Building Occupant Evacuation Response to Multiple Perceived False Fire Alarms

by

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Abstract

There is a lack of information on the relationship between nuisance alarms and occupant attitudes toward evacuation of a building due to a fire alarm. This research study compared attitudes based on gender, faculty/staff, students and age to determine if there was a difference as to when occupants evacuate a building. The study also compared whether the number of times an occupant was exposed to nuisance alarms influenced their attitude in evacuating a building during a fire alarm. The Fire Alarm Perceptions Survey was developed by the researcher to determine demographics, the participant's participation in fire drills and their evacuation experiences. Also, questions measured the participants' attitudes toward the fire alarm and evacuation, and participants' perception of fire alarms and evacuation experiences based on whether they have personally experienced a fire or fire loss or have known someone who experienced a fire or fire loss. There were 295 participants. The major implication of the study showed statistical significance ($p < .05$) between building occupant attitudes and nuisance fire alarms for participants who had not had a fire loss but knew someone who did. It was also statistically significant ($p < .05$) for those who had no fire loss and did not know anyone with a fire loss.

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Dedication

I dedicate this to my son, J.D. MacKenzie. I love you more than you will ever know. If I can complete a dissertation, know that you can do anything you set your mind to. Dream big!

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Chapter 1

Introduction

Building safety is a focus of many companies and businesses. One component of building safety is the fire alarm. Fire alarms have been a part of American life since the 1600's (Smith, 1978). Over time the proliferation of fire alarms has become increasingly more sophisticated; however, not all businesses can afford to improve their fire alarm systems when newer devices are introduced into the market. The older fire alarm systems may have a different evacuation sound than the newer alarms. The older fire alarm systems may have more service issues and nuisance alarms which can cause apathy in building occupants where they do not evacuate during a fire alarm. There is a lack of information on the relationship between nuisance alarms and occupant attitudes toward the evacuation of a building due to a fire alarm. Conceptually, it would be reasonable to assume that when people hear a fire alarm they will evacuate a building. However, when there are repeated false alarms or nuisance alarms, it would be equally reasonable to assume that people will respond it as just another false alarm and elect not to evacuate. Research studies by Nilsson and Johansson (2009), McConnell, Boyce, Shields, Galea, Day, and Hulse (2010), and Zhao, Lo, Liu, and Zhang (2009) have focused on the time it takes to evacuate, response to the evacuation signal, and response to other people evacuating or not evacuating. There can be a serious consequence for failing to evacuate or delaying evacuation. This study used an anonymous on-line survey that requested

information on demographics such as gender, race, and age; student, non-student status; fraternity housing resident, dorm housing resident, or off-campus housing resident; international member of society or national member of society; number of fire alarms occurring in buildings they have been in the last year; whether or not they evacuated; whether they were told what the reason for the evacuation was (after the fact); and whether the individual had ever sustained a fire loss or knew someone else who had sustained a fire loss. The survey also requested information on the type of fire alarm (horn/strobe and/or horn/strobe with voice) in the building where the evacuation occurred.

Statement of the Problem

At this time, there is a lack of literature relating to nuisance alarms and occupant attitudes toward evacuating a building during a fire alarm. Lack of literature may easily lead to improper procedures, policies, beliefs and attitudes related to the fire alarm.

With a tendency to ignore the fire alarm, there might be reasons for ignoring the alarm. Some reasons mentioned in the New York Times article, Schools: Playing with fire is that it goes off all the time, someone just pulled the alarm, and it's just a false alarm (Ginsberg, 2000). Fire codes in America require schools to have fire drills from kindergarten through high school including evacuation of the buildings (NFPA 101, 2014 ed.).

Purpose of the Study

The purpose of this study was to identify building occupant's attitudes about fire alarm initiated evacuations. It examined attitudes based on gender, faculty, staff,

students, age, instances of personal fire loss, and instances of fire loss among people participants know to determine if there was a difference when occupants chose to evacuate a building when a fire alarm was activated.

Research Questions

The following research questions were used in this study:

1. What is the relationship, if any, between building occupant attitudes and nuisance fire alarms?
2. What is the relationship, if any, between building occupant attitudes and evacuation of a building during a fire alarm?
3. What is the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations?
4. What is the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations?

Significance of the Study

This study helps to link the gap in research discussing evacuation times, delays in evacuating, and the impact of nuisance alarms on whether the occupants evacuate. It helps to provide additional literature on the topic of reaction to nuisance alarms which will assist building managers, architects, engineers, code officials, fire prevention educators and colleges and universities.

Limitations

The study population was limited to a Southeastern, four-year public university and provided information based on that university community. The study may not be applicable to general business locations and communities.

Assumptions

The following assumptions were made:

1. The participants responded accurately and honestly to the survey.
2. There would be differences based on whether a person identified their status as faculty/staff or student status.
3. There would be differences based on previous fire loss experience.
4. There would be differences among those who had directly experienced fire loss and those who had not.

Definitions

The following definitions of terms are furnished to provide meanings of terms as used in this study.

Alarm: a warning of danger (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.11, 2013 ed.)

Code: a standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards (National Fire Protection Association, NFPA 101, Chapter 3, Section 3.2.3, 2015 ed.)

Detector: a device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as gas, heat, or smoke (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.66, 2013 ed.)

Evacuation: The withdrawal of occupants from a building (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.94, 2013 ed.)

False alarm: any alarm that occurs that is not the result of a potentially hazardous condition (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.307, 2013 ed.)

Fire alarm system: a system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.105, 2013 ed.)

High-rise building: A building where the floor of an occupiable story is greater than 75 ft. (23m) above the lowest level of fire department vehicle access (National Fire Protection Association, NFPA 101, Chapter 3, Section 3.3.36.7, 2015 ed.)

In-building fire emergency voice alarm communications system: dedicated manual or automatic equipment for originating and distributing voice instructions, as well as alert and evacuation signals pertaining to a fire emergency, to the occupants of a building (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.87.1.2, 2013 ed.)

Initiating device: a system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.132, 2013 ed.)

Malicious alarm: an unwanted activation of an alarm initiating device caused by a person acting with malice (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.307.1, 2013 ed.)

Manual fire alarm box: a manually operated device used to initiate a fire alarm signal (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.12.3, 2013 ed.)

NFPA: National Fire Protection Association

Nuisance alarm: an unwanted activation of a signaling system or an alarm initiating device in response to a stimulus or condition that is not the result of a potentially hazardous condition (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.307.2, 2013 ed.)

Recognition phase: the period between the reception of a fire cue and the occupant's fire response (Nilsson & Johansson, 2009)

Response phase: the period between the occupant's first response and the time when he or she starts to physically move towards an exit (Nilsson and Johansson, 2009)

Sprinkler system: a system that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain and is commonly

activated by heat from a fire, discharging water over the fire area (National Fire Protection Association, NFPA 25, Chapter 3, Section 3.6.4, 2014 ed.)

Unwanted alarm: any alarm that occurs that is not the result of a potentially hazardous condition (National Fire Protection Association, NFPA 72, Chapter 3, Section 3.3.307, 2013 ed.)

Warnings: safety communications used to inform people about hazards so that undesirable consequences are avoided or minimized (Wogalter, 2006)

Organization of the Study

Chapter 1 introduces the study, provides a statement of the problem, purpose of the study, the research questions, the significance of the study, limitations of the study, assumptions of the study, definitions of terms used in this report, and the organization of the study. Chapter 2 contains a review of the literature pertaining to the history of firefighting in America, history of fatal fires, history of fire alarms and sprinkler systems, false alarms or nuisance alarms, delayed evacuation, and history of fraternity, dormitory, off-campus fires. Chapter 3 addresses the methods that will be used to conduct the study including the sampling methods and the research questions. Chapter 4 presents the results of the study and an interpretation of the data analysis of the study. Chapter 5 provides a summary, conclusions, and implications and recommendations for future studies pertaining to the research topic.

Chapter 2

Literature Review

Introduction

This chapter will cover a literature review on the history of fire-fighting in America, history of fatal fires, history of fire alarm and fire sprinkler systems, false alarms or nuisance alarms, delayed evacuation and a history of fatal fires in dormitories and fraternities.

Purpose of the Study

The purpose of this study was to identify building occupant's attitudes about fire alarm initiated evacuations. It examined attitudes based on gender, faculty, staff, students, age, instances of fire loss, and instances of fire loss among others to determine if there was a difference when occupants chose to evacuate a building when a fire alarm was activated.

Research Questions

The following research questions were used in this study:

1. What is the relationship, if any, between building occupant attitudes and nuisance fire alarms?
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History of Fire-Fighting in America

According to Smith (1978), the documented history of fire in America can be traced to the year of 1607 at a location along the James River. Within a few days the first recorded fire in America occurred when the community blockhouse caught fire. Almost all the buildings in Jamestown were destroyed in that first year. In Massachusetts, Plymouth Plantation was established in 1620. In 1623, the colony was nearly devastated by fire from the chimney that caught the thatch roofs on fire. Boston, established in 1630, built the same types of houses and experienced the same types of fires as the Plymouth colony. Smith (1978) stated:

> The Puritans responded to their misfortune, as people would do over and over again throughout the development of American firefighting, by creating laws only after a serious destruction of either life or property had occurred, instead of planning safeguards ahead of time. (p. 3)

Plymouth enacted the first building regulation in 1627: "no dwelling house was to be covered by any kind of thatch made of straw or reed" (Cannon, 1977, p. 6). In 1647, firefighting was informal and voluntary.

> When fire was sighted, the cry of "Throw out your buckets" was used to alert the citizenry. Householders would throw out leather fire buckets, and neighbors and passersby would grab them, dip them in the nearest water available, get as close to the fire as they dared, and throw the water on the fire. Often the firefighters produced more pandemonium than efficiency, and buildings burned to the ground. (Smith, 1978, p. 4)

Peter Stuyvesant, the governor of New Amsterdam, brought order to the firefighting. In 1647, the town passed an ordinance similar to what Boston had passed in 1631. The ordinance prohibited wooden chimneys and thatched roofs. Chimneys had to be swept and kept clear of wood tar. In 1648, four fire wardens were appointed. They were empowered to inspect all the chimneys of the community, and fine any offenders, making this America's first fire prevention act (Smith, 1978).

> Eight volunteers were appointed to form a "rattle watch". Prominent citizens of the colony volunteered for fire duty to set a good example for their less spirited brethren. Nicknamed "The Prowlers", these men patrolled the streets from nine in the evening till dawn. At the first sign of fire they sounded the alarm on the fire rattles they carried, and after gathering the waiting buckets and hooks and ladders they raced to the fire scene. There they directed neighbors and passersby into bucket brigades, with one line passing the filled buckets from the water source to the fire and the other passing the emptied buckets back to be refilled. (Smith, 1978, p. 5)

In 1696, Philadelphia focuses on providing equipment to fight fires. They pass a bill requiring the inhabitants to purchase ladders and leather buckets. "This bill

prohibited people from cleaning their chimneys by burning them out" (Gray, 1943, p. 13). In 1711, the mayor, Samuel Preston, recommended that "steps be taken forthwith to purchase efficient equipment as preparedness against the lusty blaze" (Gray, 1943, p. 16). There had been no serious fire prior to this recommendation, however, Philadelphia had grown tremendously and the current way of fighting the smaller fires was primitive at best. The year 1716, saw the purchase of the first fire engine and in 1730 it was in use during the first serious fire in Philadelphia. While no buildings were saved, it made the citizenry take notice that fire equipment was needed to fight fires. April of 1730, showed the city ordering "three more fire engines, four hundred leather buckets, twenty ladders and 25 hooks" (Gray, 1943, p. 25). In 1736, Philadelphia's first fire company was founded by none other than Benjamin Franklin (Gray, 1943).

In 1871, Chicago was a city of approximately 300,000 people. It had been built quickly and cheaply. Wood was plentiful and everywhere. Not only were the buildings built of wood, so were the sidewalks and streets. Owens stated that the fire department responded to twenty fires in the first week of October. "On October 7, just one day before the Great Fire, a fire destroyed four blocks on the West Side" (Owens, 2008, p. 28). There was a lack of rain during this time and a tragedy of errors seems to have had an impact on the fire on the eighth of October. A guard realized that he had reported an incorrect location to the fire. He contacted the telegraph operator to send out an updated report and the operator refused. The operator thought an updated report would confuse the responders and this was a major reason as to why the blaze was not contained. "The Great Chicago Fire killed 300 people, destroyed nearly $200 million in property, and left more than one hundred thousand people homeless" (Owens, 2008, p. 37). The fire has

been attributed to Mrs. O'Leary's cow kicking over a lantern in the barn but that was never proven. After this fire, Chicago adopted "new fire safety and building codes" (Owens, 2008, p. 101).

History of Fatal Fires

Numerous fatal fires have influenced fire codes and building construction. In the Richmond Theater in 1811, there was a command to raise the chandelier, however, the stagehand did not notice that a candle remained lit. Many of the backgrounds were made of hemp canvas and several painted with oils. The theater's property man, Rice, noticed that one candle was still burning and ordered it to be put out immediately. In the rush to lower the chandelier, the flame touched a backdrop and it immediately flamed to life. The fire spread in a matter of seconds up the hemp canvas igniting the pine ceiling. A crew member yelled a muffled fire. An actor relayed to the crowd that there was a fire and to remain in their seats. The actor quickly realized that the whole backstage area was in flames and then the panic began in the crowd. This is another example of where the main downstairs doors opened inward. On December 26, 1811, the Richmond Theater saw the deaths of seventy-two persons (Baker, 2012).

On December 5, 1876, there was a fire at the Brooklyn Theatre in New York. The play was in its' last act when the actors heard whispers of fire. They continued with their lines while people backstage tried to put the fire out. The audience realized something was wrong and one of the actors came to the stage and announced the end of the play and asked the audience to leave quietly. When the people up in the gallery realized that the fire was growing and they had a long way to go before they reached an exit, panic rose and order was lost.

> Nearly three hundred people, mostly from the upper gallery, had been killed, the victims of their own panic and an inadequate exit system. After this fire, more stringent fire laws concerning size and number of exits were put into place for theaters in New York. (Smith, 1978, p. 90)

Chicago, 1903, the grand opening of the Iroquois Theatre occurred on November 30 and it was "hailed as the grandest and safest in America" (Fliege, 2002, p. 156). The Iroquois Theatre fire started when a light above the stage blew a fuse and the sparks ignited nearby theatre gauze. The theater had over seventeen hundred people seated and another two hundred standing in the aisles. Many women and children there to enjoy the December 30th showing. When the gauze caught fire, the stagehands worked to extinguish it but made little progress. Finally the asbestos stage curtain was lowered to create a fire barrier between the stage fire and the audience, unfortunately the curtain was caught on some wire and left a gap open between it and the stage of about twelve feet. The audience panicked and ran for the exits. Another unfortunate circumstance had the exits unmarked or covered with draperies, locked or the exits opened inward instead of outward. This resulted in the deaths of six hundred and two people. Again, new fire codes were enacted, this time exit doors were to swing out, be clearly marked and no obstructions to get to them (Smith, 1978). Additional items noted in the Iroquois fire,

> Theatre personnel were to be drilled in directing people out in quick and orderly fashion. Automatic sprinkler systems were mandatory. It had taken Chicago twenty-seven years and twice the casualties to learn the Brooklyn Theatre lesson. (Smith, 1978, p. 109)

Robinson reported “of the thirty exits, twenty-seven had been locked and few of them were marked. There were no fire escapes, alarms, sprinklers, telephones, or water connections” (Robinson, 2015, p. 88). Fliege (2002) noted the following:

> Later it was established that there had been many violations of city safety codes. One of the most blatant concerned a large water pipe for a hose on the stage: not only was there no fire hose, but water had not yet been connected to the pipe. Within days arrests were made for negligence and related crimes in a rush to hold someone responsible for this horrible disaster. Although several people were indicted for manslaughter, no one was ever convicted. (p. 159)

The Iroquois Theatre fire claimed 591 victims. The Coroner’s Jury found that “city laws were not complied with relating to building ordinances regulating fire-alarm boxes, fire apparatus, damper or flues on and over the stage and fly galleries” (Everett, 1904, p. A). No signs were in place showing where the exits were from the balconies. Fireproofing requirements were violated for scenery and wood work on stage. Employees had not been trained on what to do in emergencies (Everett, 1904).

Congregants of St. John’s Lutheran Church were performing The Scottish Reformation at the Rhoads Opera House on January 13, 1908. There were about fifty actors and an audience of about four hundred. A kerosene lamp was knocked off the stage and started a small fire. When the fire was almost out, some men moved the tank of kerosene intending to move it away from the fire but spilled some kerosene in the process which ignited the fire further. The audience panicked and started for the doors. The doors opened inward instead of outward. People jammed up at the main exits and

couldn't get out. Fire escapes were unmarked. There were 170 people killed in the fire (Pearson, 2010).

The Collinwood school fire occurred on March 4, 1908, Ash Wednesday, in North Collinwood, Ohio. On that day, one hundred and seventy-two students, two teachers and a rescuer died from the fire that started in the basement. The custodian of the school rang three taps on a gong for fire and started the evacuation. The stairways were blocked by flames and smoke (Dissell, 2008). The fire was believed to have been set. Almost all the children on the second floor died. The second stairway had a door that opened inward and children stacked up against it.

The Triangle Shirtwaist fire occurred in 1911. There was a no smoking rule that was secretly ignored. Cluttered work areas of cut rags and exits that were not adequate for the size of the building. Fire officials had requested that city officials step in and have the fire safety violations fixed at the various loft like locations. Owners were warned to hold periodic fire drills. The fire occurred on March 25, 1911 (Butler, 1975). The fire started on the eighth floor in a scrap bin. The bins on that floor had scraps of sheer fabric and tissue paper that helped the fire to grow very quickly. People tried to put the fire out with pails of water but it grew too quickly. One exit, the Greene Street exit, only allowed one person at a time to pass through. It had been designed that way by management as a security measure to keep the girls from stealing since the workers had to open their purses to show they hadn't taken anything from the work floor. There were about 180 people on the floor and many of them tried to exit through the other exit named, the Washington Place stairs. One lady tried to alert the executives on the tenth floor to the fire. The telephone system was designed for all the calls to be directed through the tenth

floor switchboard. When the operator finally picked up after a several minute delay, when she caught the word fire, she set the phone down and thereby negated any further use of the telephone. The stairwells had a fire hose and standpipe on each floor but when the employees tried to use it there was no water pressure. The fire was spreading so quickly in the space of the eighth floor and the manager tried to direct the girls to go down the stairwell. The doors to the stairwells were designed to swing in and some could actually be locked. Another supervisor was able to move the girls away from one of the doors and open it allowing the girls to flood into the stairwell. The fire chief had made comments about four months earlier as to the heights of some of the buildings, too many people working in them and not enough provision for safety. He immediately threw the blame of the fire at the Building Department. Management denied that the exit doors were ever locked. Blame was thrown everywhere. One newspaper, the World, however, called for "new laws to mandate better fire escapes, enclosed fireproof stairs, automatic sprinklers, and fire drills" (Von Drehle, 2003, p. 185).

Faith (1999) noted, "exit doors from all floors had been built to open inwards so the pressure of people trying to get out prevented them being opened" (p. 47). Faith also noted that the NFPA created a committee on building exit safety which is now referred to as the Life Safety Code. Faith (1999) stated,

> Codes like this tend to turn into compilations, with new requirements piled upon old ones, making them increasingly inflexible and creating resentment and willingness to cheat among builders, architects and their clients. (p. 47)

The fire resulted in 146 deaths that day.

In 1920, the Cleveland Clinic building was four stories and a basement, constructed of a "reinforced concrete frame with brick walls and eight inch tile roof between reinforced concrete joists" (Greene & Newell, 1929, p. 3). There were two elevators and two stairwells. The 1929 fire originated in the basement X-ray film room. The day of the fire there was a steam leak in the film room of the basement. There are three theories as to how the fire may have started: the decomposition of the nitrocellulose film was caused by the rise in temperature due to the leak, films may have been ignited from an incandescent lamp's heat, and the third theory is that a lighted match or cigarette stub was dropped on or near the films. A steam fitter tried to put the fire out but was unsuccessful. The burning film let off poisonous gases that spread through the pipe ducts in the building. There were 121 people who lost their lives and about fifty who were treated for the gas effects. The fire door did not close completely to the film storage room as the counterweight lever struck against the steam pipe. The fire door did not close between the stair and elevator hall since it was blocked open with a barrel. There were three fire doors that did not close completely and that allowed the flames and gases to spread throughout the hospital. The building did not have a sprinkler system (Greene & Newell, 1929).

Cocoanut Grove in Boston received a fire inspection eight days before the fire occurred on November 28, 1942. The fire inspector noted that there were artificial palm trees that decorated the club but he was unable to light one on fire with a match so he wrote on his report that the condition was good. In the Melody Lounge, a patron unscrewed a light bulb and the bartender told a bar boy to screw it back in. When the bar boy attempted to screw the bulb in, he used a match to see and ignited one of the artificial

palm trees near the ceiling. The flame traveled to some curtains and in a matter of seconds a large fire was burning. People attempted to escape from the burning room through the single exit from the room. 491 people died that night, most of them due to toxic smoke (Butler, 1975).

In 1944, the military were the only ones who had access to the "only proven flame-retardant waterproofing solvent for use on canvas tents" (Cohn & Bollier, 1991, p. 7). On July 6, the circus was in full swing in the city of Hartford when a band leader spotted a small flame in the canvas. He immediately had the band play a song that indicated there was an emergency and other circus employees quickly responded. The tent quickly burned and people were trapped inside. The tent material was flammable, exits were blocked and there had been inadequate training for employees. One hundred sixty-nine people died (Cohn & Bollier, 1991). Butler (1975) states "the fire was a short one. From the time the feeble flame appeared at the main entrance until the entire tent was down in smoldering ruins, it lasted not more than ten minutes" (p. 172).

Chicago was home to the twenty-two story LaSalle Hotel which was built in 1909. The building had no fire alarm or sprinklers and no fire stops in the ventilation shafts. The fire that started June 6, 1946 injured two hundred people and caused sixty-one deaths (Robinson, 2013).

Effingham, Illinois: St. Anthony's Hospital was built in 1873 of mainly wood and brick. The three story facility had been expanded several times and was now approximately 21,000 square feet and designed for 100 beds. On April 4, 1949, a fire broke out in the basement laundry chute. The hospital engineer, Ries, tried to extinguish the fire. He ran to each floor telling the nurses to close the patient's doors. One hundred

twenty-eight people were in the hospital at the time, patients, visitors and staff, and seventy-four of them died. There was no sprinkler system or fire alarm (Robinson, 2015). In 1954, a new six story hospital was dedicated. This one was built with concrete block, enclosed stairwells, fire alarm and sprinkler system (Pierce, 2015).

Less than a year later, on January 7, 1950, a fire broke out in the St. Elizabeth's Women's Psychopathic Building of Mercy Hospital in Davenport, Iowa. The only reported differences in this fire compared to the one at St. Anthony's, were the "locked doors, barred windows, furred interior finish on exterior walls and partition construction" (McElroy, 1950, p. 145). The cause of the fire was determined to be a patient who lit her curtains on fire. There was not a plan for evacuation, no fire alarm and no sprinkler system. Fire department officials had repeatedly recommended a sprinkler system to this facility. There was a delay in notifying the fire department and due to the barred windows rescue was difficult. Forty-one women died that night, forty of whom were patients (McElroy, 1950).

Our Lady of Angels School sustained a fire at about 2:30 p.m. in December of 1958. The teachers on the first floor could smell it and evacuated their children. The school's janitor discovered the origin of the fire at about 2:42 p.m. and called for the fire alarm to be sounded and either the fire alarm didn't work or he was not heard (History.com Staff, (2009).

The fire occurred approximately twenty minutes before the final bell would have rung and the children were to be released for the day. Approximately, sixteen hundred students attended the school from age five to fourteen years (Butler, 1975). The fire traveled so quickly that many of the students forgot what they had rehearsed in the fire

drills. If the building had complied with the codes for schools erected after 1949 and had the fire-resistant doors and materials at each floor, more lives could have been saved (Butler, 1975). There were 93 fatalities from the fire.

One of the largest fires was The MGM Grand Hotel in Las Vegas, Nevada. The hotel started construction in 1972. In 1973, the building codes changed and required fire sprinklers. November 21, 1973, the MGM Grand Hotel caught fire. The hotel had almost two thousand miles of wiring and the "primary cause of the MGM Grand fire was a short circuit in a brief stretch of wire in the wall of a serving station in the Deli restaurant" (Coakley, Greenspun, Gerard, and the staff of the Las Vegas Sun, 1982, p. 166). There were various forms of charred bodies as a result of the fire. There was one searcher who remembered "carrying six bodies, as rigid as department-store mannequins, to the coroner's van" (Coakley et al., 1982, p. 131).

> A metro policeman had gone into a stairwell at the hotel. People were sitting there on the floor with their eyes wide open. He went over to help them up, and when he touched them, they toppled over. They were all dead. (p. 115)

The materials that burned in the fire breed toxic fumes and smoke.

> Stairwells, meant to save lives, were death traps instead. Often the proximity to the elevator banks was enough to bring swift unconsciousness and death. It was an irony that day that the higher the floor and the more convenient a room's location to the elevators, the greater the chance of death. (p.126)

The Amadors were staying in a room on the sixth floor. When they realized there was an emergency, they crawled through the corridor looking for an exit. Three of the exit doors were locked and the fourth led to a stairwell that dumped out into an enclosed

patio that they had to then jump over the wall. The Amadors survived the fire. Nevada's Governor walked through fire devastated building with two of the top hotel officials. He promised a panel to "examine our ordinances and codes in Nevada and compare them to national standards. I want to satisfy myself that we are doing everything we can to minimize the chances of a recurrence of the MGM tragedy" (Coakley et al., 1982, p. 136).

> Bishop McFarland delivered a short, moving homily to a standing-room-only congregation at the mass. The bishop and twenty priests celebrated the Eucharist in remembrance of those who had died in the second worst hotel fire in this country's history. The worst U.S. hotel fire occurred in December 7, 1946, when the Winecoff Hotel in Atlanta burned and 119 people died. (Coakley et al., 1982, p.156)

Questions asked by the media concerning the MGM fire included:

> Q: Why were there no alarms sounded?
>
> A: The hotel has a manual alarm system, apparently hooked up in the basement. We haven't checked yet to see why it didn't go off.
>
> Q: Did the hotel have smoke alarms?
>
> A: There are none in the structure
>
> Q: How many people were in the building at the time?
>
> A: We figure there were about forty-five hundred to five thousand people in the highrise portion of the hotel. With the employees and the people in the casino added on, I'd say about eight thousand all together. (Coakley et al., 1982, p. 129)

Hotel chairman Benninger told reporters that he thought not having a comprehensive alarm system was a good thing. He felt that if there had been warning devices that the guests would panic and more people would have died in smoke filled hallways. "Benninger adamantly denied rumors that MGM Grand executives had been advised by the Clark County Fire Department to upgrade sprinkler and alarm systems beyond minimum code standards" (Coakley et al., 1982, p. 153).

> Fire Chief Parrish was silent when reporters asked him if he had ever met with MGM executives to suggest such improvements. Parrish had hinted to some reporters that even if he had made recommendations, he would have been in no legal position to demand that the MGM Grand carry them out. As long as the hotel is up to code, my hands are tied. I can make all the recommendations I want, but they don't have to do a thing. (Coakley et al., 1982, p. 153)

Naum, 2010 noted that "85 people died and more than 700 were injured" in the MGM fire.

The MGM fire was the second largest loss of life hotel fire. Cause of fire was determined to be an electrical ground fault but several other building and design flaws contributed to the fast movement of the fire and smoke throughout the hotel (Naum, 2010). The NFPA reported that the hotel was partially sprinklered. There were six stairs and they were not enclosed properly with a two-hour fire rated construction. (Best & Demers, 1982).

The Beverly Hills Supper Club was built in 1937 and remodeled in 1969. A fire occurred in 1970 and a large area was destroyed and rebuilt. The club reopened in 1971. In 1974, the building was expanded. The completed building was not of a regular shape

and some of the work had been completed without proper building permits. On May 28, 1977, the club had approximately 2,400 to 2,800 patrons. A small fire had started in what was called the Zebra Room. There was no fire alarm or sprinkler system in the club and while some patrons evacuated, the patrons in the Cabaret Room were not immediately notified of the fire. The Cabaret Room was occupied by three times its regular occupancy load of 400. There was no evacuation plan established for the club and employees had not been trained on what to do in a fire emergency. One hundred sixty-four fatalities occurred that evening with most of them being in the Cabaret Room. The fire traveled so fast that most of the people in the room were overcome with toxic smoke and gases before they could move to the exits (Best, n.d.).

The seventeen-story Doubletree Hotel located in New Orleans was built in 1973 and was constructed of reinforced concrete. On July 19, 1987, a fire started on the unoccupied tenth floor. The cause of the fire was determined to be arson. There was one death and ten injuries. The automatic fire alarm system failed to work, there were no sprinklers in the guest rooms, storage was in the exit corridors and not all employees were effectively trained. One hundred and fifty people were able to be evacuated successfully due the working manual fire alarm system (Shapiro, 1987). Shapiro notes that the sprinkler system mainly protected non-guest areas such as storage closets, kitchen areas, and assembly areas to name a few. Guest rooms and corridors were excluded from the sprinklers. Shapiro notes the numerous pranks in the building on July 18-19th. The author also states:

> Some of the occupants said they failed to evacuate when the fire alarm went off because of the previous series of false alarms. These occupants complained that

they were not aware that there was an actual fire until they smelled smoke or were later told to evacuate. (Shapiro, 1987, p. 11)

The Indianapolis Athletic Club sustained an electrical malfunction in the third floor bar in or near a refrigerator at approximately 12 midnight on February 5, 1992. The Athletic Club was nine stories high and about seventy years old. There was no automatic sprinkler system and only a partial fire alarm system. The building that was completed in 1922, had the standard features of the day which included "open stairways, non-continuous egress paths, large air handling shafts without fire or smoke dampers, an unsupervised manual fire alarm system, occupant use standpipes without fire department hose outlets, and no automatic sprinklers" (Chubb, n.d., p. 3). Within twenty minutes, the fire had turned fatal with a flash fire that killed two firefighters. Four firefighters were injured. A guest was killed on the stairs when fire and smoke spread there. There was a delay of fifteen minutes before the fire department was notified which allowed the fire to grow. When a full investigation was conducted, it was found that the building was only provided with partial smoke detection and that the closest smoke detector to where the fire occurred was not even connected to the building alarm system (Chubb, 1992).

One of the failures of the World Trade Center evacuation in 1975 was discovered to be that "many people were reluctant to leave after having been docked wages after previous incidents" (Averill, Mileti, Peacock, Kuligowski, Groner, Proulx, et al., 2005, p. 5).

Building upgrades made after the 1975 evacuation included stair towers having emergency lighting installed and connected to an emergency generator. Self-illuminated

signage and stripping was also installed to improve the occupants decent on the stairs (Murphy, 2002).

Kakutani (n.d.) wrote of Marissa Panigrosso who worked on the ninety-eighth floor of the south tower of the World Trade Center in 2001. She was speaking with two co-workers when she felt the explosion at the north tower. She went to the nearest emergency exit and left the building. Her co-workers did not leave and did not survive. Grosz stated that many people ignored the fire alarm and what was going on in the north tower. He states that "research has shown that, when a fire alarm rings, people do not act immediately. They talk to each other, and they try to work out what is going on. They stand around" (Kakutani, para. 6).

Many people who were involved in the 1993 evacuation started to evacuate and the Morgan Stanley Dean Witter Company was known to practice "full building evacuation drills above and beyond those required by code" (one every six months) (Murphy, 2002, p. 96). Murphy (2002) stated only six of the company's three thousand seven hundred employees was lost on that day (p. 96).

The Station nightclub in West Warwick, Rhode Island caught fire on February 20, 2003. The cause of the fire was pyrotechnics used during the Great White rock concert. One hundred people were killed and approximately 200 others were injured (Aguirre, Torres, Gill, Hotchkiss, 2011). Aguirre, et al. (2011) conducted a study titled Normative Collective Behavior in The Station Building Fire. They found that 72 percent of the patrons had visited the nightclub previously. They also found that social factors played a part in the evacuation. Ten percent of the patrons were by themselves, with the others being in groups of two or more. No reports of people becoming hysterical or having an

inability to act were reported. Many of the victims who died were competing for egress but "they were helping each other until the very end" (Aguirre, et al., 2011, p. 114). Findings also showed that for the survivors "cooperation and care for others in their groups was a key aspect of their survival" (Aguirre, et al., 2011, p. 114).

History of Fire Alarm and Fire Sprinkler Systems

The first American fire alarm was developed in 1658 in New York where the "firemen walked the streets checking for fire" (Bixler, n.d.). When the alarm was activated it required a response on the part of the people in the vicinity of the alarm.

Firefighting is most successful when it is caught in the earliest stages and the firefighters can get to the location in the quickest amount of time. For many years the firefighters had been dependent on a bell ringing to tell them there were a fire and its location. When Samuel Morse invented the telegraph in the early 1840s, it changed firefighting forever. William F. Channing, a doctor in Boston:

> Designed a system of metal alarm boxes that, when pulled, would immediately transmit their location to a central office. From here the location of the box would be tapped out to firehouses so that the one nearest the fire alarm box pulled could respond to that location. By 1852 Boston had fire alarm boxes all over the city, and on April 29 of that year the first fire box alarm was pulled. (Smith, 1978, p. 63)

Francis Robbins Upton is credited with inventing the first fire alarm (Chavis, n.d.). Upton and Dibble received the patent for their work on September 23, 1890. The smoke detectors were efficient in design and the working but very expensive to buy. Their cost was out of reach for the average person. Today, they are much more

affordable costing about ten dollars per detector and installed in many homes (Gallagher, 2011).

Automatic fire alarm systems are designed to provide occupants early warning of a fire. Early detection of a fire provides the occupant with the opportunity to evacuate the building and call the fire department for suppression services. Lobeto (1996) discusses types of fire alarm systems such as local fire alarm, proprietary fire alarm system and central-station fire alarm systems. Local fire alarms "announces an alarm only to the area it protects" (Lobeto, 1996, p. 2); this requires the occupants to notify the fire department there is a fire. Proprietary fire alarms send a "signal to a monitoring station staffed by on-site personnel familiar with the alarm operations" (Lobeto, 1996, p. 2); the on-site personnel have the opportunity to see if the alarm is valid and if so, call the fire department. The third type of alarm noted, central-station alarm, "is transmitted over telephone lines to the central-station monitoring company, which then calls the local fire department for mitigation" (Lobeto, 1996, p. 2). Donahue (2014) stated:

> Even when fire alarms became the norm in the 1900s, the piercing screech and flashing lights told people there was a fire, but not where the fire was, where the exits were, or if people were heading into the inferno. (p. 32)

Fire alarms have improved over the years and yet many people continue to ignore the alarm. Jelenewicz (2010) makes the following recommendations: make sure detectors are placed properly, occupant notification should be provided through voice communications, verify that occupants can hear and understand voice communication messages. Check to make sure the building emergency plan includes procedures for

responding to the fire alarm system. Regular maintenance and inspection for the fire alarm system.

In 1874, Henry Parmelee created the first sprinkler system by lining his "ceilings with a series of water pipes into which he had inserted valves plugged by pieces of metal that would melt at 155 degrees Fahrenheit" (Smith, 1978, p. 93). Since Parmelee was a maker of pianos and other instruments, "if fire started in the factory, the heat would melt the plug and water would spray all over the area" (Smith, 1978, p. 93).

A man named, John Freeman joined the Factory Mutual Inspection Department in 1886. He spent ten years changing the way the Department looked at and evaluated fire protection. He took a very scientific approach and modern sprinkler technology today is due in a large part to John Freeman's efforts (Grant, n.d.).

The National Fire Protection Association (NFPA) would play a large role in governing America's fire protection codes and standards. The NFPA began as an association in 1896 and held its first meeting in 1897. Three technical committees were established with one of them being automatic sprinklers. Five papers were presented with one of them being on thermo-electric fire alarms. Fire loss in the United States was listed at "four hundred thousand dollars a day" (Bugbee, 1971, p. 3). The NFPA sent a representatives to the fire chiefs' convention in New York, in 1902, to provide some suggestions for the safety in high rise buildings which included sprinklers in the basements and subbasements. The NFPA provided a report in 1904 on the Iroquis Theater fire showing its value to the insurance agencies and the public. After the Triangle Shirtwaist fire in 1911, the State of New York implemented a Committee on Safety. Miss Frances Perkins addressed the NFPA in 1913 at its yearly meeting and

inspired the committee to create the Safety to Life Committee which was the first of what is now known as the Life Safety Code (Bugbee, 1971). Holliday (2004) stated:

> The fire service must take the lead and compel local governments to bring building and life safety codes up to standards that will protect the public and their property through the use of modern automatic fire detection and protection systems. (p. 85)

First Interstate Bank in Los Angeles, California, experienced a fire in May of 1988. The bank was sixty-two floors and in the process of being retrofitted with automatic fire sprinklers. The evening of the fire the automatic sprinkler system had not been connected. Several detectors activated which were silenced and reset by security personnel. It wasn't until twelve minutes after the first smoke detector activation that the fire department was notified. It took almost forty-five minutes for the fire department was able to put water on the fire. Some of the lessons learned from this fire included that automatic sprinkler systems would most likely have controlled the fire and the building personnel failed to take appropriate action (Holliday, 2004).

Cordasco (2000) described in his article that while sprinklers help limit the spread of fire, they are not a single fix. Sprinklers and automatic fire alarm systems need to work in tandem. A fire alarm system is the early warning system of the pair. When the smoke or heat detector is triggered, it sets off an alarm allowing the occupants of the building some time to get out of the building. If we just had a sprinkler system, it could take much longer for it to activate and conditions could already be unbearable by that time. The average sprinkler head will not activate until the temperature reaches one hundred and fifty-five degrees Fahrenheit. The sprinklers can help control a fire until the

firefighters arrive to extinguish the fire. Fire fatalities are usually due to the products of combustion that burn and cause smoke and fumes. Faith (1999) stated,

> The smoke and hot gases generated by fire are deadly enemies. If the fumes meet an obstruction like a ceiling or roof, they spread out laterally until they reach a wall. Smoke, in particular, will discover any hidden cavities or voids and appear in places far removed from the source of the fire. (p. 1)

Grace, Olsson and Woodger (2001) noted:

> The purpose of detection and alarm systems is to decrease the occupant pre-movement times by providing an early warning to occupants given an emergency fire situation, resulting in more rapid egress and thus providing a higher level of life safety. (p. 185)

They state that if you increase the number of cues that you move the occupant to a quicker decision to act. Some cues include alarm sounding, smell of smoke, strange noises, and being notified by others. They researched attempting to lower pre-movement times by utilizing voice alarms over a typical bell alarm. One item noted that needs to be considered with a voice alarm is the speech intelligibility.

At a fire in Gothenburg, Sweden in 1998, the researchers noted that the fire cues of smoke smell and smoke in the dance hall was mistaken by the occupants as smoke from the fog machine. An exit was also blocked and the end result of the fire was 63 people died and 213 were injured (Bengtson, Holmstedt, Kecklund, Lorin & Widlundh, 2001).

False Alarms or Nuisance Alarms

People make decisions whether or not to evacuate when there is an alarm. Averill, Kuligowski, and Peacock (2011) stated:

> Social scientific theory has acknowledged for more than 70 years that human action or response is the result of a process. Instead of actions based on random chance or even actions resulting directly from a change in the environment, an individual's actions are frequently the result of a decision-making process. (para. 3)

People in the vicinity of the alarm have had various reactions to the alarm. A common reaction has been to ignore the alarm. According to Ginsberg (2000), at Rutgers University, fire alarms were a regular occurrence with some residence hall alarms activating several times a week during the 1997-1998 school year with officials counting 107 malicious alarms. Some students began to ignore the alarms and stay in their rooms. Elaine Hannah, a senior who lived on the university's main campus for two years, said: "When you hear the alarm, it's not Oh my God, where's the fire? It's who pulled the alarm this time? You get so used to people crying wolf, when it happens for real, you don't expect it" (Ginsberg, 2000, para. 6). Another incident was reported at a triplex in Wichita, Kansas, where the alarm rang for hours. Wichita Fire Marshal Bricknell said, "Can you believe that? The alarm was activated, and people were disregarding the noise". As a result of waiting to call 911, the man in the middle unit died. ("Ignored Smoke Detectors", 2007)

Outside the United States there have been similar attitudes about false alarms. In the London Community News (n.d.) reported:

> One person is dead and two are in critical condition after a massive fire ripped through the second floor of a London-Middlesex Housing apartment complex. London Fire Department Deputy Chief Jessop confirmed at the scene that three firefighters received minor injuries when they fell down the stairs while escorting residents of the 14-floor tower to safety. Two residents on the top floor said they stuck it out on the balcony while fire fighters worked 12 floors below. Another, said she was awakened by the building's fire alarm, but ignored it and tried to go back to sleep. ("Fatal Fire on Walnut", para. 1-2, 11, 13)

Even in commercial industry, people have ignored the alarm or have been directed to ignore an alarm. In a garment factory in Bangladesh:

> On the night of the fire, more than 1,150 people were in the eight-story building, working on a tight deadline to fill orders for international buyers. When the fire broke out and an alarm sounded, some managers told their employees to ignore the alarm and continue to work. As the fire spread, many workers found themselves trapped in smoke-filled staircases or behind windows that were covered with iron grilles. (Manik & Barry, 2014, para. 3)

Warnings are given to notify occupants of unsafe conditions, how to use a product correctly, and even to notify occupants of what to do in an emergency situation. Rice, Trafimow, Keller and Hunt (2010) indicated that people have come to depend on automation even with alarms. Emergencies do not occur on a routine basis and

technology is not always reliable. When an alarm has malfunctions, it can reduce the trust in the system and thereby reduce compliance with the alarm. A threat can trigger an alarm. Breznitz (1984) wrote that "the two most important features of threats are: (1) the objective ability to cope with the impending danger and (2) their imminence" (p. 5). He further stated "for a warning system to have any effectiveness at all, there must be some objective control over the danger and sufficient time to carry out the necessary actions" (Breznitz, 1984, p. 5). False alarms are a negative effect on warning systems such as a fire alarm system. Credibility of the alarm can be lessened and future alarms may receive less attention. Breznitz states "credibility loss due to a false alarm can be labeled the false alarm effect. It is assumed that the false alarm effect is the consequence of a false alarm episode" (p. 11). Breznitz (1984) further stated:

> The credibility loss following a false alarm is inevitable in any warning system. That much has already been established. Protecting a warning system from the false alarm effect is therefore bound to be a difficult and arduous task, and complete success is impossible. (p. 23)

Ahrens (2014) conducted research on smoke alarms in home fires and provided an update for the National Fire Protection Association in March of 2014. Ahrens listed the reasons why a smoke alarm did not operate during a home fire as the following:

1. Missing or disconnected batteries
2. Dead batteries
3. Hardwired power source problems

When asked about nuisance alarms, respondents replied that 73% of the alarms were due to cooking, which "were cited as the reason for the largest share of smoke alarms missing batteries or disconnected from power" (Ahrens, 2014, p. 16).

James (2015) covered a fire in the Bankstown building in September of 2012. A tenant stated she ignored the fire alarm at first since the false alarms had become a weekly occurrence. This time the fire was for real and another lady leapt to her death to escape the fire.

A fire in an apartment complex was believed to have been caused by a cigarette smoldering on a couch. Due to the repeated false alarms in the complex, most tenants did not evacuate. Tenants interviewed stated that the fire alarm had almost weekly false alarms and that one night the alarm sounded eight times. One month the alarm had sounded forty-two times. With the alarm being real, and the tenants ignoring the alarm, three people were admitted to the hospital for smoke inhalation (Rosie DiManno Toronto, 1986).

George (2010) reported on a fire in a care home that killed fourteen elderly people. After the investigation of the fire it was learned that there had been no safety training for the staff, there were weekly false fire alarms and only three fire drills performed in five years. Camblin and Weinland (1987) defined a false fire alarm as:

> Malicious reports- that is, deliberate, intentional false reporting. Equipment malfunctions (such as a defective alarm) or citizens' reports judged as legitimate (whether there is an actual fire or not) are not included in this category. (p. 83)

Bliss and Chancey (2014) in their introduction, comment on researchers studying false alarms and automated signaling systems. The false alarms create a lack of trust

termed the cry wolf effect and this in turn results in reactions to those systems becoming less frequent.

Chow, Fong and Ho (1999) conducted research on automatic fire alarm systems and classified alarms into three categories: fire alarms, trouble alarms, and ground fault alarms. Their results showed false fire alarms of 48.24% with the cause of the largest source of false alarms being related to construction work at 23.85%. The next cause cited was due to detector faults at 24.66%. Detector faults could be related to dirt and dust in the detectors. "Performance of the smoke detectors depends on many factors such as smoke concentration, relative humidity, air velocity, and ambient temperature" (Chow, et al., 1999, p. 64). Chow, et al. (1999) stated as one of their conclusions that "construction work at the sites were an important factor in causing a false alarm…the area must be isolated from the system first to avoid activating of detectors" (p. 65).

Proulx (2000) provided an update of why occupants seem to ignore alarms. Proulx wrote that in some instances occupants ignore the alarm and continue on with whatever they are doing. Three reasons are cited:

1. Failure to recognize the signal as a fire alarm
2. Loss of confidence in the system because of nuisance alarms
3. Failure to hear the signal (p. 1)

Occupants may mistake the fire alarm as another type of alarm such as a burglar alarm, elevator alarm or security door alarm. Research has shown that "more than three nuisance alarms in one year can undermine the credibility of the system and that the assumption that nuisance alarms are usually prank alarms is not true" (Proulx, 2000, p. 2). Proulx listed statistics for two million false alarm fire calls in 1999 with 44% of these

being system malfunctions, 30% well intentioned calls that were not fires, 15% mischievous false calls and 11% other types of false alarms. Proulx also noted that if a fire alarm was silenced prior to evacuation being completed that occupants quit evacuation efforts and returned to where they came from (Proulx, 2000).

Stanton and Edworthy (1999) noted that with auditory warnings some problems include; there were too many of them, too loud and sound too frequently. They also commented that "Patterson (1990) indicated that the perceived urgency communicated by the warnings may be altered by adjusting the pitch, intensity and speed of the burst" (Stanton & Edworthy, 1999, p. 12).

Bryan (2013) wrote of a three-step method for fire departments to reduce unnecessary alarms:

> 1. Determine alarm system upgrade standards, publish them, and authorize alarm companies to complete phased-in work (p. 87).
>
> 2. Develop a premises inspection program for all businesses with fire alarm systems to ensure system improvements, determine any needed permit fees for alarm companies to fund the necessary staffing, and implement the program (p. 88). 3. When responding to alarm-initiated incidents, determine the most plausible reason for system activation, and bill the contractor, the business/premises, or the alarm company as appropriate (p. 88).

Often, the response bill will be the responsibility of a contractor doing work or the business performing some operation that activated the system causing the unwanted incident response and did not advise the alarm company (Bryan, 2013).

Bryant (2008) reported that some students at the Meridian Hill dorm were ignoring the fire alarm. A new fire alarm was installed recently and several students have made comments about the alarms. Fry states "they are annoying, and I don't take them seriously. I will go outside if the alarm has been on for five minutes, but when I first hear the fire alarm my first thought is not to go outside" (para. 2). Smith commented "I agree with having fire alarms because they are very important to your personal safety, but when they blare in your ears at all hours in the morning, you can't help but wonder who invented them" (Bryant, 2008, para. 8). The new alarm was installed due to previous fires, four kitchen and two room fires (Bryant, 2008).

Roberts-Gray (1988) reported the author's experience of hearing an alarm and the response to that alarm. She was in a hotel lobby when the author heard an alarm and a weak female voice announcing a fire detection device has been triggered (p. 79). She watched the occupants in lobby for their response to the alarm. She stated that:

> Of the 28 evaluators, 17 heard the message that preceded the fire bell's change from beep-beep to blant-blant, 5 heard only the bells and the all-clear message, 4 heard none of the verbal messages, and 2 were not present during the fire alert… Of the 8 who heard the speaker's explanation of the fire bell's changing sound, 4 answered my questions in ways indicative of a felt need for recommendations. (Roberts-Gray, 1988, p. 80)

The other four said the message was confusing. The answers indicated the need for additional information. Two occupants stated they did not need to hear the verbal message because they always evacuate when a fire alarm sounds (Roberts-Gray, 1988).

Laughery (2006) stated two objectives for warnings: "attract attention and provide understandable information needed for recipients to make informed decisions" (p. 467). Laughery notes in his research that voice technology does increase the likelihood that people will respond to the emergency and people's familiarity with the alarm impacts their response as well.

Pipe (2011) quotes Ken Corriveau:

> It's really disheartening as a fire prevention officer- when I spend a good part of my time singing the praises and preaching to people about the importance of having working smoke alarms - to still hear that people are dying in fires because smoke alarms are disabled or not in place. (para. 2)

Delayed Evacuation

Evacuation behavior has been described as the actions people take when they first learn there is an emergency. There has been shown to be a connection between fire injuries and death in residential buildings and hotels and a delayed evacuation (Kobes, Helsloot, de Vries, and Post, 2010).

Kobes, et al (2010), defined human behavior during the initial phase of a fire as "the actions that people take based upon their perception of the situation, their intention to act, and the considerations involved before these actions are carried out" (p. 2). Kobes, et al. further state that the initial "evacuation signal is often not regarded as being a clear indication of danger" (p. 5).

Crandall (2002) stated that "the concept of fire safety implies relative safety for the occupants and firefighters in a building, during the time that they are trying to escape from or extinguish a fire" (p. 6). It would be difficult if you were to try and predict how

you would react to a fire in a building and most people have no experience on which to base their prediction. The author mentions that you might base your reaction on what other people are doing and maybe your perception of the amount of danger you may be in. The author also mentions that everyone has had experiences with false alarms and the probability that an alarm is false and not real. However, the time it takes to get more information on whether a fire alarm is real or false can be the determining factor between living and dying. "New York's Local Law 5 was passed in 1973, and represents the first detailed ordinance addressing high-rise office building evacuation planning" (Jennings, 2002, p. 24). Two of the requirements of New York's Local Law 5 required that fire alarm systems had to be constantly connected to a monitoring station which would allow for the monitoring company to immediately notify the fire department of the possibility of a fire instead of waiting for a building occupant to call 911. Another requirement was that each building had to have its own fire safety plan with a fire safety director and deputy director who had been trained and certified and the plan filed with the fire department. Jennings also noted in his book that high-rise buildings can experience numerous false alarms. He noted occupants can become lax in regards to reacting to the fire alarm after they have experienced multiple false alarms. By having the Fire Safety Director interact with the building occupants, training them in phased evacuations, sheltering in place, and having regular communications and providing information on false alarms to the occupants can keep them responsive to the fire alarm. The author noted that Britain had great success with response to fire alarms when voice instructions were given instead of just a bell or horn. He stated,

> Regarding a 1993 fire at a department store, a report issued by the local fire service found people generally may have become immune to the sound of alarms and bells. The importance of voice alarm systems and their potential to improve occupant response is well documented. (Jennings, 2002, p. 26)

Jennings (2002) stated that the following can reduce the false alarm effect

- Fire Warden Teams reduce false alarm effect
- Identify causes and corrective actions in the event of false alarms
- Require participation in drills and training for occupants
- Provide a realistic assessment of risk, probability of emergency, and imminence of danger in administration of building evacuation plan. (p. 27)

Proulx (1993) developed a stress model for people facing a fire. Proulx discusses that when devising a plan of action and then carrying out that plan, two types of reaction occur:

> When users notice ambiguous information in public buildings, they either ignore the situation, or they investigate (Canter, 1985). Ignoring the situation and pursuing normal activities is a common reaction to ambiguous cues because it corresponds to the users' role in a public building of not taking action. (Proulx, 1993, p. 138)

Rice, Trafimow, Keller and Hunt (2010) conducted a study about attitudes and subjective norms about disaster alarms. Rice, et al, referenced the theory of reasoned action which utilizes two pathways.

> One is the attitudinal pathway, with attitudes being defined as evaluations of behaviors. Attitudes are determined by beliefs about the consequences of

> behaviors (termed behavioral beliefs) and evaluations of those consequences. The second pathway is the normative pathway. Subjective norms are people's opinions about what most others who are important to them think they should do, and are caused by beliefs about what specific others think they should do (normative beliefs) and motivations to comply with them. (Rice, et al., 2010, p. 82)

According to Aguirre (2005), evacuations can be influenced by the size of the group. "The bigger the group, the more difficult it will be for the group to decide to evacuate as a response to the crisis" (p. 125). Main behaviors in a fire have been categorized as follows:

> First, concern with evacuation of the building by either oneself or with others. Second, concern with firefighting or at least containing the fire, and third, concern with warning or alerting others, either individuals or the fire brigade. (Wood, 1980, p. 84)

Other notations are that "women were more likely to warn others, immediately leave the building, request assistance and evacuate their family" (Wood, 1980, p. 85). Kuligowski (2009) concluded that the way occupants behave in a fire evacuation is due to the behavioral process. During an evacuation, an individual interprets cues and determines what actions to take or not to take; this process goes on all during the evacuation. Proulx and Fahy (1997) also noted that there was a time delay in evacuation for office buildings that included "gathering valuables, getting dressed and notifying others" (p. 787). Zhang, Li and Hadjisophocleous (2014) found that following an alarm, people take time to interpret the source of the alarm and then they will take action such as

calling the fire department, notifying other occupants and evacuating the building. Zhao, et al. (2009) stated:

> The recognition stage begins at an alarm or cue and ends with the first response. During this period, occupants realize that there is a threat and begin to respond. (p. 73) Responses can be searching for information by occupants themselves, discussion with other occupants, alerting other people, calling the fire brigade and fighting the fire. (p. 74)

Also reported was that the "response stage begins at the first response and ends with the commencement of moving towards the exits" (Zhao, et al., 2009, p. 75). Occupants may conduct a variety of tasks prior to starting evacuation such as collecting personal belongs, instructing others as to the emergency and to exit the building, sheltering in place or leaving immediately (Zhao, et al., 2009).

Nilsson and Johansson (2009) researched delayed evacuation time utilizing the following information:

1. Time required for occupants to escape is often called required safe escape time
2. Pre-movement time is sometimes divided into two separate phases, namely recognition and response
3. The recognition phase is the period between the reception of a fire cue and the occupant's first response
4. The response phase is the period between the occupant's first response and the time when he or she starts to physically move towards an exit (p. 71)

Occupants are influenced by others and if during the pre-movement phase if no one recognized the fire cue/alarm and did not move toward an exit, others would not move as well. If the fire alarm bell is ambiguous, social influence can change an occupant's behavior. People don't want to feel foolish and may delay moving toward an exit. Others may interpret that behavior as the alarm being a false alarm (Nilsson & Johansson, 2009).

Nilsson and Johansson (2009) wrote:

> The response phase can include a variety of actions that person performs before he or she starts to move towards an exit. During this phase the person will prepare to evacuate, which may include for example putting on clothes and gathering belongings. (p. 73)

During their study, participants who looked at others beside or behind them were observed.

> It is believed that people who look at others beside or behind them clearly observe what others are doing…. In addition, participants looked at others beside or behind them to a greater extent when the alarm bell was used, which suggests that the social influence was stronger for that case. The alarm bell was the more ambiguous of the two alarm types that were included in the study. … The analysis revealed that the cumulative distribution for the recognition time was very similar for all experiments in which the spoken message was used. The same trend was obvious for the pre-movement time. A likely explanation is that the information

> provided in a message makes it easier for people to decide on a form of action, namely to evacuate. (Nilsson & Johansson, 2009, p. 78)

Zhao, Lo, Liu and Zhang (2009) found that people behave differently when there is a fire or a fire alarm. Different examples include moving toward an exit, staying and continuing to work, waiting for rescue from the fire department and some may even try to fight the fire. In some situations, it has been found that people do not move toward the exits even after they recognize that the fire alarm has sounded. The behavioral response to fire does impact the time of evacuation.

Benthorn and Frantzich (1999) determined in their research that the general ring signal was an alarm with only about one in five perceiving it as a fire alarm. They determined that a spoken message was more readily identified with an emergency and can provide more information as to what actions the occupants should take.

Kuligowski (2013) in the section on building evacuation models noted that occupants tend to participate in other activities before starting evacuation. Such activities can include gathering their personal belongings, trying to get more information on what is going on, helping others or even trying to fight the fire. Goffman (1963) stated:

> An act can, of course, be proper or improper only according to the judgment of a specific social group, and even within the confines of the smallest and warmest of groups there is likely to be some dissensus and doubt. (p. 5)

McConnell, Boyce, Shields, Galea, Day and Hulse (2010) worked on the UK project High-rise Evacuation Evaluation Database. "The project aimed to develop a better understanding of the inter-relationships between a developing fire, human behavior

and building technology" (p. 21). One on one interviews were conducted gleaning information related to the following: "cue recognition, patterns of response, cognitions, leadership, training, perception of risk, stair densities, merging flows, deference and other evacuation behaviors" (McConnell, et al., 2010, p. 21). It has been noted in studies that a factor that contributes to fire death is the delay in warning occupants and the delay in occupant evacuation. McConnell, et al. (2010) indicated that in work by Proulx and Sime and Sime, it was suggested that the delay in starting evacuation actions can be greater that the time it would take to travel to the exits and evacuate the structure. They cite pre-movement time of searching for information and other activities as an issue. McConnell et. al. (2010) also reference a study by Galea and Blake where in the NIST study it is suggested "that the perception of risk is related to the quality of information gained" (p. 22). McConnell et. al. reported the findings of their study as follows:

> The most frequently occurring initial response in all floor clusters was to 'seek information on event' (24.6%). The second most frequent initial response was to 'collect belongings' (17.5%), followed closely by 'provided verbal instruction to evacuate' (15.1%). It was also observed that over 10% of participants 'initiated evacuation' as a first response. (2010, p. 26)

They also noted that "participants located in the lower floor cluster were more likely to wait for further information/instruction... The most common second and third action across floor clusters was to initiate evacuation" (McConnell, et al., 2010, p. 27). The study concluded that the majority of the participants interviewed moved toward an exit within eight minutes of the World Trade Center 1 impact. This is not a typical fire in a building and there were no fire alarms that sounded in WTC1 (McConnell, et al., 2010).

The Final Report on the Collapse of the World Trade Center Towers produced by the National Institute of Standards and Technology indicated that the fire alarm system provided automatic smoke detection (i.e. smoke detectors, duct detectors) but required an occupant to pull a pull station to activate the horns and strobes. The alarm system utilized multiple communication pathways but it appears that fire alarm notification and other functions were lost on the upper floors of the impact in WTC1. This resulted with the occupants on the upper floors delaying to evacuate since they were trying to get more information as to what was happening and what they should do. This increased the likelihood that they would encounter smoke or fire during their evacuation (Gann, 2005). Xie, Liu, Chen and Chen (2014) reported in their study:

> A key point is that occupants must make their decision quickly….Prior research has proved that training, more specifically risk preference and stress capacity trainings, impact individuals' decision making and behaviors in a fire. Fire drill can help occupants make correct decisions and take proper actions during a fire. (p. 143)

Kobes, Helsloot, de Vries, Post, Oberije, et al. (2010) reported that "cue validation and way finding performance during evacuation affect the probability of survival in case of fire substantially" and that "occupants generally evacuate by using familiar routes, mostly the main exit which is normally the entrance to a building" (p. 538). Also noted in their study is that a voice fire alarm or personal directives are taken the most serious by occupants.

Warnings are provided in many situations and people's responses to a warning has been studied. Bliss, Fallon and Nica (2006) explained in their study's introduction that:

> One common factor that may underlie the strategies is the match between alarm stimuli and operators' mental conceptualizations of a valid signal. Guillaume et al. (2003) suggested that mental representations of alarm signals stored in long-term memory might affect operators' perceptions of incoming stimuli. (p. 191)

Kuligowski (2014) provided a guidance document for emergency communication in buildings and included the following: use flashing lights to gain attention, alert signal should include instructions on what the emergency is. Message content is important as well. She lists the following points to remember:

1. Who is providing the message?
2. What should people do (actions to take)?
3. When do people need to act?
4. Where is the emergency (location of building)?
5. Why do people need to act? (p. 2)

The fire alarm can be a real asset during an evacuation. If the fire alarm provides clear information and instruction, it can reduce the amount of time it takes a person to start evacuating. Two factors which can affect evacuation is: "the clarity of the warning and the believability of the alarm" (Gwynne, Galea, Owen, & Lawrence, 2002, p. 49). The author stated that a voice recorded message conveys more authority than just a horn or bell. In this situation it is imperative that the correct message is delivered to the occupants. At an airport in Dusseldorf, wrong information was broadcast and the occupants ended up where the fire was located instead of safely evacuated from the area. The clearness of the alarm is important as well. If the ambient noise or other noises drown out the alarm or make it hard to hear, occupants will tend not to take the alarm

seriously. Occupants need to believe the alarm is maintained and operating as required (Gwynne, et al., 2002).

Dunne (2013) discusses three types of responses by groups:

1. Ten to twenty percent will stay composed and maintain their reasoning and decision making abilities
2. Ten to twenty percent may experience a paralyzing level of anxiety and exhibit extreme emotional distress
3. The majority, seventy to eighty percent will tend to become sheep-like, stunned and uncertain of what to do next (p. 45)

When fire alarms were the norm in the 1900s, the noise of the alarm and the flashing light would indicate there was a fire, but no information was provided on where the fire was or how to get out of the building. Code now provides requirements for incorporating mass notification systems for other emergencies than just a fire. The Code provides information on installation of such systems and the inspection, testing and maintenance of the systems (Donahue, 2014).

Panic in fires has been a common report of the media. However, Sime (1980) argued that "the use of the concept has actually delayed systematic research of people's behavior in fires" (p. 63). For example, Sime discusses that when a fire occurs and people try to exit out of the same set of doors that the media will attribute it to panic instead of looking at the possibility that other exits were available but people did not use them. Sime further relates the reports on the Beverly Hills Supper Club in which the media attributed the deaths to panic when in fact; the main causes were the delay in notifying the occupants, the estimated 1,350 people in the cabaret room that had a

maximum occupancy of 536 and the lack of seriousness of the emergency. Cornwell stated that the fire started in an empty room on the other side of the building from the Caberet Room. There was a delay of approximately eight minutes which factored into the number of fatalities drastically (Cornwell, 2003). Researchers actually started to focus on occupant behaviors back in the 1960-1970s and as the research progressed it found "fascinating studies regarding response to fire cues, timing of escape, impact of training, and original wayfinding systems" (Proulx, 2001, p. 2). Occupant behavior varies among "occupant characteristics, building characteristics and fire characteristics" (Proulx, 2001, p. 3). Proulx (2002) also found that the "means of alerting occupants directly impacts the time delay before evacuation" (p. 5). Means of alerting occupants can include a bell/horn system, recorded voice system, live voice system, word of mouth, and etcetera.

Paulsen (1984) found that "people generally respond to emergencies in a rational, often altruistic manner" (p. 16). Panic is not a common reaction in a fire or emergency situation. People will assess the situation or they may consult with others and then place a level of risk to the situation and determine a plan of action (Kuligowski, 2009, p. 10). "Awareness applies to a person's knowledge of the building-fire environment. Capability relates to a person's ability to take actions" (Hurley & O'Connor, 2001, p. 403).

History of Fatal Fires in Dormitories and Fraternities

In 2013, Campbell provided an updated report for the NFPA on structure fires in dormitories, fraternities, sororities, and barracks. He noted that during a five year period, 2007 to 2011, there were a yearly average of 3,810 fires in dormitory, sorority, fraternity,

and barracks in the United States. These fires caused $9.4 million in property damage, two deaths and thirty injuries.

Goldsmith (2000) reported some of the deadliest fires on U.S. college campuses as follows:

> Providence College in Rhode Island, 1977, ten women dead; University of North Carolina, Chapel Hill, 1996, five killed in fraternity fire; University of California Berkeley, 1991, three killed in fraternity fire; Murray State University in Kentucky, 1996, one killed one injured due to arson. (para. 5)

Lewis (1999) posted about a fire alarm at a women's dorm at Shaw University. It was thought that the fire started around two a.m. from a couch on the fifth floor. Lewis noted that everyone evacuated from the dorm with several students being treated for smoke inhalation.

> Students say the situation could have been worse because false alarms have become a common occurrence. Student Crystal Moore stated 'You hear the fire alarms so often, you don't take it seriously until you open up the door, and the smoke's there in your face. And sometimes, it's too late'. (para. 5-6)

Sander (2006) indicated off-campus housing presents its' own fire safety challenges. Fraternities are known for their parties and lack of housekeeping. According to the National Fire Protection Association, during the years of 1973-2003, there were 49 fatal fires in dorms, fraternities and sorority housing that left 77 students dead. Over half of the fires occurred in fraternities (44 dead) and only one death in a sorority. Often the houses are old, located off-campus and privately owned. Many times they lack the fire protection that is provided for on-campus residences. May of '99 saw the death of a

freshman in the Sigma Chi Fraternity enrolled at the University of Missouri. The nineteen year old's bed was ignited by a burning candle. "His roommate, who was sleeping in a lower bunk, heard his screams and tried to put out the fire by using paper cups, filling them with water from the bathroom across the hall" (para. 10). Two other fatalities (2006) involved fraternities that did not have sprinkler systems. Pi Kappa Alpha, a seventy-six year-old-house, saw the death of senior Brian Schlittler, who attended the University of Missouri-St, Louis. Nebraska Wesleyan University, Phi Kappa Tau member Ryan Stewart, died in a fire of the eighty-three year old non-sprinklered house. In both cases the cause of the fire is listed as under investigation. Sara Boatman, who was the vice-president of student life at Nebraska Wesleyan is quoted as saying:

> While fire and university officials agree that automatic sprinklers can buy precious time in the chaotic early moments of a blaze, the sprinklers are not the silver bullet. People say if there had been a sprinkler system in that house, Ryan Stewart would not have died. We don't know that. It's about having good procedures and remembering that college students change every year. And they believe they are invincible. (Sander, 2006, para. 19)

Providence College, a woman's dorm called Aquinas Hall, had a fire on the fourth floor in the early morning hours of December 13, 1977. There is thought that the cause of the fire was due to someone trying to dry their mittens with a blow dryer and it was left on unattended in a closet (Goldsmith, 2000).

May 1996, Chapel Hill, North Carolina was the scene of a fatal fire that killed five at a fraternity house hours before the scheduled graduation. The eighty year old

brick building was gutted and a determination was not immediately made about what caused the fire. The Phi Gamma Delta fraternity house did not have a sprinkler system but one of the injured said they were awakened by the fire alarm. The fraternity house had held pre-commencement party just hours before the graduation (Beitler, 2008).

The Michael H. Minger Foundation has pictures and the story of a fraternity fire on its website. The story reveals that around two pm one afternoon, a fraternity brother awoke and realized he was late for class. In his haste to leave, he accidently threw his blankets over a burning candle. It wasn't until he was on the bus headed for class that he looked back and saw the fire coming out of his bedroom window. Someone at the house called the fire department but gave the wrong address. The fraternity house had thrown a party the night before and covered all the smoke detectors so the fire alarm would not be triggered. So the fire alarm never activated for the fire and the house was destroyed. When they rebuilt the house, an automatic sprinkler system was installed ("Fraternity fire", n.d.).

University of Arizona has reduced false alarms at the Coronado Residence Hall by installing plastic covers over the pull stations and installing security cameras directed at the stations. Deane, who was a resident assistant at Coronado for two years, said she felt safe in case of an emergency. However, she said she wouldn't have felt as secure as a regular resident since prank alarms occurred on a regular basis. The eight hundred residents that resided at the hall experienced approximately twenty false alarms each semester during the morning hours of two and four. Deane stated that many residents assumed the alarms were false (Davis, 2000).

> In January 2000, a fire in a dorm at Seton Hall University in New Jersey killed three and injured fifty-eight. Alarms went off when the fire started but most students did not react because false alarms were common at the dorm. (Grahmann, 2014, para. 25)

"January 19th, 2000, a fire in a dormitory at Seton Hall University killed three 18-year-old Seton Hall students and injured 62 others" (Story, Cornish, Schrieber & Powell, n.d). The fire occurred in the early morning hours. One student suffered third degree burns over most of his body. Fire investigators determined the fire was started by lighting flammable material on a couch in the lounge area of the third floor. Many of the 640 residents of Boland Hall heard a fire alarm but ignored it. There had been eighteen false alarms since the beginning of the year. There were no fire sprinklers in the six floor dorm. The forty-eight year old building did have a fire alarm and portable fire extinguishers (Story, et al., n.d).

Mazzola (2015) reported on the fifteen year anniversary of the Seton Hall fire where three students were killed and fifty-eight others were injured. Two students admitted they were responsible for setting the deadly fire. They plead guilty to third degree arson and were sentenced to five years in prison.

Children learn the stop, drop and roll fire safety theme as soon as they are old enough to attend school and sometimes even at an earlier age. School children are taught to evacuate the school building when they hear the fire alarm and they learn other important fire safety instructions, such as crawling low to avoid smoke and feeling the door with the back of your hand to make sure it is cool to the touch before opening it. We are taught not to play with matches. All this is drilled into the student's heads in the

K-12 setting. Sometime between K-12 and finishing college, students seem to forget or ignore what they were taught about fire. MIT initiated a new fire safety inspection policy, in an effort to crack down on fire safety at the school. In early 2000, a fire alarm went off in the Burton-Conner dorm at 3 a.m. "The ear-piercing siren is nearly impossible to sleep through" (Thomas, 2000, para. 4). So when the researcher of the article looked back at the dorm, she noticed that there were still kids inside sitting on the stairs. The question then arose "so at which point do people decide that the fire alarm must be insignificant and ignore it? What happened to all those years of incessant training" (Thomas, 2000, para. 4). The temperature outside with the wind chill was probably less than zero degrees. Regardless of that, students should not have stayed inside when a potential fire could be in the building. Thomas (2000) stated, "It's far better to be cold and alive than burned to death" (para. 5). The day after the alarm, it was determined that a fire alarm pull station had been activated. Rumor ran that it was a prank. Dorm occupants were angry and emailed furiously people on the dorm mailing list demanding justice for the prank.

> Thomas, 2000, remarked that it's unthinkable that people think it's amusing and funny to pull the fire alarm, and evacuate sleeping people into the bitter cold. We know the story of the boy who cried wolf: eventually when there was really a wolf, no one believed him. (para. 6-7)

In regards to fire alarms, Alexis (2014) wrote:

> While the regularly occurring weekend fire alarm no longer really scares me, the first time was scary because I had no idea what was going on and thought there

was actually a fire. There should be major concern when people are no longer affected by the urgency of a blaring fire alarm. (para. 9)

Providence College, Aquinas Hall women's dorm, December 13, 1977, the fire was accelerated by the Christmas decorations and crepe paper that covered the walls on the fourth floor. Within thirty minutes of the fire, ten women were dead (Howe, 2010).

Hubbuch (2012) reported four people were ticketed for not evacuating from a dormitory during a fire on January 29, 2012. The ticket had a cost of $200.50.

At MIT, Burton-Conner dorm was evacuated for the seventh time when a smoke detector activated the fire alarm. MIT officials stated that the reasons for the alarms were due to overcooked food and malfunctioning equipment. Vogt revealed that many of the residents were frustrated with the false alarms and the majority of them happened between 7 pm and 10 pm. This interrupts study and sleep hours. Some residents re-enter the dorm when the alarm stops and prior to the fire department or dorm staff giving an all clear. A student, Alice Tsay said "We're pretty sure they're false by now" (Vogt, 2002, para. 8). Vogt further stated "some residents say that they have started to ignore the alarms because they happen so frequently, and that next time there is an alarm they will not leave the dormitory. We're getting accustomed to the alarms. Next fire alarm, I'm not going to leave if I'm in bed, said Gregor B. Cadman" (Vogt, 2002, para. 10).

Sid Richardson College and Baker College experienced eight false fire alarms in one week in September 2001. Someone had tampered with the water-flow valves on the sprinkler system activating the fire alarm at Sid Richardson. President Anisha Patel said she didn't believe the individual wanted to set off the fire alarm; however, setting off the alarm can result in a six hundred dollar fine. A Sid freshman, Clare Johnson, stated that

the students did not react to the alarm because false alarms happened on a regular basis. On September 7, Baker College experienced six false alarms within forty minutes. A Baker College junior, Justin Brickell stated "The fire alarms go off at least once a week, everyone ignores them" (Grahmann, 2014, para. 10).

In 2011, Eastman wrote in her opinion column that on November 7, a fire alarm went off and students were slow to respond. Then on November 11, around 4 a.m. in Johnson Hall dorm, a fire alarm activated and students were forced to evacuate the building out into the rain while it was checked by Campus Safety. It took approximately twenty minutes to clear the building for the students to be able to return to their rooms. The author speaks to the fact that students have been through fire drills over and over again and now that even if the alarm is screeching and annoying, that they will ignore them. They did not feel the need to be bothered by an alarm that doesn't mean anything. Eastman (2011) stated that part of the problem is "…shoddy equipment. The fire alarms often 'malfunction' and go off sporadically" (para. 4). She feels that a bigger problem is people pulling the alarm as a prank. This creates a mindset with the students where they ignore the alarm and stay inside since they assume it is just a prank or failure in the equipment. The attitude was "Don't get me wrong; if I see flames or smell smoke, I'll be out of my room and in the rain. But for now, it's going to take a lot more than an alarm to get me out of my bed" (Eastman, 2011, para. 6).

The Delta Sigma Phi fire alarm sounded and the building evacuated. When the firefighters conducted a sweep of the house they found that a Western Illinois University student was still present in his room, eating lasagna. "Police say the student told officers that the alarm had been going off for 20 minutes and that the fire department had taken

too long. Fire officials told police the student wasn't cooperative" (Abernathy, 2011, para. 5). The student was ticketed for failing to evacuate.

In 2005, Groover reported on the Campus Fire Safety Right to Know Act which would require colleges to publish information on an annual basis regarding the number of fires, fire injuries and fatalities involving residence halls, sororities and fraternities. The Act also required disclosure on the fire protection features of those residence halls, fraternity and sorority houses.

Summary

This chapter reviewed selected literature relating to the following areas of emphasis: a brief history of fire-fighting in America, a short history of fatal fires, history of fire alarm and fire sprinkler systems, false alarms or nuisance alarms, delayed evacuation, and a short history of fatal fires in dormitories and fraternities. This chapter provided a broad overview of how fire-fighting and building codes came about, fatal fires in the United States inclusive of theaters, hotels, large assembly occupancies such as casinos, schools, clubs and other locations, the development of fire alarms and sprinkler systems, the problems with false alarms and nuisance alarms, what some of the causes of delayed evacuation and the impact on life safety, and fire incidents in dormitories and fraternities.

Chapter 3

Methods

Introduction

A quantitative, descriptive research design was used in this study. In addition, this chapter describes the sample population, demographics of the sample, the research data collection instrument, reliability of the instrument produced data, data collection procedures, and the summary.

Purpose of the Study

The purpose of this study was to identify building occupant's attitudes about fire alarm initiated evacuations. It examined attitudes based on gender, faculty, staff, students, age, instances of personal fire loss, and instances of fire loss among people participants know to determine if there was a difference when occupants chose to evacuate a building when a fire alarm was activated.

Research Questions

The following research questions were used in this study:

1. What is the relationship, if any, between building occupant attitudes and nuisance fire alarms?
2. What is the relationship, if any, between building occupant attitudes and evacuation of a building during a fire alarm?

3. What is the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations?
4. What is the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations?

Sample Population

Population sample was taken from a large, southern, land grant university and included undergraduate and graduate students, faculty and staff associated with the university. The sample was taken during the fall semester of 2015. All students whose responses were used in this survey were at least eighteen years of age or older.

Demographics

The demographics of the sample population was as follows: gender (male/female), age, type of participant (faculty/staff/student/other), level in college (freshmen, sophomore, junior, senior, master's student, PhD student), living situation (dorm, fraternity, off-campus), nationality (United States/International community), number of years at university (faculty/staff), and physical impairment (deaf or hard of hearing/legally blind/mobility impairment/other type of impairment).

Research Data Collection Instrument

The Fire Alarm Perceptions Survey (see Appendix A), developed by this researcher, consisted of 31 items with answers being fill in the blank, multiple choice, yes/no, and five-point likert style "strongly agree" to "strongly disagree". Approval was

granted by the Institutional Review Board at Auburn University to conduct this study (See Appendix D).

The survey questionnaire was composed of four types of questions:

1. Items 1-8 focusing on demographic information
2. Items 10-22 focusing on fire drill and evacuation experiences
3. Items 9, 23-24, 30-31 focused on the perceptions the participant and whether they had experienced a fire or a fire loss or known someone who had experienced a fire or a fire loss
4. Items 25-29 address the participant's attitude toward nuisance fire alarms and evacuations.

The first eight questions of the instrument requests responses regarding the participant's demographic information. The participant was asked to complete the eight questions in a multiple-choice format and two were asked in a fill in the blank format. The answer that most described the participant was marked with an X next to the appropriate answer.

The next section of the survey, questions 10-22, was designed to determine the participant's participation in fire drills and evacuation experiences. This section was composed of yes/no questions and multiple choice questions.

The third section of the survey consisted of five questions (25-29). These questions were to measure the participants' attitude toward the fire alarm and evacuation. They required choice from a five-point lickert type scale with responses of strongly agree, agree, neither agree nor disagree, disagree, strongly agree.

The fourth section consisting of questions 9, 23-24 and 30-31 requests the participants' perception of fire alarms and evacuation experiences based on whether they have personally experienced a fire or fire loss or have known someone who experienced a fire or fire loss. The questions were designed with one having a yes/ no answer, and the other four requiring a choice from a five-point lickert type scale with responses of strongly agree, agree, neither agree nor disagree, disagree, strongly agree.

All questionnaire items were reviewed and approved by the dissertation committee for usefulness to the study and clarity. See Appendix A for copy of Fire Alarms Perceptions Survey.

Research Strands

The literature review showed the individuals perceptions of danger and their attitude toward the danger did impact evacuations. For purposes of this study, four research strands were identified to provide clarity and structure in the Fire Alarm Perceptions Survey. The strands were demographics, fire drill/evacuation experience, attitude and perception. These strands were used to develop the questions for the Fire Alarm Perceptions Survey.

Q-Sort Technique

A Q-Sort technique was used in the creation of the survey. Witte (1997) stated "when utilizing the technique an individual is given a set of items or statements, usually on cards, and asked to place them into specified categories so that each category contains some minimum of cards" (p. 55).

Panel members were given a set of descriptors and the four strand identifiers. The panel members were then asked to place the descriptor with the appropriate strand

identifier. Upon completion, revisions were made as required. Content validity is used "when you want to know whether a sample of items truly reflects an entire universe of items in a certain topic" (Salkind, 2011, p. 118). Although the survey was developed it did not have a strong Cronbach's Alpha for the various sections such as perception (.585) and attitude (.379). It is recommended that the questions be reviewed and perhaps additional questions added in those sections to strengthen the content validity of the survey. Questions that were not agreed on during the Q-sort by the safety professionals should be re-evaluated and rewritten as needed.

Reliability of Instrument Produced Data

Reliability can be stated as "whether a test, or whatever you use as a measurement tool, measures something consistently" (Salkind, 2011, p. 106). The internal consistency reliability coefficient of this instrument was a Cronbach's alpha, which was .754, n = 64. Content validity is "whether a sample of items truly reflects an entire universe of items in a certain topic" (Salkind, p. 118). To ensure content validity a panel of three members in the field of safety at Auburn University established the instrument content validity through the Q-Sort technique. Q-sort technique panel members are listed in Appendix B.

Data Collection Procedures

The researcher worked with the Office of Institutional Research, Residence Life, Greek Life, Liberal Arts and what was called the Grads list (an email list already set up for various Auburn Departments and graduate students) to distribute the fire alarm perceptions survey (see Appendix A). Participants voluntarily provided information through the online Qualtrics survey. The data participants provided served as the agreement to participate in the survey. The total time commitment was approximately

five to ten minutes. The identity of the participants remained anonymous throughout the data collection process. All data was stored using the VPN client software, SPSS and Microsoft Office. All electronic equipment needed for the project was password protected.

Analysis of Data

Careful annotation of procedures allows replication and further study. Inter-rater reliability and instrument validity were key issues within this study. Cronbach Alpha for inter-rater reliability was .689. The consensus acceptance of the instrument by the panel of safety professionals constituted the degree of validity.

An analysis of variance was used to identify patterns with this study. Descriptive statistics were used to summarize and describe relevant data.

The procedures for data gathering and procedures for content validation supported the overall purpose of this study. The methods were specifically designed to address the research questions:

1. What was the relationship, if any, between building occupant attitudes and nuisance fire alarms?
2. What was the relationship, if any, between building occupant attitudes and evacuation of a building during a fire alarm?
3. What was the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations?

4. What was the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations?

The fire alarm perceptions survey, validated by a panel of safety professionals, produced a means to gather data, which when analyzed, provided insight related to the attitudes and perceptions of the participants.

Summary

This chapter covered the introduction, purpose of the study, sample population, demographics, research data collection instrument, reliability of instrument produced data, data collection procedures, and analysis of data.

Chapter 4

Findings

This chapter presents and discusses the statistical analysis of the data collected in this study.

Purpose of the Study

The purpose of this study was to identify building occupant's attitudes about fire alarm initiated evacuations. It examined attitudes based on gender, faculty, staff, students, age, instances of personal fire loss, and instances of fire loss among people participants know to determine if there was a difference when occupants chose to evacuate a building when a fire alarm was activated.

Research Questions

The following research questions were used in this study:

1. What is the relationship, if any, between building occupant attitudes and nuisance fire alarms?
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3. What is the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations?
4. What is the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations?

The instrument used in this study consisted of eight demographic variables (questions 1-8) about the participants, fire/drill and evacuation experience variables (questions 10-22), five attitude variables, and five perception variables. Descriptive statistics were used to report the demographic variables. Univariate analysis of variance was used to analyze the data collected.

Demographics

The sample of this study consisted of faculty, staff, and students who worked or were enrolled at Auburn University in the city of Auburn, Alabama in the Fall Semester of 2015. The sample population consisted of 297 participants, over half of them were female (n = 170), while the rest were male (n = 127). Gender information is shown in Table 1:

Table 1

Participant's Gender

	Frequency	Percent
Female	170	57.2%
Male	127	42.8%
Total	297	

The nationality of the participants was as follows: 93.6% of the sample was from the United States (n = 278), with 6.4% from the International Community (n = 19).

Table 2

Participant's Nationality

	Frequency	Percent
The United States	278	93.6%
International Community	19	6.4%
Total	297	

There were 30 faculty (10.1%), 93 staff (31.3%), 190 students (64%), and 11 in the other category (3.7%). See Table 3.

Table 3

Type of Participants

	Frequency	Percent
Faculty	30	10.1%
Staff	93	31.3%
Student	190	64.0%
Other	11	3.7%
Total	297	

Housing statistics were as follows: 13.1% (n = 39) live in a dorm and 86.9% (n = 258) live off campus (see Table 4).

Table 4

Housing Statistics

	Frequency	Percent
Live in dorm	39	13.1%
Live off campus	258	86.9%
Total	297	

Graduate level students accounted for 138 of the 297 participants (46%), undergraduate students were represented by 59 participants at 20%.

Table 5

Level in College

	Frequency	Percent
Freshman	13	4.4%
Sophomore	21	7.1%
Junior	12	4.0%
Senior	13	4.4%
Master's student	58	19.5%
PhD student	80	26.9%
Not applicable	100	33.7%
Total	297	

The Participant's ages showed a range of 50 years with ages between 18 and 68 (n = 295), with a mean of 34.39 (μ = 34.39) and a standard deviation of 13.608. See Table 6 for detailed information related to age, frequency and percent of participation in research.

Table 6

Age of Participants

	Frequency	Percent
18	8	2.7%
19	23	7.7%
20	13	4.4%
21	9	3.0%
22	6	2.0%
23	15	5.1%
24	16	5.4%
25	14	4.7%
26	8	2.7%
27	10	3.4%
28	12	4.0%
29	12	4.0%
30	9	3.0%
31	4	1.3%
32	8	2.7%
33	10	3.4%
34	3	1.0%
35	5	1.7%
36	4	1.3%
37	2	.7%
38	9	3.0%
39	1	.3%

Age of Participants - continued

	Frequency	Percent
40	5	1.7%
41	5	1.7%
42	2	.7%
44	3	1.0%
45	7	2.4%
46	7	2.4%
47	3	1.0%
48	1	.3%
49	2	.7%
50	7	2.4%
51	3	1.0%
52	6	2.0%
53	5	1.7%
54	7	2.4%
55	1	.3%
56	1	.3%
57	4	1.3%
58	4	1.3%
59	2	.7%
60	2	.7%
61	4	1.3%
62	4	1.3%
63	3	1.0%

Age of Participants - continued

	Frequency	Percent
65	4	1.3%
66	1	.3%
68	1	.3%
Total	295	99.3%
Missing	2	.7%

Figure 1 histogram provides a pictorial representation of the participants' ages and the age frequency. Figure 1 histogram also provides the mean (34.39). the standard deviation (13.608) and the number of participants (n= 295).

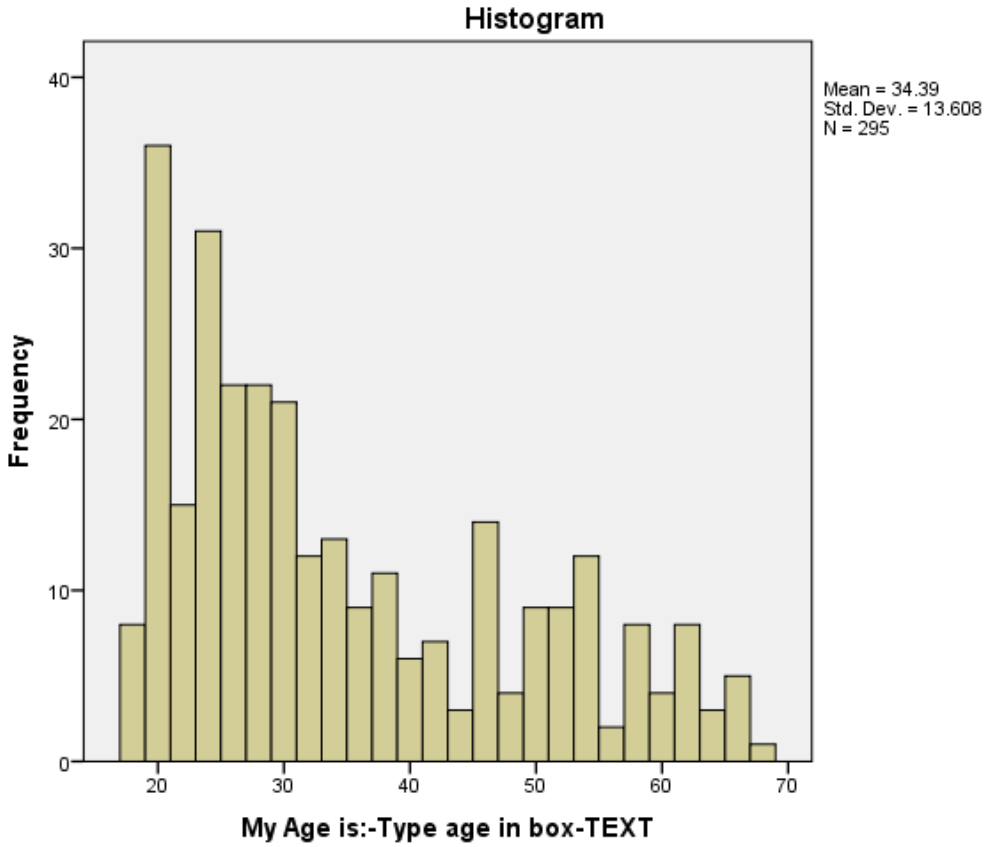

Figure 1: *Age of Participants*

Fourteen participants (5%) reported a physical disability such as being legally blind (n = 1), deaf or hard of hearing (n = 2), mobility impaired (n = 6), or another type of impairment not listed (n = 5).

Table 7

Physical Impairments

	Frequency	Percent
Deaf/hard of hearing	2	.7%
Legally blind	1	.3%
Mobility impairment	6	2.0%
Other Impairment	5	1.7%
Not applicable	279	93.9%
Total	293	

Fire Loss

One of the survey questions was whether a person had a personal fire loss. Only two ways to answer was provided: yes or no. The number, mean and standard deviation of those who responded are listed in Table 8. There were 295 participants with 37 (12.5%) stating they had sustained a personal fire loss.

Table 8

Personal Fire Loss

Source	Number (n)	Mean (M)	Standard Deviation (SD)
Age	295	1.87	.332
Faculty	30	1.67	.479
Staff	93	1.84	.370
Student	190	1.91	.286
Other	11	1.91	.302
Gender - male	127	1.85	.358
Gender - female	170	1.89	.309
From - United States	278	1.87	.332
From - Intl Com.	19	1.89	.315
Live - dorm	39	1.95	.223
Live - off campus	258	1.86	.343
Student - freshman	13	2.00	.000
Student - sophomore	21	1.90	.301
Student - junior	12	1.92	.289
Student - senior	13	1.77	.439
Student - master's	58	1.97	.184
Student - PhD	80	1.88	.331
Physical - deaf	2	1.50	.707
Physical - blind	1	2.00	
Physical - mobility	6	1.83	.408
Physical - other	5	1.80	.447

One of the survey questions was whether a person had known someone with a fire loss. Only two ways to answer was provided: yes or no. The number, mean and standard deviation of the participants who have known someone with a fire loss are

shown in Table 9. There were 295 participants with 213 (71.7%) stating they had known someone with a fire loss.

Table 9

Known Someone with Fire Loss

Source	Number (n)	Mean (M)	Standard Deviation (SD)
Age	295	1.28	.452
Faculty	30	1.37	.490
Staff	93	1.22	.413
Student	190	1.30	.459
Other	11	1.36	.505
Gender - male	127	1.30	.460
Gender - female	170	1.27	.446
From - United States	278	1.26	.439
From - Intl Com.	19	1.63	.496
Live - dorm	39	1.31	.468
Live - off campus	258	1.28	.449
Student - freshman	13	1.31	.480
Student - sophomore	21	1.24	.436
Student -junior	12	1.33	.492
Student - senior	13	1.15	.376

Known Someone with Fire Loss - continued

Source	Number (n)	Mean (M)	Standard Deviation (SD)
Student - master's	58	1.31	.467
Student - PhD	80	1.34	.476
Physical - deaf	2	1.00	.000
Physical - blind	1	1.00	
Physical - mobility	6	1.00	.000
Physical - other	5	1.40	.548

Addressing the Research Questions

Research Question 1

1. What was the relationship, if any, between building occupant attitudes and nuisance fire alarms?

A univariate analysis of variance (ANOVA) was conducted. Results were as follows:

Dependent variable: Total attitude

Fixed factors: Have you ever had a fire loss? Have you known someone who has had a fire loss? Five questions related to perception and fire alarms.

For those who reported that they had a fire loss (yes) and knew someone who had a fire loss (yes), the test was not statistically significant, $F(17,12) = 2.496$, $p > .05$. Because the p value for the overall test is more than .05, we accept the null hypothesis that there was no relationship between building occupants and nuisance fire alarms. For

those who reported that they had a fire loss (yes) and but did not know someone who had a fire loss (no), the test was not statistically significant.

For those who reported that they did not had a fire loss (no) and but they knew someone who had a fire loss (yes), the test was statistically significant, $F(61,121) = 3.122$, $p < .001$. Because the p value for the overall test is less than .05, we reject the null hypothesis that there are no relationship between building occupants and nuisance fire alarms. Post hoc tests were not performed since there were less than three groups in the test. It also showed statistical significance in relation to question 24 (when a horn/strobe goes off in a building, I know that I should evacuate because there is a fire emergency), $F(4,121) = 3.420$, $p < .05$. It also showed statistical significance in relation to question 30 (people should evacuate when a fire alarm sounds), $F(4,121) = 2.888$, $p < .05$. It also showed statistical significance in relation to questions 24 and 30 (Q24 when a horn/strobe goes off in a building, I know that I should evacuate because there is a fire emergency, Q30 people should evacuate when a fire alarm sounds), $F(5,121) = 2.297$, $p < .05$ It also showed statistical significance in relation to question 24 and 31(Q24 when a horn/strobe goes off in a building, I know I should evacuate because there is a fire emergency, Q31 fire alarms are designed to keep us safe), $F(3,121) = 2.976$, $p < .05$. For those who reported that they did not had a fire loss (no) and they did not know someone who had a fire loss (no), the test was statistically significant, $F(34,42) = 2.681$, $p < .05$. It also showed statistical significance in relation to question 24 (when a horn/strobe goes off in a building, I know that I should evacuate because there is a fire emergency), $F(4,42) = 4.915$, $p < .05$.

It showed statistical significance in relation to question 23 and 24 (Q23 a fire alarm with a voice message and a horn/strobe would make it easy to know I should evacuate the building, Q24 when a horn/strobe goes off in a building, I know that I should evacuate because there is a fire emergency), $F(3,42) = 3.032$, $p < = .05$.

It also showed statistical significance in relation to question 24 and 30 (Q24 when a horn/strobe goes off in a building, I know that I should evacuate because there is a fire emergency, Q30 people should evacuate when a fire alarm sounds), $F(2,42) = 5.026$, $p < .05$.

Levene's test for homogeneity of variances showed a significance value of .128 (yes/yes); .334 (no/yes); and .174 (no/no); which is greater than .05, which means the assumption of homogeneity of variance had not been violated (the samples from the population are independent and are approximately normally distributed).

Research Question 2

2. What was the relationship, if any, between building occupant attitudes and evacuation of a building during a fire alarm?

A univariate analysis of variance (ANOVA) was conducted. Results were as follows:

Dependent variable: Total attitude

Fixed factors: Have you ever had a fire loss? Have you known someone who has had a fire loss? Four questions related to evacuation history.

For those who reported that they had a fire loss (yes) and knew someone who had a fire loss (yes), the test was not statistically significant, $F(15,14) = .855$, $p > .05$.

Because the p value for the overall test is more than .05, we accept the null hypothesis that there are no relationship between building occupants and nuisance fire alarms.

However, it did show statistical significance in relation to question 15 (how many times in the last month have you evacuated a building due to a fire alarm, $F(1,14) = 5.895$, $p < .05$. For those who reported that they had a fire loss (yes) and but did not know someone who had a fire loss (no), the test was not statistically significant, $F(3,3) = 1.878$, $p > .05$

For those who reported that they did not had a fire loss (no) and but they knew someone who had a fire loss (yes), the test was not statistically significant, $F(35,147) = .922$, $p > .05$

For those who reported that they did not had a fire loss (no) and they did not know someone who had a fire loss (no), the test was not statistically significant, $F(26,50) = 1.353$, $p > .05$

Levene's test for homogeneity of variances showed a significance value of .586 (yes/yes); .549 (yes/no); .008 (no/yes) and .343 (no/no); which is greater than .05, which means the assumption of homogeneity of variance had not been violated (the samples from the population are independent and are approximately normally distributed).

Research Question 3

3. What was the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations?

A univariate analysis of variance (ANOVA) was conducted. Results were as follows:

Dependent variable: Have you ever been in a fire or had a fire loss?

Fixed factors: total score for attitude.

The test was not statistically significant, $F(18,278) = .609$, $p > .05$. Because the p value is more than .05, we accept the null hypothesis that there are no differences among the groups related to attitude for participants with personal fire loss and responding to nuisance fire alarms and building evacuations.

A second univariate analysis of variance (ANOVA) was conducted. Results were as follows:

Dependent variable: Have you ever been in a fire or had a fire loss?

Fixed factors: total score for perception.

The test was not statistically significant, $F(14,282) = 1.282$, $p > .05$. Because the p value is more than .05, we accept the null hypothesis that there are no differences among the groups related to perception for participants with personal fire loss and responding to nuisance fire alarms and building evacuations.

Research Question 4

4. What was the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations?

A univariate analysis of variance (ANOVA) was conducted. Results were as follows:

Dependent variable: Have you known someone who has been in a fire or had a fire loss?

Fixed factors: total score for attitude.

The test was not statistically significant, $F(18,278) = 1.020$, $p > .05$. Because the p value is more than .05, we accept the null hypothesis that there are no differences among the groups related to attitude for participants who have known someone who have had a fire loss and responding to nuisance fire alarms and building evacuations.

Another univariate of variance (ANOVA) was conducted. Results were as follows:

Dependent variable: Have you known someone who has been in a fire or had a fire loss?

Fixed factors: total score for perception

The test was not statistically significant, $F(14,282) = .858$, $p > .05$. Because the p value is more than .05, we accept the null hypothesis that there are no differences among the groups related to perception for participants who have known someone who have had a fire loss and responding to nuisance fire alarms and building evacuations.

Additional Analysis

Other analysis conducted included the type of participant and whether they stayed in a building when the fire alarm sounded. The frequency and percent are descripted in Table 10.

Table 10

Participants that Stayed in Building During an Active Alarm

Participant	Stayed	Frequency	Percent
Faculty	Yes	11	40.7%
Faculty	No	16	59.3%
Staff	Yes	23	31.9%

Participants that Stayed in Building During an Active Alarm - continued

Participant	Stayed	Frequency	Percent
Staff	No	49	68.1%
Student	Yes	75	45.2%
Student	No	91	54.8%
Other	Yes	1	16.7%
Other	No	5	83.3%

Analysis of participation in fire drills showed that most of the participants (n = 272), participated in fire drills during K-12 school. This group represented 91.6% of the participants. See Table 11 for mean and standard deviation of participation in drills and Table 12 for frequency of fire drills.

Table 11

Participation in Fire Drills

Where	Mean (M)	SD
K-12	.92	.278
International school	.04	.189
Job	.48	.501
Other	.18	.384
No participation	.02	.152

Table 12

Frequency of Fire Drills

Where	Frequency	Percent
K-12	272	91.6%
International school	11	3.7%
Job	143	48.1%
Other	53	17.8%
No participation	7	2.4%

Analysis of non-evacuation of building during fire alarm showed several reasons why participants (41%) had remained in a building during an active fire alarm. The two highest percentages showed 26.9% for usually a false alarm; and 63.6% for another reason not listed. Table 13 provides more detail on frequency and percentages. Mean and standard deviation are provided in Table 14.

Table 13

Non-Evacuation During Fire Alarm (frequency and percent)

Reason	Frequency	Percent
Stayed in Building	122	41.1%
Work to complete	27	9.1%
Usually false alarm	80	26.9%
Did not want to take stairs	2	.7%
Supervisor said not to leave	20	6.7%
Friends/co-workers not leaving	15	5.1%
Waiting for more information	20	6.7%
Other reason	189	63.6%

Table 14

Non-Evacuation During Fire Alarm (means and standard deviation)

Reason	Mean	Standard Deviation
Stayed in Building	1.59	.493
Work to complete	.09	.288
Usually false alarm	.27	.444
Did not want to take stairs	.01	.082
Supervisor said not to leave	.07	.251
Friends/co-workers not leaving	.05	.219
Waiting for more information	.07	.251
Other reason	.64	.482

Table 15 shows other reasons that participants cited for non-evacuation during an active fire alarm. Some reasons cited were: did not recognize alarm, did not hear the alarm, asleep, knew it was a drill, and always a false alarm.

Table 15

Other reasons cited for not evacuating

- False alarm and I was very sick/asleep
- Airport staff said not to evacuate
- Alarm company working on alarm
- Student pulled alarm
- Burnt popcorn
- Drill
- Evacuating others, then left
- Fire drills
- In charge of ensuring evacuation of building
- Did not hear the alarm
- Did not recognize the alarm
- Knew it was a drill and had too much to do
- Knew it was a drill and it was my planning period
- Knew it was a drill and slept through it
- Testing alarms
- Told it was a test
- To far inside a set of rooms and did not hear the alarm
- Visiting hospital and told to stay where I was
- Did not recognize the alarm. It was a buzz instead of a siren
- It is always a false alarm
- Knew it was a drill
- Knew it was a false alarm or test
- No alarms
- Planned system test
- Sleeping
- Fire alarm broken per maintenance
- Tornado warning at the same time
- Asleep in hotel/alarm had been going off for two hours. After first notification, ignored it
- Late for test, needed to finish getting ready
- Notified false alarm
- Slept through alarm

Table 16 shows the Cronbach's alpha reliability coefficients for the different sections of the fire alarm perceptions survey. The total survey shows a Cronbach's Alpha of .754. However, the sections on attitude and perception show a Cronbach's Alpha of .379 and .585 respectively.

Table 16

Alpha Reliability Coefficients for the Fire Alarm Perceptions Survey

Questionnaire Domains	Cronbach's Alpha
Total Survey	.754
Demographics	.803
History of experiences	.084
Attitude	.379
Perception	.585

Chapter 5

Summary, Conclusions, Implications, and Recommendations

Purpose of the Study

The purpose of this study was to identify building occupant's attitudes about fire alarm initiated evacuations. It examined attitudes based on gender, faculty, staff, students, age, instances of personal fire loss, and instances of fire loss among people participants know to determine if there was a difference when occupants chose to evacuate a building when a fire alarm was activated.

Research Questions

The following research questions were used in this study:

1. What is the relationship, if any, between building occupant attitudes and nuisance fire alarms?
2. What is the relationship, if any, between building occupant attitudes and evacuation of a building during a fire alarm?
3. What is the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations?

4. What is the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations?

This chapter includes a summary, conclusions, implications, and recommendations.

The results of this study establish a basis for more in-depth research and study.

Summary

The first component of this study was to research the literature for the history of firefighting in America, history of fatal fires, history of fire alarms and sprinkler systems, studies related to false alarms and nuisance alarms, studies related to delayed evacuations and fatal fires in dormitories and fraternities. The second component was to develop a survey that would capture demographics, the history of evacuations of the participant, their perceptions and attitudes regarding nuisance fire alarms and evacuations of buildings. The third component was to have the survey accessed for reliability and content validity. The fourth component was to implement the survey and to assess the results.

For the second component, the survey was developed by the researcher and modified for clarity and completeness based on input from the dissertation committee. The questions of the survey were then reviewed by the use of a Q-sort technique by three safety professionals. The survey was then distributed via email with assistance from the Auburn Institutional Research Department, and an Auburn University email directory named the Grad List serve. The result was 297 responses with 295 being complete.

Conclusions

The main theory of this researcher was that individuals that have experienced a fire loss or a person who knew someone with a fire loss would be more likely to evacuate a building when a fire alarm activated every time, regardless of whether the fire alarm was due to a fire or for some other reason.

Research Question 1, what was the relationship, if any, between building occupant attitudes and nuisance fire alarms, showed significance for participants who had not had a fire loss but knew someone who did. It was also statistical significance ($p < .05$) for those who had no fire loss and did not know anyone with a fire loss. The literature review did not show this as a variable in the studies. The statistical significance provided a new variable for future research.

Research Question 2, what was the relationship, if any, between building occupant attitudes and evacuation of a building during a fire alarm, showed no statistical significance amongst the participants. The literature review did show research where occupants do not react immediately to an alarm.

Research Question 3, what was the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations, showed no statistical significance. The literature review did not show this as a variable used in previous studies.

Research Question 4, what was the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations, showed no statistical significance. The literature review did not show this as a variable used in previous studies.

Implications of the Study

The major implication of the study showed statistical significance ($p < .05$) between building occupant attitudes and nuisance fire alarms for participants who had not had a fire loss but knew someone who did. It was also statistically significant ($p < .05$) for those who had no fire loss and did not know anyone with a fire loss. These findings contributed to expanding the literature relating to attitudes and perceptions about fire alarms. The findings provided additional information for college and university communities and how they view fire alarms. The information can be used for future development of fire safety training and in the development of fire alarm systems (sounds used for the notification of emergency).

Recommendations for Further Study

Although the survey was developed it did not have a strong Cronbach's Alpha for the various sections such as perception (.585) and attitude (.379). It is recommended that the questions be reviewed and perhaps additional questions added in those sections to strengthen the content validity of the survey. Questions that were not agreed on during the Q-sort by the safety professionals should be re-evaluated and rewritten as needed.

A further study and understanding of when and why people evacuate a building during a fire alarm would facilitate in the types of fire safety training people should receive concerning fire alarms and evacuation. It may also provide information to the fire alarm industry for future alarm improvements (fire alarm with horn/strobe vs. fire alarm with horn/strobe and voice). Also, to have 40.7% of faculty, 31.9% of staff and 45.2% of students stay in a building with an active fire alarm sounding should be

investigated more fully. For example, it would be interesting to see at what age it appears that people start to ignore the fire alarm. Since they are mandated to evacuate in K-12, at what age does the change take place? If the penalties were enforced such as arrest or fines for non-evacuation, would that increase the evacuation percentage? One of the prevailing reasons listed for non-evacuation was it is usually a false alarm (26.9%). How is this being addressed in the colleges to increase evacuation?

With the growth of international students, which represented 6.4% of the participants in this research study, it would be recommended to seek more information from the international communities to determine their attitudes and perceptions to evacuations. There is possibly a wealth of information to be collected and analyzed here, such as, do their home countries have fire drills, what type of fire safety information do they receive in school, if any?

More information needs to be collected from those living in dorms (13.1%). Fraternities were not represented in these numbers and the timing of the release of the survey impacted this area. The survey was released at the end of the fall semester at the time of finals. The survey should be administered at the beginning of the fall semester or spring semester to obtain more participation from this group.

This study drew upon the strands of perception and attitude. Further study based upon additional strands such as social influence, group behavior, perception of time for evacuation, may prove valuable.

Race was not used as a variable since it was not referenced in previous literature studies but future studies may want to include this information as it may prove to be a

factor not considered previously. Also, a more targeted study to the disabled community might be interesting as well. Only fourteen of the two hundred and ninety-three participants reported a disability. Further studies should include a more targeted approach to receive feedback from the disabled community since the input could have a direct bearing on training needed for this population in the college/university setting.

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Appendices

Appendix A

Fire alarm perceptions survey

1. My age is: _____

2. I am:
   - o Faculty
   - o Staff
   - o Student
   - o Other

3. My gender is:
   - o Male
   - o Female

4. I am from:
   - o The United States
   - o The International Community

5. What best describes your living situation?
   - o I live in a dorm
   - o I live in a fraternity house
   - o I live off campus

6. If you are faculty/staff: how many years have you worked at the university?
   _____

7. If you are a student, what year are you in?
   - o Not applicable
   - o Freshman
   - o Sophomore
   - o Junior
   - o Senior
   - o Master's student
   - o PhD student

8. I have a physical impairment
- o Not applicable
- o Deaf or hard of hearing
- o Legally blind
- o Mobility impairment
- o Other type of impairment

9. Do you know what a fire drill is?
   - o Yes
   - o No

10. I have participated in fire drills at:
    - o In school (K-12)
    - o International school
    - o Job
    - o Other
    - o I have not participated in a fire drill

11. Have you ever stayed in a building when the fire alarm was going off?
    - o Yes
    - o No

12. If you did not evacuate the building, what was the reason for not evacuating?
    - o I had work to complete
    - o It is usually a false alarm
    - o Did not want to take the stairs
    - o My supervisor told me not to leave
    - o My friends/co-workers were not evacuating
    - o I wanted to wait for more information
    - o Other _____

13. Have you ever been in a fire or had a fire loss (house, car, other)?
    - o Yes
    - o No

14. Have you known someone who has been in a fire or had a fire loss?
    - o Yes
    - o No

15. How many times in the last MONTH have you evacuated a building due to a fire alarm?
    - o 0
    - o 1
    - o 2
    - o 3
    - o 4+

16. How many times in the last Year have you evacuated a building due to a fire alarm?
    - o 0
    - o 1
    - o 2
    - o 3
    - o 4+

17. How many times in the last Year did you evacuate a building because there was an actual fire?
    - o 0
    - o 1
    - o 2
    - o 3
    - o 4+

18. How many times in the last Year were you evacuated from a building for a reason besides a fire?
    - o 0
    - o 1
    - o 2
    - o 3
    - o 4+

19. Thinking about the question above, were you told the reason for the evacuation(s)?
    - o Yes
    - o No
    - o Not applicable

20. Are any of the reasons for the evacuation(s) listed below?
    - o Malfunctioning alarm
    - o Cleaning
    - o Maintenance
    - o Construction
    - o Burnt popcorn
    - o Cooking
    - o Steam
    - o Other
    - o Not explained
    - o Not applicable

21. Did the fire alarm in the building you were evacuated from have a horn only sound (beep, beep)?
    - o Yes
    - o No
    - o Don't remember
    - o No fire alarm in the building
    - o Not applicable

22. Did the fire alarm in the building you were evacuated from have a voice message and a horn/strobe alarm? For example: "Beep, beep, beep, a fire emergency has been detected, please leave the building through the nearest exit. Beep, beep, beep"
    - o Yes
    - o No
    - o Don't remember
    - o No fire alarm
    - o Not applicable

23. A fire alarm with a voice message and a horn/strobe alarm would make it easy to know I should evacuate the building.
    - o Strongly disagree
    - o Disagree
    - o Neither agree nor disagree
    - o Agree
    - o Strongly agree

24. When a horn/strobe goes off in a building, I know that I should evacuate because there is a fire emergency.
    - o Strongly disagree
    - o Disagree
    - o Neither agree nor disagree
    - o Agree
    - o Strongly agree

25. If I hear/see a fire alarm; I evacuate the building immediately
    - o Strongly disagree
    - o Disagree
    - o Neither agree nor disagree
    - o Agree
    - o Strongly agree

26. If I hear/see a fire alarm; I wait for more information
    - o Strongly disagree
    - o Disagree
    - o Neither agree nor disagree
    - o Agree
    - o Strongly agree

27. If I hear/see a fire alarm; I wait to see if other people are going to evacuate
    - o Strongly disagree
    - o Disagree
    - o Neither agree nor disagree
    - o Agree
    - o Strongly agree

28. If I hear/see a fire alarm; I stay at my desk and work
    - o Strongly disagree
    - o Disagree
    - o Neither agree nor disagree
    - o Agree
    - o Strongly agree

29. If I hear/see a fire alarm, and I know there is no fire, it is ok to not evacuate.
    - Strongly disagree
    - Disagree
    - Neither agree nor disagree
    - Agree
    - Strongly agree

30. People should evacuate when a fire alarm sounds
    - Strongly disagree
    - Disagree
    - Neither agree nor disagree
    - Agree
    - Strongly agree

31. Fire alarms are designed to keep us safe.
    - Strongly disagree
    - Disagree
    - Neither agree nor disagree
    - Agree
    - Strongly agree

Appendix B

Panel member's professional positions for Q-sort technique

Member 1: Fire Safety Professional Auburn University

Member 2: Radiation Safety Professional Auburn University

Member 3: Fire Alarm Professional Simplex Grinnell

Appendix C

IRB Application

AUBURN UNIVERSITY INSTITUTIONAL REVIEW BOARD for RESEARCH INVOLVING HUMAN SUBJECTS

REQUEST FOR EXEMPT CATEGORY RESEARCH

For Information or help completing this form, contact: **THE OFFICE OF RESEARCH COMPLIANCE**, 115 Ramsay Hall
Phone: 334-844-5966 **e-mail:** IRBAdmin@auburn.edu **Web Address:** http://www.auburn.edu/research/vpr/ohs/index.htm

Revised 2/1/2014 Submit completed form to IRBsubmit@auburn.edu or 115 Ramsay Hall, Auburn University 36849.

Form must be populated using Adobe Acrobat / Pro 9 or greater standalone program (do not fill out in browser). Hand written forms will not be accepted.

Project activities may not begin until you have received approval from the Auburn University IRB.

1. **PROJECT PERSONNEL & TRAINING**

PRINCIPAL INVESTIGATOR (PI):

Name MaryAnn May Title PhD Student Dept./School EFLT

Address 305 South Central Avenue AU Email mzm0036@auburn.edu

Phone 334-734-1715 Dept. Head Sherida Downer

FACULTY ADVISOR (if applicable):

Name James Witte Title Professor Dept./School EFLT

Address 4010 Haley Center

Phone 334-844-3054 AU Email witteje@auburn.edu

KEY PERSONNEL: List Key Personnel (other than PI and FA). Additional personnel may be listed in an attachment.

Name	Title	Institution	Responsibilities

KEY PERSONNEL TRAINING: Have all Key Personnel completed CITI Human Research Training (including elective modules related to this research) within the last 3 years? ☑ YES ☐ NO

TRAINING CERTIFICATES: Please attach CITI completion certificates for all Key Personnel.

2. **PROJECT INFORMATION**

Title: Building Occupant Evacuation Response to Multiple Perceived False Fire Alarms

Source of Funding: ☑ Investigator ☐ Internal ☐ External

List External Agency & Grant Number:

List any contractors, sub-contractors, or other entities associate with this project.

List any other IRBs associated with this project (including those involved with reviewing, deferring, or determinations).

FOR ORC OFFICE USE ONLY

DATE RECEIVED IN ORC: _____ by _____ APPROVAL # _____

DATE OF IRB REVIEW: _____ by _____ APPROVAL CATEGORY: _____

DATE OF ORC REVIEW: _____ by _____ INTERVAL FOR CONTINUING REVIEW : _____

DATE OF APPROVAL: _____ by _____

COMMENTS:

3. **PROJECT SUMMARY**

a. **Does the research involve any special populations?**

- ☐ YES ☑ NO **Minors (under age 19)**
- ☐ YES ☑ NO **Pregnant women, fetuses, or any products of conception**
- ☐ YES ☑ NO **Prisoners or Wards**
- ☐ YES ☑ NO **Individuals with compromised autonomy and/or decisional capacity**

b. **Does the research pose more than minimal risk to participants?** ☐ YES ☑ NO

Minimal risk means that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests. 42 CFR 46.102(i)

c. **Does the study involve any of the following?**

- ☐ YES ☑ NO **Procedures subject to FDA Regulation** Ex. Drugs, biological products, medical devices, etc.
- ☐ YES ☑ NO **Use of school records of identifiable students or information from instructors about specific students**
- ☐ YES ☑ NO **Protected health or medical information when there is a direct or indirect link that could identify the participant**
- ☐ YES ☑ NO **Collection of sensitive aspects of the participant's own behavior, such as illegal conduct, drug use, sexual behavior or use of alcohol**
- ☐ YES ☑ NO **Deception of participants**

If you checked "YES" to any response in Question #3 STOP. It is likely that your study does not meet the "EXEMPT" requirements. Please complete a PROTOCOL FORM for Expedited or Full Board Review.
You may contact IRB Administration for more information. (Phone: 334-844-5966 or Email: IRBAdmin@auburn.edu)

4. **PROJECT DESCRIPTION**

a. **Subject Population** (Describe, include age, special population characteristics, etc.)

The population for this study is comprised of faculty, staff, and students of Auburn University.

b. **Describe, step by step, all procedures and methods that will be used to consent participants.**

☐ **N/A (Existing data will be used)**

1) Data gathering will be cordinated through the Office of Institutional Research.
2) Participants will do the survey online anonymously.
3) The data participants provide through online Qualtrics survey will serve as an agreement to participate in the study.

c. **Brief summary of project.** (Include the research question(s) and a brief description of the methodology, including recruitment and how data will be collected and protected.)

Research Questions

1) What is the relationship, if any, between building occupant attitudes and nuisance fire alarms?
2) What is the relationship, if any, between building occupant attitudes and evacuation of a building during a fire alarm?
3) What is the relationship, if any, between building occupants who have experienced a fire loss and their response to nuisance fire alarms and building evacuations?
4) What is the relationship, if any, between building occupants who have known someone who has experienced a fire loss and their response to nuisance fire alarms and building evacuations?

Methodology

Current Auburn University faculty, staff and students will be selected as possible participants. Participants who decide to participate in this research study will be asked to take an anonymous online survey through Qualtrics. The total time commitment will be approximately 5-10 minutes. Participation in this study is completely anonymous and voluntary. Confidentiality will be maintained for all responses. Data collected will remain anonymous. Participants can withdraw from the survey at any time by closing the browser window if they feel uncomfortable during the survey. Once they have submitted anonymous data, it cannot be withdrawn since it will be unidentifiable.

The principal investigator will oversee data collection process and protection throughout this study. The principal investigator will analyze and store all data using the VPN client software, SPSS and Microsoft Office. All electronic equipment needed for this project will be password protected.

d. **Waivers. Check any waivers that apply and describe how the project meets the criteria for the waiver.**

- ☐ **Waiver of Consent (Including existing de-identified data)**
- ☑ **Waiver of Documentation of Consent (Use of Information Letter)**
- ☐ **Waiver of Parental Permission (for college students)**

I am seeking a waiver of documentation of consent in order to utilize an information letter.

e. **Attachments. Please attach Informed Consents, Information Letters, data collection instrument(s), advertisements/recruiting materials, or permission letters/site authorizations as appropriate.**

Signature of Investigator _____ Date 8-25-15

Signature of Faculty Advisor _____ Date 9-30-2015

Signature of Department Head Sherida Downer _____ Date 9-10-15

Appendix D

Informational Letter

AUBURN UNIVERSITY
COLLEGE OF EDUCATION
EDUCATIONAL FOUNDATIONS, LEADERSHIP AND TECHNOLOGY

(The Auburn University Institutional Review Board has approved this document for use from November 9, 2015 to November 8, 2018. Protocol # 15-424 EX 1511.)

INFORMATION LETTER

"Building Occupant Evacuation Response to Multiple Perceived False Fire Alarms"

You are invited to participate in a research study to investigate *Building occupant evacuation response to multiple perceived false fire alarms.* This study is being conducted by MaryAnn May, graduate student of the Department of Educational Foundations, Leadership, and Technology at Auburn University, under the direction of Dr. James Witte, a professor of the Department of Educational Foundations, Leadership, and Technology at Auburn University. You were selected as a possible participant because you are currently enrolled or employed by Auburn University.

If you decide to participate in this research study, you will be asked to take an anonymous online survey through Qualtrics. Your total time commitment will be approximately 5-10 minutes.

Your participation in this study is completely anonymous and voluntary. There are no foreseeable risks associated with this study. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any time by closing your browser window. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate will not jeopardize your future relations with the Department of EFLT and Auburn University.

There will be no costs to participants or compensation. Information collected through your participation may be used for publication or professional presentation.

If you have any questions about this study, please contact MaryAnn May at mzm0036@auburn.edu

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334) 844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu

4036 Haley Center, Auburn, AL 3684-5221; Telephone: 334-844-4460: Fax: 334-844-3072

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HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. YOU MAY PRINT A COPY OF THIS LETTER TO KEEP.

*MaryAnn May*_____ *November 12, 2015*_

Investigator's signature Date

MaryAnn May_____

Print Name

Follow the link to take the survey:

https://auburn.qualtrics.com/SE/?SID=SV_bxW85m5rDFYaIpn