk management in a dynamic society: a modeling problem, pp. 183-213

Reason, J. (1997) Managing the Risks of Organizational Accidents Ashgate Publishing Company, Burlington, VT 1997

Reilly, J.M. & Mirchandani, P.B. Fire Technology (1985) 21: 181. https://doi-org.argo.library.okstate.edu/10.1007/BF01039973

Simpson, N. C., & Hancock, P. G. (2009). Fifty years of operational research and emergency response. *The Journal of the Operational Research Society, 60*, S126-S139. http://dx.doi.org/10.1057/jors.2009.3

Smith, Todd, Hughes, Kevin, DeJoy, David, Dyal, Mari-Amanda. (2018). Assessment of relationships between work stress, work-family conflict, burnout and firefighter safety behavior outcomes, Safety Science, Volume 103, 2018, Pages 287-292

Swersey, Arthur (1994). Chapter 6 The deployment of police, fire, and emergency medical units, In Handbooks in Operations Research and Management Science, Elsevier, Volume 6, 1994, Pages 151-20, https://doi.org/10.1016/S0927-0507(05)80087-8.

Stevens, S. S. (1946). On the theory of scales of measurement.

Stevens, S. S. (1951). Mathematics, measurement, and psychophysics.

Swersey, A. J. (1982). A Markovian decision model for deciding how many fire companies to dispatch. *Management Science*, *28*(4), 352-365.

Von Hallmayer, A., Klingbeil, M., Kohn-Seyer, G.(1981), `Physische und Psychische Belastu ngs-komponenten in der TaÈtigkeit des Feuerwehr-mannes', Zeitschrift fuÈr die Gesamte Hygiene und IhreGrenzgebiet e, Volume 27, Number 3, pp. 191±194.

Walker, W. (1975). The Deployment of Emergency Services: A Guide to Selected Methods and Models. Rand Corporation. Retrieved from https://www.ncjrs.gov/pdffiles1/Digitization/34185NCJRS.pdf on 12/01/2017.

Walker, W. E., Chaiken, J. M., & Ignall, E. J. (1979). *Fire department deployment analysis*. Rand Corporation.

Wassell, J. T., Peterson, K., & Amandus, H. (2010, 03). Applying findings from NIOSH investigations: Incident command, safety officers and rapid intervention. *Firehouse, 35*, 119-121. Retrieved from http://argo.library.okstate.edu/login?url=https://search-proquest-com.argo.library.okstate.edu/docview/229532934?accountid=4117

Weick, K. (1987). Organizational culture as a source of high reliability. California Management Review, 29, 112-127.

Weick, K., &Roberts, K. (1993). Collective mind in organizations: Heed full interrelating on flight decks. Administrative Science Quarterly, 38, 357-381.

Weick, K. (1995). South Canyon revisited: Lessons from high reliability organizations. Wildfire, pp. 54-68.

Wenger, D., Quarantelli, E.L. and Dynes, R. (1990) 'Is the incident command system a plan for all seasons and emergency situations?', Hazard Monthly, Vol. 10, March, pp.8–12

Wilson, Michael P. Madison, Heather N. & Healy, Stephen B. (2011). Confined Space Emergency Response: Assessing Employer and Fire Department Practices, Journal of Occupational and Environmental Hygiene, 9:2, 120-128, DOI: 10.1080/15459624.2011.646644

Wu, H. C., Greer, A., Murphy, H. C., & Chang, R. (2017). Preparing for the new normal: Students and earthquake hazard adjustments in Oklahoma. *International Journal of Disaster Risk Reduction*, *25*, 312-323.

Voelkl, K. E., & Gerber, S. (1999). Using SPSS for Windows: Data Analysis and Graphics.

Whitehouse.Gov. (2017). State and Local Government. retrieved from https://www.whitehouse.gov/1600/state-and-local-government on August, 20, 2017.

US Census Bureau (2017). 2015 Statistics of the US. Retrieved from https://www.census.gov/quickfacts/fact/table/US/PST045216 on 08/29/2017

United States Fire Administration (2001). Firefighter Fatalities in the United States during 2001. retrieved from https://www.usfa.fema.gov/ downloads/pdf/publications/fa-237.pdf on 04/26/2018

United States Fire Administration (2018a). Review and Assessment of Data Quality in the National Fire Incident Reporting System. Retrieved from https://www.usfa.fema.gov/downloads/pdf/ publications/nfirs_data_quality_report.pdf on 04/17/2018

United States Fire Administration (2018b). About NFIRS. Retrieved from https://www.usfa.fema.gov/data/nfirs/about/index.html on 04/18/2018

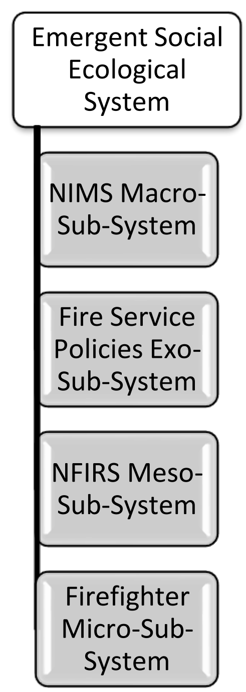
Zeig-Owens, R., Webber, M. P., Hall, C. B., Schwartz, T., Jaber, N., Weakley, J., ... & Kelly, K. (2011). Early assessment of cancer outcomes in New York City firefighters after the 9/11 attacks: an observational cohort study. *The lancet*, *378*(9794), 898-905.

APPENDICES

MODELS

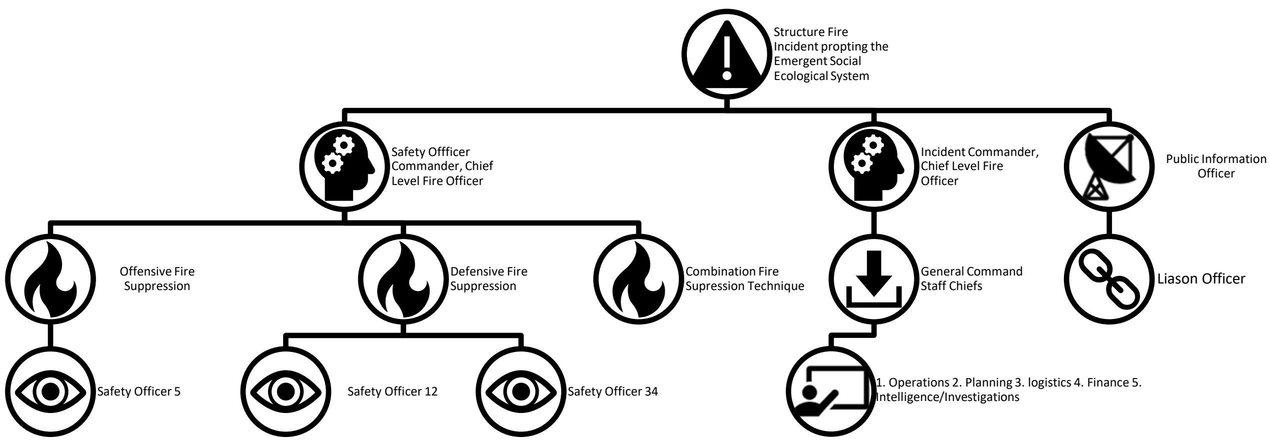
Model 1:

Emergent Social Ecological System Theory Model



Model 2:

Operational Fire Incident: Safety Matrix Model



VITA

David J. Yonko

Candidate for the Degree of

Master of Science

Thesis: Phenomena within the National Fire Incident Reporting System: Practices of Resource Deployment and Safety Concerns from 1998-2014 in the American Fire and Emergency Services

Field of Study: Fire and Disaster Sciences

Biographical: Born and raised in Phoenix, Arizona in 1982, Naval combat veteran 2001-2005, Firefighter/EMT 2001-present, fire and disaster scientist 2003-present.

Education:

Completed the requirements for the Master of Science in Fire and Emergency Management at Oklahoma State University, Stillwater, Oklahoma in May, 2018.

Completed the requirements for the Bachelor of Applied Science in Emergency Management at Arizona State University, Tempe, Arizona in 2015.

Experience: Served in the US Navy from 2001 until 2005, worked as a firefighter in Virginia from 2001 until 2005. In total, worked in the fire and emergency services in 2000 and presently.

Professional Memberships: International Association of Fire Chiefs and Pi Sigma Alpha.