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Nuclear Facility Emergency Management: Effective Implementation of Training, Drills, and Exercises

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Walden University
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Abstract

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By

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MS, Columbia Southern University, 2015

BS, Columbia College, 2010

Dissertation Submitted in Partial Fulfillment

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Doctor of Philosophy

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Abstract

The continuous availability of affordable and sustainable energy is the essence of modern economies, not only in the developed countries, but also in developing countries. However, nuclear power also has considerable public health and safety hazards that create emergency situations that must be responded to urgently and effectively. It is necessary that every player in the nuclear industry implements effective training, drills, and exercises to ensure emergency preparedness and response in line with the federal requirements. The normalization process theory was applied in this qualitative, single case study to address the key factors needed for effective training, drills, and exercises in nuclear facilities. The guiding questions for this study related to understanding the experiences of first responders and staffs at nuclear facilities; implementation problems experienced; strategies used in the implementation; and the impact of training, drill, and exercise programs in sustainability issues. The participants were 13 employees of a nuclear power plant in the southeastern United States who had worked at the facility for at least 6 months. Data were collected through questionnaires and interviews and coded using NVivo before being thematically analyzed. The key finding was that there is a need to review the emergency preparedness policy and plans to meet the threshold of real emergencies. The implications of the findings for positive social change are that they demonstrate the need to review the existing policies, training, drill, and exercise programs, which will, in turn, help the organization to meet the threshold.

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Dedication

This dissertation is dedicated to my children, Marquis and Deshia. I hope that by witnessing and being a part of this endeavor, you have seen that any goal you set for yourself is achievable through commitment, hard work, discipline, and perseverance. “The dictionary is the only place that success comes before work. Work is the key to success, and hard work can help you accomplish anything.” ― Vince Lombardi

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Chapter 1: Introduction to the Study

Study Overview and Background

Effective emergency management planning in all nuclear facilities is an important measure for protecting the public (Nuclear Energy Institute [NEI], 2016). Adequate emergency preparedness planning is an indication that an organization or an industry is ready to minimize the impact of any crisis that may arise and protect the safety and health of the population during emergency situations (Coombs, 2014). A training, drill, and exercise program is an example of emergency preparedness techniques used in nuclear facilities. Proper planning, adequate training of the emergency responders, and development of an emergency response framework has been found to be an effective way of strengthening emergency preparedness and response to nuclear facility related situations (Perry & Lindell, 2003).

The Savanah River Site Nuclear plant, for example, is one of the nuclear facilities that continues to offer training, drills, and exercises to their first responders and the community living around the site. Despite existing for many years, the effectiveness of the program in improving emergency preparedness, especially as a result of poor implementation, has been in question (Office of Enterprise Assessments [OEA], 2018). This has led to inadequate emergency preparedness and the inability to effectively respond to real, occurring emergencies, posing a potential risk that can result in serious problems, such as the loss of lives and destruction of properties (Defense Nuclear Facilities Safety Board [DNFSB], 2015; OEA, 2018).

Similarly, Turcanu et al. (2016) found that there is a continuous need for more effective training, practical sessions, and discussions involving emergency preparedness, response, and recovery. By focusing on the implementation of the training, drill, and exercise program, this study has the potential to provide a solution to the problem and strengthen emergency preparedness and response, which would save many lives and prevent the loss of property.

An example of the ramifications of nuclear facilities lacking adequate preparation to mitigate possible consequences of nuclear accidents would be the Fukushima Daiichi nuclear power accident, which resulted in land contamination, long-term relocation of many people, loss of productive farming areas, loss of land for industrial production, and significant loss of electric capacity (Denning & Mubayi, 2017). Poor emergency preparedness presents unique challenges that put the facilities at risk of experiencing such consequences in the future. Adequate training, drills, and exercises present an opportunity to strengthen emergency preparedness and reduce these risks.

According to Castro and Mederios (2015), nuclear emergency planning is another key area that is likely to improve emergency preparedness if strengthened. performance indicator applicable to nuclear energy exercises and responsible for the evaluation of nuclear plants. It is one of the performance indicators applicable to nuclear energy exercises and an important level of defense in ensuring safety of people during emergency situations (Castro & Mederios, 2015). An efficient emergency preparedness management system should, therefore, have well-designed and efficiently executed plans.

In this study, I explored the perspectives of individuals involved in the training, drill, and exercise program at a nuclear facility to establish best practices for implementing and integrating the training, drill, and exercise program into people's daily activities. Developing these best practices will ensure that sustainable emergency preparedness and response practices are adopted by both the site's first responders and the people living near the nuclear facility.

Gap in Research Knowledge

Through reviewing the literature on this topic, I found that several researchers have investigated this problem by particularly focusing on the awareness and development of emergency preparedness plans and exercises (CastroSilva & Mederios, 2015; Malesic et al., 2015; Zablotska, 2016) and protection of the public (Domeneghetti et al., 2017; Fisher, 2014; Hammond & Bier, 2015; Katona & Vilimi, 2017; Na & Lee, 2016), with little focus on the implementation aspect.

According to Turcanu et al. (2016), there is a continuous need for more effective training, practical sessions, and discussions involving emergency preparedness, response, and recovery. This study filled the gap in research by adding new knowledge of the effective implementation measures by targeting the training, drill, and exercise program conducted by the Emergency Management Team of the nuclear power plant under study located in the southeastern United States. I conducted interviews to explore the perceptions of individuals on this team to have a better understanding of implementation of the training, drill, and exercise program. The implementation areas of focus were the implementation planning and procedures; integration of the program into other existing

programs; sustainability of the program; and the applicability of the types of drills, training, and exercises that are employed.

Problem Statement

Adequate emergency preparedness is an indication of the readiness of an organization or an industry to minimize the impact of a crisis and protect the safety and health of the population during emergency situations (Coombs, 2014). As part of emergency preparedness, the study site nuclear plant continues to employ a training, drill, and exercise program; however, the program has been found to lack effective implementation, leading to inadequate emergency preparedness and an inability to effectively respond to real, occurring nuclear emergencies at the nuclear plant (DNFSB, 2015; OEA, 2018).

According to OEA (2018), the training, drills, and exercises conducted by this nuclear power plant in the southeastern United States are only confined to specific facilities or areas; therefore, they are not sufficient to handle severe incidents or emergencies affecting many facilities or wider areas. These weaknesses in the implementation of an effective training, drill, and exercise program were first reported 5 years back, but until now they have not been fully addressed, posing a great danger to both the site workers and the public (DNFSB, 2015).

The development and maintenance of effective nuclear emergency preparedness plans in every nuclear facility is a legal requirement that aims at protecting the safety of the public (NEI, 2016). Therefore, the lack of effective implementation of training, drills, and exercises at the study site nuclear plan nuclear power plant in the southeastern United

States poses risk of serious ramifications, which could result in the loss of many lives and destruction of properties if not immediately addressed.

Purpose Statement

The purpose of this qualitative study was to examine the perceptions of individuals regarding the processes involved in the implementation of the training, drills, and exercises at a nuclear power plant in the southeastern United States. The major themes examined in the study include implementation strategies as well as challenges facing and the sustainability of the trainings, drills, and exercises for adequate nuclear emergency preparedness.

Research Questions

RQ1: What key implementation problems experienced in the training, drill, and exercise program conducted by the nuclear plant arise from the three concepts (i.e., implementation, embedding, and integration) of the normalization process theory (NPT)?

RQ2: What are the experiences of emergency first responders and the staff involved in the trainings, drills, and exercises in nuclear emergency preparedness and response?

RQ3: What strategies used by the nuclear plant in the implementation of training, drill, and exercise program are effective in strengthening emergency preparedness and response?

RQ4: How does the training, drill, and exercise program at the nuclear facility address sustainability issues for adequate emergency preparedness and response?

Theoretical Framework

In this study, I applied the NPT as the theoretical framework. This theory addresses the key factors needed for the effective implementation of interventions, integration of the interventions into people's daily activities, and effective monitoring and evaluation strategies (Murray et al., 2010). According to May et al. (2009), the NPT focuses on three major implementation areas: implementation of a practice or practices through social organization, embedding a practice or practices into people's daily activities, and integrating the practice or practices in ways that are sustainable and reproducible among organizations and institutions. The NPT is pertinent to this study because it offers theoretical approaches favorable to the implementation of complex interventions, including emergency programs. This theory targets identifying interventions that are sustainable by influencing positive social change. NPT was useful in understanding how the various variables in this study interact with each other.

Nature of the Study

In this study, I employed a qualitative methodology that involved gathering information from selected participants at a nuclear power plant in the southeastern United States. A qualitative research methodology majorly focuses on the meaning, concepts, and description of the topic of study based on people's perceptions, feelings, and opinions (Jamshed, 2014). It was, therefore, the most appropriate methodology for this research because the study's focus was on collecting information that is not numerical in nature. This methodology was effective in gathering information, such as the implementation strategies used when executing training, drills, and exercises; the

strengths and weaknesses related to the implementation of the program; and possible recommendations to policy makers and implementers of the program. The qualitative method also allowed for flexibility in the type of data collected by using nonstructured or semistructured questionnaires. A qualitative approach also allows the researcher to ask the respondent probing questions during the interview for clarification and more information.

In addition, I employed a single case study design. According to Crowe et al. (2011), a case study approach is particularly relevant when there is a need to gain an in-depth understanding of a problem or a phenomenon of interest in the context of its natural, real-life existence. A case study is an established research approach that has been widely applied across disciplines to understand a complex issue in its real-life context (Crowe et al., 2011). The techniques used in this design, such as key informant interviews and in-depth interviews, were achieved through the use of qualitative research methodology.

Definition of Terms

In order to ensure that there is a common understanding of the terms used in this study, I have provided the following definitions for the terms that are not accompanied by any references.

Emergency preparedness: The capability to take actions that will effectively mitigate the consequences of an emergency for human health and safety, quality of life, property, and the environment (Canon & Schipper, 2015).

Nuclear emergency planning: Specifying response mechanisms that should be followed in an event of a nuclear accident or emergency (NEI, 2016).

Nuclear emergency: A nonroutine situation or event that necessitates prompt action, primarily to mitigate a hazard or adverse consequences for human health and safety, quality of life, property, or the environment (Canon & Schipper, 2015).

Nuclear or radiological accident: Any unintentional event involving facilities or activities from which a release of radioactive material occurs or is likely to occur, and the consequences or potential consequences of which are not negligible from the point of view of protection or safety (Canon & Schipper, 2015).

Assumptions of the Study

In this study, I assumed that the respondents participated in the process with total honesty. This assumption ensured that the information provided by the sample population represented the opinions of others who did not participate.

Another assumption was that all participants had sincere interest in being a part of the study and did not participate with other motives in mind. This assumption was necessary in order for the respondents to provide honest responses.

Scope and Delimitations of the Study

This study covered emergency preparedness management at a nuclear power plant in the southeastern United States with a focus on possible challenges to effective implementation of training, drills, and exercises. This nuclear plant was purposively selected for this study because the facility has for over 5 years failed to achieve adequate nuclear emergency preparedness and response despite implementing a training, drill, and

exercise intervention program to address the problem (see DNFSB, 2015). The study was focused on the planning, implementation, and sustainability of the program because these areas determine the effectiveness of a program.

I conducted this study in one nuclear facility and was limited to the first responders and officials involved in the implementation of training, drills, and exercises. Therefore, the findings of this study are only applicable to this nuclear power plant in the southeastern United States and other nuclear power and radiological plants with similar characteristics that offer the same program. Because the number of potential participants was large, I only included the nuclear plant's officials involved in the implementation of the program and the site's first responders.

Limitations of the Study

Due to the uniqueness and size of the available sample, the results of this study may not be generalizable to populations other than the one from which the sample was drawn. Further research in other facilities will, therefore, be required to compare research findings and have a broader understanding of the situation.

Because the study included actual implementers of the program, the sample participants might not have provided accurate responses, thus their opinions may not reflect those of the other members of the organization. This limitation was minimized by assuring all participants of their confidentiality at all stages of the research process. I had no direct relationship with the federal security specialist at the site or the study participants that had the potential of imparting bias on the research study. All the respondents were treated equally, and there was strict adherence to the principles of

research ethics, including justice, beneficence, and respect of autonomy, to avoid any potential biases.

A third limitation of the study was that not all data were collected using interviews. An advantage of using interviews as a method of data collection is that it allows room for the researcher to probe the respondent for more information and accurate answers. However, in this study, the interviews were only conducted with the three key informants. The other participants, the emergency first responder and the facility staff members, only responded to the questionnaire. My decision to use the questionnaires was informed by the fact that it was a cheap and efficient alternative to interviews. The need to collect such a large amount of data from the many respondents made it necessary to consider the use of questionnaires over the interviews. Furthermore, the use of questionnaires was facilitated by the need to abide by the COVID-19 guidelines that required minimum human interactions. As such, the use of questionnaires was considered safer because I could not be present in the same space when the respondent was completing the questionnaire. The fact that the majority of the study participants responded to the questionnaire and not in interviews limited the possibility of obtaining more information because I was not able to probe the respondents for clarification or more information in their responses to the questionnaires. The lack of interviews conducted may further limit this study in that the respondents did not have the opportunity to seek clarification about unclear questions. This means that the respondents answered the questionnaires based on their interpretation of the questions, which puts the validity of the study at risk.

Significance of the Study

The findings from this study were useful in identifying effective ways of implementing training, drills, and exercises at nuclear facilities. The results add new knowledge that bridges the research gap in exploring the best implementation strategies of trainings, drills, and exercises to strengthen nuclear emergency preparedness (see Turcanu et al., 2016). The study will also be helpful in equipping first responders and employees of the study site nuclear plant with adequate knowledge of the emergency preparedness requirements and procedures, possibly preventing disastrous outcomes in the event of a nuclear emergency.

By examining the perceptions of individuals on the various ways in which a training, drill, and exercise program can be integrated into people's daily activities, this study has the potential of contributing knowledge that can be useful in achieving adequate emergency preparedness and response. This positive social change will ensure that sustainable emergency preparedness and response practices are adopted by both the site's first responders and the people living near the nuclear facility.

Summary

In this qualitative study, I sought to identify the challenges related to the implementation of a training, drill, and exercise program at a nuclear power plant in the southeastern United States. The participants were implementers of the program, site first responders, and emergency first responders attached to the facility. Researchers have found that training, drills, and exercises have a potential of strengthening emergency preparedness at nuclear power facilities; however, several nuclear plants have been

unable to effectively implement the program, leading to increased risk of loss of life and property in emergency situations (NRC, 2014).

This study particularly focused on establishing an effective way of implementing training, drills, and exercises at the study site nuclear plant, an area that has not been adequately covered by researchers. The results of this study may be useful to multiple stakeholders, including the nuclear plant's program implementers, first responders, the population living around the facility, and the DNFSB.

In Chapter 2, I provide a comprehensive literature review on emergency preparedness management at nuclear facilities and particularly focus on the research gap related to the implementation of training, drills, and exercises.

Chapter 2: Literature Review

An effective training, drill, and exercise program is a key component of a nuclear emergency preparedness plan aiming to protect the safety of the public. Weaknesses in the implementation of the program have been reported as a major shortcoming in achieving adequate preparedness and the ability to properly respond to nuclear emergencies (Zablotska, 2016). The study site nuclear power plant in the southeastern United States, for example, has a training, drill, and exercise program that is confined to specific facilities and is not sufficient to handle severe incidents or emergencies affecting many facilities or wider areas (DNFSB, 2015; NEI, 2016; OEA, 2018). This has for many years hindered the facility's ability to respond to real, occurring nuclear emergencies. If not immediately addressed, it poses a potential for serious ramifications that could result in the loss of many lives and the destruction of properties.

The purpose of this study was, therefore, to examine the perceptions of individuals regarding the processes involved in the implementation of the training, drills, and exercises at a nuclear plant in the southeastern United States. The major themes examined in the study include implementation strategies as well as the challenges and sustainability of the trainings, drills, and exercises for adequate nuclear emergency preparedness. The objective of this chapter is to present the recent literature on the use of training, drills, and exercises in strengthening nuclear emergency preparedness. The chapter is divided into five key sections.

In the first section, I describe the literature search strategy used for the study. This includes a list of the library databases and search engines used, the key search terms and

concepts, and the process followed during the search. The second section contains a discussion of the selected theoretical framework that guides the various aspects of the study. This section addresses the rationale for selecting the theory and how it relates to the study topic. The third section includes the presentation of an exhaustive review of current studies on the key variables, including literature on nuclear and radiological emergency preparedness and response. In the next section, I review existing literature on the effectiveness of training, drill, and exercise programs, with a focus on the program coverage, the implementation procedures involved, and the key challenges encountered when implementing the programs. The last section concludes the chapter with a summary of the key findings in the literature and includes a discussion of what is known, unknown, and how the present study fills the identified gaps and challenges.

Literature Search Strategy

I commenced the literature search strategy for this study by conducting a preliminary search on Google Scholar to identify key concepts, words, and terms to address the research questions. The key concepts and words identified included *nuclear emergency, radiological emergency, emergency preparedness and response, implementation, drill, training, and exercises, NPT,* and *normalization process theory*. The databases and resources searched for relevant literature included SAGE Journals, Taylor and Francis Online, PubMed database, BioMed Central, Science Open, Science Direct, and Walden University Library Public Policy and Administration database. The identified concepts and terms were entered into the selected databases to search. Research papers that proved irrelevant from their abstracts were automatically excluded from the

study. Because the topic of study had not been extensively researched, I did not limit the search to a specific discipline or timeline. All published academic literature on nuclear emergency or radiological emergency were considered.

Theoretical Foundation

Theories are indispensable tools for understanding and explaining certain phenomena. Implementation theories are specifically concerned with exploring implementation-related problems, such as factors influencing the incorporation of desired practices into people's everyday life. This study was founded on the NPT, which was developed by May et al. (2009) to address various implementation challenges. The theory was originally designed for use in the health care setting and has its roots in the normalization process model, a model that explains the process of embedding innovative health technologies through sociological processes (May et al., 2007). Unlike the normalization process model, the NPT has been modified for use in different fields of research, including qualitative research projects in different disciplines.

The NPT facilitates the understanding of complex interventions by focusing attention on three key problems: implementation, embedding, and integration (May et al., 2009). In the theory, May et al. (2009) explained how implementers put interventions into action, how they are embedded into people's everyday life, and how they can be integrated into the social matrices of institutions or organizations to make the practices reproducible and sustainable.

Theoretical Propositions and Assumptions

According to May et al. (2009), NPT has three major propositions. Firstly, it proposes that complex interventions become routinely embedded into people's routine practice as a result of people working individually and collectively to achieve them. Secondly, implementation occurs through four mechanisms: coherence, cognitive participation, collective action, and reflexive monitoring. These four mechanisms can universally be applied to understand the inhibitors and promoters of implementation. Lastly, integration of a complex intervention requires a continuous investment that can be achieved through commitment, effort, and appraisal. All stakeholders involved in the implementation of an intervention, therefore, have a responsibility to work as a team and with more focus on the beneficiaries who must incorporate the practices into their routine life for the intervention to be effective and sustainable.

May et al. (2009) also identified three assumptions concerning the theory. Firstly, coherence, cognitive participation, collective action, and reflexive monitoring are the four key constructs representing generative mechanisms and are the means by which social goals are achieved and, in turn, are the foci of contests and conflicts. Secondly, the fact that individual and collective contributions are interdependent is assumed in the theory. The last assumption in this theory is that its mechanisms are constrained and released by the operation of norms and conventions or processes, and the notions of how beliefs, behaviors, and actions should be accomplished versus how they are practically accomplished (May et al., 2009).

By focusing on these three factors, the theory offers favorable approaches to understanding the various factors that promote or inhibit the normalization of desired practice or practices. Therefore, the NPT provides an effective framework that can be used as a guideline for implementation, monitoring, and evaluation of complex interventions, such as nuclear emergency preparedness training, drills, and exercises.

Applicability of the NPT

The NPT has successfully been applied in several qualitative research studies. For example, McNaughton et al. (2019) applied the theory in a qualitative study aimed to understand the various factors influencing the experience of and engagement with a National Health Service Health Check Program. They applied NPT across its life course to inform the choice of research design; formulation of research questions; and identification of key indicators at the design stage, data analysis, and interpretation (McNaughton et al., 2019). This approach was similar to how the NPT applied to the present study.

In another study, Leesa et al. (2015) applied the NPT to understand the barriers and facilitators of implementing an enhanced screening model into Maternal and Child Health nurse clinical practice. The researchers used the four NPT constructs of coherence, cognitive participation, collective action, and reflexive monitoring to successfully derive and analyze outcome indicators for effective implementation of the program (Leesa et al., 2015).

Similarly, Agreli et al. (2019) applied NPT to understand the implementation process of infection prevention and control (IPC) guidelines in Ireland and specifically to

formulate research questions and interpret the results during the analysis. The authors identified coherence, cognitive participation, collective action, and reflexive monitoring as the four major themes influencing implementation of the IPC program (Agrieli et al., 2019). This is an indicator that NPT is a valuable tool in identifying the factors that inhibit or promote the processes of implementing, monitoring, or evaluating a project.

Moreover, Glynn et al. (2018) successfully applied NPT as theoretical framework in a qualitative research study that used a SMART MOVE trial to understand the potential implementation promoters and barriers to effective implementation of a M-health program. Their research study was conducted in the West of Ireland and included SMART MOVE trial participants, people living around Clare Primary Care Network, and staff from four primary care centers. NPT was used to identify key discussion topics for both in-depth interviews and focus group discussions as well as guided analysis of the resulting data set (Glynn et al., 2018). This same approach was used in in the current research, indicating an absolute similarity.

Furthermore, Gillespie et al. (2018) used a framework derived from NPT to evaluate the implementation of the Surgical Safety Checklist program. The program was introduced in 2008 with an aim of reducing surgery-related mortality and morbidity and improving teamwork among health care professionals. The study was necessitated by the need to evaluate processes involved in its implementation and address the various implementation challenges reported in many health care institutions. In their research, Gillespie et al. (2018) applied the four constructs of the NPT (i.e., coherence, cognitive

participation, collective action, and reflexive monitoring) to explain the respondents' self-reported perceptions of implementation of the program.

Finally, NPT constructs have been applied to identify and explain the various factors that inhibit or promote routine incorporation of complex interventions into people's everyday life. Gould et al. (2016) effectively used the theory in interpreting and explaining findings of their qualitative study evaluating a program targeting the promotion of health workers' ownership of IPC.

In conclusion, the NPT is a midrange theory that has been widely applied and is effective in identifying the various factors inhibiting or promoting implementation and incorporation of complex interventions into people's routine practice.

Rationale for Theory Selection

The rationale for selecting the NPT to explore the processes involved in the implementation of nuclear emergency preparedness training, drills, and exercises was informed by a number of factors. First, NPT provides an explanation of the diverse mechanisms that guide processes involved in implementation of a project. It specifically aligns with the current study because its focus is on observable characteristics. Secondly, the theory is relatively easy to apply, but very effective in explaining interaction among components in complex interventions. This is because the theory groups the processes of effective implementation into three components (i.e., implementation, embedding, and integration), making it easy to formulate research questions and identify their indicators. Lastly, as an implementation theory that has successfully been applied across disciplines and is increasingly being used in many qualitative research studies, NPT provides better

approaches to understanding and exploring the implementation processes at every stage of an intervention.

The current study relates to the NPT in several ways. Firstly, the theory has a similar focus to that of the present study. NPT focuses on explaining the social organization of work during implementation, the process of embedding practices into people's routine life, and how to make the embedded practices sustainable (May et al., 2009). On the other hand, in the current study, I sought to understand the implementation shortcomings of the nuclear emergency preparedness drills, training, and exercises. The theory provided a practical framework for the identification of key study areas, such as the specific objectives, the research questions, their indicators, and how to analyze the generated data. In addition, the present study focused on multiple, interacting components that are all reflected in the NPT framework. I aimed to identify the people involved in the implementation process; the coverage of the emergency preparedness training, drills, and exercises; the procedures followed in the implementation; the implementation challenges faced; and the effectiveness of the program in enhancing nuclear emergency program.

The research questions developed for this study were built on the three components of the NPT: implementation, embedding, and integration. The first research question was directed towards the initial stages of implementation and was intended to identify and address the possible gaps related to area of coverage and stakeholder involvement in the study site nuclear facility emergency preparedness training, drills, and exercises. I developed the second research question to identify and address any possible gaps in the key implementation procedures required to achieve success in implementation

of nuclear emergency preparedness interventions. The third research question was intended to identify the various implementation challenges in the entire process of implementing nuclear emergency preparedness training, drills, and exercises. The last research question was aimed at assessing the effectiveness of the emergency training, drills, and exercises. This question addressed both the embedding and integration of the program by investigating how the program is integrated into other social matrices and how it has been incorporated into people's daily routine.

Nuclear Emergency Preparedness and Response

Nuclear emergency preparedness is a key measure taken to protect the public from radiological exposure and other nuclear related disasters. The World Health Organization (2007) considers level of emergency preparedness and adequacy of emergency response as the major contributing factors to effective disaster management.

Some of the worst nuclear disasters ever recorded in history include the Three Mile Island Nuclear Accident in 1979, Chernobyl in 1986 and more recently the Fukushima Daiichi nuclear disaster in 2011 (Hasegawa et al., 2016). These three nuclear accidents caused massive loss of lives, destruction of properties and relocation of communities. The Fukushima nuclear power accident resulted into the largest discharge of radiation into the ocean killing many aquatic animals and contaminating the ocean water (Hasegawa et al., 2016).

According to International Atomic Energy Agency (2005), an effective nuclear emergency preparedness program should have a number of factors: First, it should have emergency plans and procedures capable of addressing all the potential hazards.

Secondly, it should incorporate training programs which have adequate theoretical and practical courses. Thirdly, for the program to be successful, there should be enough resources to ensure that the program runs smoothly as planned for. Additionally, the program should have a means of testing its effectiveness, this should basically be through continuous drills and exercises. Lastly, the program must have a feedback mechanism to aid in identifying the areas which require improvement.

The Fukushima nuclear accident is the recent incident to catch attention of many governments and researchers who have since put more effort in identifying the various ways of strengthening emergency preparedness and response at nuclear plants. Adalja et al. (2014) for example, conducted a qualitative research using key informant interviews to better understand the dynamics of nuclear preparedness and acquire more knowledge on hazard preparedness. The study focused on emergency preparedness in a 10-mile emergency planning zone surrounding 17 nuclear plants.

In their findings, Adalja et al. (2014) reported that most of the facilities included in the study conducted their nuclear emergency preparedness education and outreach using meetings, calendars, pamphlets, and programs on televisions. The use of modern technology, especially the social media platforms, such as Facebook, Twitter, and WhatsApp were very limited (Adalja et al., 2014). Similarly, Perko et al. (2016) argued that despite the increasing popularity and importance of the social media, the traditional media is still used as the major source and means of disseminating information to the public in cases of radiological and nuclear emergencies. This finding from Perko et al. (2016) was as a result of a research study which adopted both qualitative and quantitative

methodological approaches. The qualitative data for this research was collected through a round table discussion involving 100 communication experts involved in nuclear emergencies. Quantitative data on the other hand was generated from media content analysis of newspapers articles and tweets reporting about Fukushima (Perko et al., 2016).

In another research, Nyaku et al. (2014) found that only 13.6% of the locals trusted the information provided through the internet. The study was carried out to assess the radiation emergency preparedness using Community Assessment for Public Health Emergency Response. Community Assessment for Public Health Emergency Response is an accurate and reliable survey methodology which has been applied in both disaster and nondisaster settings (Nyaku et al., 2014). Compared to the traditional media, social media uses current technology which is fast and reliable hence would be more effective in passing information. Furthermore, based on the lessons learnt from both the Chernobyl and Fukushima nuclear accidents, immediate and comprehensive information is essential in minimizing the impact of nuclear or radiological accidents (Perko et al., 2016). In case of an emergency the first responders should have the information and be able to pass it early enough before many people are affected, this can be possible if new communication technologies are adopted.

In light of these findings, the use of technology, therefore, takes precedence and should be integrated into the current training, drill, and exercise programs. The present study aims to address this gap by helping in generating information which will help implementers to understand how modern technology can be effectively integrated into the

emergency preparedness programs and incorporated in people's daily routine for a faster and more convenient way of responding to emergency situations.

According to Perko et al. (2016), a trans-disciplinary approach which brings together nuclear emergency management team and experts in social sciences and humanities should be embraced at all stages of emergency preparedness and planning. This will ensure that a better approach to information dissemination is adopted and emergency preparedness and response is strengthened. Although the findings by Perko et al. (2016) only reflects results from one nuclear emergency incident, the study included a larger sample size for both the quantitative and qualitative data. Furthermore, by using both qualitative and quantitative approaches for data collection, the researchers were able to complement the quantitative data and have a better interpretation. There is, however, a need to replicate the study using other populations to have a general understanding of the situation.

In a similar research, Jennings et al. (2017) argued that there is need to have an independent in-house information technology (IT) department in the local emergency management agencies. This finding is a result of a survey of local emergency managers in the United States, with focus on the relationship between the existence of an independent IT department within an emergency management agency and the adoption of three types of information and communication technologies, including risk communication, emergency operations, and social media technologies (Jennings et al., 2017). The findings of this study further indicate that emergency management agencies have a higher likelihood of using all the three types of information and communication

technologies if an independent IT department is in-house, confirming the importance of a trans-disciplinary approach in emergency response (Jennings et al., 2017). However, the study has one major limitation, it uses a cross-sectional methodology, therefore, it does not provide information on how the findings might change with time.

In attempt to shed more light on the expertise that public officials working in emergency management require, Yoon and Kim (2015) carried out a Delphi survey with an aim of collecting views of public officials in emergency management regarding the components of the needed expertise. The results of this survey indicated that public officials who are in the central government and are involved in emergency management, considered horizontal collaboration with government organizations as the most essential component of expertise (Yoon & Kim, 2015). On the other hand, public officials working in emergency management in local government identified on the job experience in emergency management the most necessary component (Yoon & Kim, 2015). In terms of the level of emergency management, public officials leading prevention and preparedness identified professional knowledge of emergency management the most important while the officials in charge of response stated that shrewd judgment ability was the most needed skill (Yoon & Kim, 2015). These findings suggest that public officials involved in emergency management must not only have knowledge, but also vast experience to adequately handle emergency situations.

In addition, Adalja et al. (2014) also discovered that effective emergency preparedness and response was hindered by use of emergency exercises and drills which lacked practicality and would not be applicable in real occurring nuclear emergencies.

The exercises did not meet the threshold for real emergencies as they were only concentrated in particular areas and did not include all the key stakeholders due to inadequate collaboration during preparations. The study also identified insufficient emergency preparedness and response resources, and lack of enough qualified radiological staff as the other key challenges inhibiting effective emergency preparedness (Adalja et al., 2014).

One key strength of the study by Adalja et al. (2014) is its inclusion of a relatively larger sample size. However, it had some weaknesses, especially employing a data collection approach which only applied over the phone key informant interviews giving way for recall related biasness. The other weakness of this study is the absence of the community members in the study. The study should have given community members a chance to present their opinion on their interaction with the program to better understand its effectiveness in achieving adequate emergency preparedness and response.

Nuclear Emergency Training, Drills, and Exercises

Nuclear and radiological emergency training, drills, and exercises are commonly used to evaluate the ability of a nuclear plant to effectively respond to real occurring nuclear emergencies. The aim of emergency preparedness exercises is to test the overall performance of an emergency plan and is usually conducted after emergency plans and procedures have been completely implemented, training is successfully completed, and resources allocated (IAEA, 2005). Exercises also provide a learning opportunity for the emergency response team as they become exposed to their specific roles and work together to achieve the objectives of the emergency program.

Emergency drills are used together with training and exercises and are meant to provide first responders and the public essential skills and knowledge required to appropriately respond to nuclear emergencies (IAEA, 2005). Unlike emergency drills, emergency exercises are usually carried out in a simulated situation and targets practical execution of the set emergency response plans and procedures (IAEA, 2005). While emergency exercises are carried out in larger groups and are directed towards assessing the effectiveness of the whole emergency program, drills are primarily training tools for developing and maintaining skills in certain areas and are meant to reinforce a specific practice or procedure (IAEA, 2005).

A continuous execution and assessment of training, drills, and exercises is necessary for the purpose of identifying weaknesses in key implementation elements, including emergency planning, implementation procedures, embedding, and integration of the practices. The exercises are also useful in establishing gaps in the implementation process. Therefore, providing implementers with a chance to make improvements on their implementation approach.

Most nuclear plants use the model of performance indicators in nuclear energy emergency to assess their emergency preparedness plans. The suitability of this model in evaluating the effectiveness of exercises and drill has however, been in question. Based on the assessment done by CastroSilva and Medeiros (2015), the model has a limitation and requires some modifications in order to facilitate the comparison among different stages of preparedness of nuclear emergency plans, as well as for different nuclear power stations.

To understand the impact trainings, drills, and exercises have on emergency preparedness and response, Schildkraut et al. (2019) assessed the perception of students on emergency preparedness across multiple drills. The study findings established that respondents expressed greater familiarity with the protocols at the final survey time than at the beginning of the study (Schildkraut et al., 2019). Based on these results, continued participation in trainings, drills, and exercises may be useful in improving the general awareness of emergency response strategies.

In a qualitative study that aimed at examining the development and implementation of emergency preparedness policy and practice in Massachusetts hospitals, Taschner et al. (2016) identified training as a major component of effective emergency preparedness. According to Taschner et al. (2016) Emergency preparedness requires continual skill building and training because the skills are lost when they are not used and also because the key skills change as technology improves. The study also established that emergency trainings should be standardized, interpersonal, and should accommodate employees new to the workforce (Taschner et al., 2016).

The study further proposed that policy at the federal and state levels influenced emergency preparedness practice and policy by hindering effective implementation and integration of emergency trainings, drills, and exercises (Taschner et al., 2016). The study applied a case study approach and included key informant interviews with nurses, public health personnel, health policy makers, and emergency first responder informants. In addition to emergency trainings, Taschner et al. (2016) identified communication, organization, funding, and events as the key themes influencing emergency.

Nuclear Emergency Preparedness Plans and Procedures

The Nuclear Regulatory Commission (NRC; 2014) recommended that every nuclear emergency preparedness and response program should have adequate planning and emergency response procedures that are well communicated and properly understood. This recommendation was made after the NRC conducted an in-depth review of literature on the events that occurred during the Fukushima incident. The study evaluated several published reports on the Fukushima Daiichi accident with an aim of obtaining a better understanding of emergency preparedness plans and response procedures followed during the incident (NRC, 2014).

NRC (2014) discovered that the plant did not have adequate staffing to particularly handle nuclear emergencies involving multiple number of reactors. The study also found out that the facility lacked well integrated emergency procedures and required strengthening in order to be able to address arising emergencies (NRC, 2014). Considering these findings, the National Research Council encouraged the US Nuclear Industry and NRC to strengthen their ability to evaluate and identify possible risks to nuclear emergencies (NRC, 2014). One key weakness of this report is that the researchers limited their sources to those that had been published by 2011 and did not accommodate recent publications.

Similarly, in a comprehensive literature review of issues regarding emergency planning for nuclear accidents in the context of The Three Mile Island, Seley and Wolpert (1988) proposed remedies for several hazards identified in the nuclear emergency response system. The proposed remedies covered six major emergency

planning issues, including nuclear emergency mainstreaming, groupthink, triage, resource availability, readiness and performance, and flex planning. Mainstreaming refers to the practice of approaching arising emergencies in a way similar to how services are provided in everyday circumstances. According to Seley and Wolpert (1988) an improved emergency plan should have better integrations of functions to avoid chains of communications, often associated with having services mainstreamed. Seley and Wolpert (1988) suggested that specialized services which are appropriate and relevant to emergency situation and proper communication mechanisms could be a possible remedy to mainstreaming of services during emergencies.

Secondly, Seley and Wolpert (1988) argued that to improve performance and readiness there is need to make drills and exercises more instrumental in the training and evaluation process. Drills need to more realistic, more comprehensive in terms of participants involved, include public involvement, allow for criticism, and conducted more frequently and on a random basis (Seley & Wolpert, 1988). In addition, Seley and Wolpert (1988) proposed that realistic exercises should be used to assess resource gaps and emergency personnel for example, the emergency first responders need proper training to have the capacity to adequately respond to emergencies.

Seley and Wolpert (1988) further reported that there was need to have triaging as an option in the emergency plans. The use of triaging in emergencies needs to be planned in advance. This will particularly help in determining the need for resources and the possibility of having alternative plans (Suley & Wolpert, 1988). These emergency preparedness and response issues reflect the findings by other researchers. For example,

Watkins et al. (2011) indicated that most states lack adequate emergency planning and are poorly prepared to sufficiently respond to major radiation emergency situations. These findings resulted from a 2010 radiation readiness survey conducted by the Council of State and Territorial Epidemiologists (Watkins et al., 2011). According to Watkins et al. (2011) most of participating states had done little or did not have emergency plans to assess the potential consequences of a radiological emergency. A few states had adequate resources to conduct radiological assessment exposure while less than half did not have any documented or detailed plans and procedures to address potential nuclear or radiological emergencies (Watkins et al., 2011). The findings from this study indicates the need for more research that specifically aim to identify the key implementation problems in emergency preparedness programs. This particularly targets emergency training, drills, and exercises to bridge the existing knowledge gap and strengthen emergency preparedness and response.

In addition, Benjamin et al. (2011) identified four major phases of emergency preparedness: prevention, preparedness, response, and recovery. According to Benjamin et al. (2011) emergency preparedness plans should be executed during the periods of normalcy and should include all the four phases of emergency preparedness. This finding came as a result of a research carried out to understand the events following the 2010 Haiti earthquake. The researchers in this study also found out that the existing emergency preparedness mechanisms are not adequate and require strengthening through a multidisciplinary approach. Benjamin et al. (2011) further recommends that there should be more proactive intervention by the international community. For example, minimum

emergency preparedness standards should be set, and every country should adhere to them.

Moreover, Ingram (2018), conducted a research on the protective measures provided to the first responder population and made similar discoveries. The study reported that despite undergoing several emergency drills and training, many emergencies first responders remain fearful of the consequences related to radiological exposure. This is due to the lack of platforms where the first responders can discuss or make enquiries about after-action reports on the emergency incidences (Ingram, 2008). Provision of such communication platforms have the potential of helping first responders to have adequate knowledge and understanding of the emergency situations building their confidence. From the research, it is evident that safety measures should be integrated into the emergency preparedness plans and first responders need to be given adequate protection. Implementers, therefore, must develop emergency plans which aim to protect both the emergency first responders and the public.

Lastly, in a survey which aimed to explore how residents respond during a radiation emergency, Nyaku et al. (2014) reported insufficient emergency planning and preparedness among households. The study included 210 selected households in a two-stage cluster sampling design and applied individual surveys to identify the households which had adequate essential needs and supplies and how they responded to a radiological emergency (Nyaku et al., 2014). The study reported that almost all (85.4%) the respondents had water and nonperishable food which would not last for more than 3 days while almost half (48%) did not have an alternative source of heat (Nyaku et al.,

2014). Despite the existence of emergency preparedness training, drills, and exercises, majority of the households did not have adequate emergency planning and did not follow the required procedures. Therefore, there is need to identify the factors in the implementation processes which inhibit incorporation of the practices into the people's routine life. This justifies the need for the present research and why the selected factors are key to the study.

Summary and Conclusion

In summary, there are four major themes that clearly came out in the literature review chapter. First, the findings presented points out the need to adopt a multidisciplinary approach that brings on board professionals from other fields. Researchers in this area of study particularly suggested that implementers should integrate new technology into the existing communication system to have a more convenient way of passing information.

The second theme in the chapter was what constitutes an adequate emergency preparedness. Based on literature reviewed, adequate nuclear emergency preparedness refers to the ability of a nuclear facility to adequately respond to any arising nuclear emergency. Adequate nuclear emergency preparedness in the context of this study has been linked to effective implementation of training, drills, and exercises.

The third theme discussed in this chapter is the applicability of the normalization process theory in addressing implementation problems. Several implementation researchers whose work are presented in this chapter applied the normalization process theory throughout the life cycle of their projects. The theory has emerged as a very

important tool that can be used by implementers to identify project indicators and to monitor and evaluate the effectiveness of projects.

Another theme in this chapter was the effectiveness of training, drills, and exercises in addressing nuclear or radiological emergencies. The literature review reveals that most of the training, drills, and exercises are insufficient and lack practicability. Researchers have reported that the exercises specifically do not reflect the situations during real nuclear emergencies and need to be approached in a more integrative way and the coverage expanded to emulate nuclear emergencies affecting larger populations.

The final theme discussed was the consequences of poor emergency preparedness and response. Most researchers cited in this section of literature review made their references to the major historical nuclear accidents. Lessons from The Three Mile Island nuclear accident, Chernobyl, and Fukushima nuclear disaster were discussed to understand the need for adequate emergency preparedness and response. Loss of lives, destruction of property, and relocation of communities are some of the consequences highlighted in the study.

From the literature review, it is evident that emergency preparedness training, drills, and exercises contribute to adequate emergency preparedness and response. However, the shortcomings of the implementation processes are responsible for the poor status and the inability to address the intended purpose. The present research, therefore, is purely an implementation research and aims to device better ways of implementing the program and does not focus on finding out if the drills and exercises are effective. The

current research will also add knowledge to the discipline and will provide the researchers interested in the study area with approaches to better understand the topic.

The next section after literature review is Chapter 3, in which I present the methodological approach to be adopted for the study. In this section I explained the study design, population of study, sample size and sampling procedure, the selected data collection methods and procedures, data collection methods, how ethical issues were handled and how the generated data were collected.

Chapter 3: Research Method

The purpose of this study was to examine the perceptions of individuals at the nuclear site regarding the processes involved in the implementation of the training, drills, and exercises at nuclear plant in the southeastern United States. The objective of this chapter is to present a comprehensive description of the methodological approaches and strategies that will be adopted to collect and analyze data for this study. The chapter is divided into four major sections. In the first section, I provided a justification for using the selected research design. The second section contains a description of the role of the researcher in the study, while the next section contains an in-depth description of the research methodology, including the participant selection logic, instrumentation, recruitment process for potential participants, and the data collection process and data analysis plans. In the final section of this chapter, I explain how the issues regarding trustworthiness and ethical concerns will be handled, including data credibility and ethical procedures to be followed in the study.

Research Design and Rationale

Research Questions

The following research questions guided this study:

RQ1: What key implementation problems experienced in the training, drill, and exercise program conducted by the nuclear plant arise from the three concepts (i.e., implementation, embedding, and integration) of the NPT?

RQ2: What are the experiences of emergency first responders and the staff involved in the trainings, drills, and exercises in nuclear emergency preparedness and response?

RQ3: What strategies used by the nuclear plant in the implementation of training, drill, and exercise program are effective in strengthening emergency preparedness and response?

RQ4: How does the training, drill, and exercise program at this nuclear facility address sustainability issues for adequate emergency preparedness and response?

Key Concepts

The effective implementation, embedding, and integration of emergency preparedness activities is key to achieving adequate emergency preparedness. Implementation is the process by which implementers put interventions into action, while the process of embedding refers to how the implemented activities are embedded into people's everyday life. Integration, on the other hand, is the process of integrating the desired practices into the social matrices of institutions or organizations to make the practices reproducible and sustainable. Shortcomings related to these three concepts are the major challenges in the implementation of emergency drills, training, and exercises. In this study, I focused on examining the perceptions of individuals at the nuclear site to understand the key implementation problems arising from the three concepts of the NPT and presenting a possible solution.

Research Tradition and Rationale

In the current study, I primarily applied a qualitative method. A qualitative research methodology majorly focuses on the meaning, concepts, and description of the topic of study based on people's perceptions, feelings, and opinions (Jamshed, 2014) and is most appropriate for use in studies that seek to understand the relationship between several variables (Creswell, 2003). This methodology was effective for gathering information required to address the research questions, such as the procedures and implementation measures that are taken when executing training, drills, and exercises; the strengths and weaknesses related to the implementation of the program; and the possible recommendations to policy makers and implementers of the program. The method also allowed for flexibility in the type of data collected by using nonstructured or semistructured questionnaires and interviews.

I collected data from the emergency first responder and the nine facility staff using a nonstructured questionnaire. The rationale for using a nonstructured questionnaire was based on the fact that I needed to capture the opinions and experiences of the respondents as self-described. A nonstructured questionnaire gave the participants the freedom to express themselves in a manner not limited by me. Given that the respondents are more conversant with the topic of discussion than the investigator, the nonstructured questionnaire is more suited because it gives the respondents full control of the responses they provide (Guest et al., 2013). The use of open-ended questionnaire was appropriate because it allowed for the respondents to express their feelings, perceptions, and opinions without being confined to certain answers.

I also collected data from informants using interviews. The rationale for using interviews for a portion of respondents was to allow me to collect sufficient information. The informants were the staff in charge of various departments and activities and were, therefore, privy to much more information regarding training and drill programs and policies. The use of interviews in this case was appropriate because it allowed me to collect in-depth information from the informants who were well versed with the information about the policies and programs under study.

I used the single case study design in this study. A case study approach is particularly relevant when there is a need to gain an in-depth understanding of a problem or a phenomenon of interest in the context of its natural, real-life existence (Crowe et al., 2011). According to Yin (2003), a single case study approach is appropriate when a study represents a critical case in testing a well-formulated theory. A case study is an established research approach that has been widely applied across disciplines to understand complex issues in their real-life context (Crowe et al., 2011). The design was relevant to this research because the study was bounded by a single facility and sought to understand a phenomenon by applying the NPT, which is well formulated.

Role of the Researcher

According to Denzin and Lincoln (2003), the researcher is considered an instrument of data collection in qualitative research. This means that qualitative researchers interact and collaborate with participants as well as collect data by themselves. Therefore, the quality of the data collected from qualitative research majorly depends on this human instrument. To achieve this role, a qualitative researcher needs to

provide an adequate description of their ability to conduct the research and explain any possible biases that may affect the quality of the data collected (Denzin & Lincoln, 2003). I was an instrument of data collection in this study and assumed the role of a facilitator for the interviews and disseminator of the questionnaires.

I had the responsibility of interviewing study participants who took part in the key informant interviews and completing questionnaires. There was no direct relationship between the study participants and me that had the potential of imparting bias on the research study. All the participants were treated equally, and no incentives were provided to any potential participant or participant. I also tried to eliminate interviewer bias by avoiding asking leading questions, allowing the participants to respond to the questions in the manner they were comfortable with, and not probing too much. Furthermore, the study strictly adhered to the principles of research ethics, including justice, beneficence, and respect of autonomy. This helped to avoid issues that had the potential of affecting the credibility of the data collected, including potential biases, conflicts of interest, or compromising the privacy of participants.

For the data collected by questionnaire, I assumed the role of data collector by administering the questionnaires to the respondents and gathering the questionnaires once they were completed. All the participants were subjected to equal treatment in terms of receiving the time and freedom required to complete the questionnaire. No respondent was given an incentive for completing questionnaires. All ethical considerations were also adhered to in this form of data collection, including the principles of justice, beneficence, and respect of autonomy.

Methodology

Study Population

The study participants for this research were the staff members of a nuclear plant in the southeastern United States who are involved in the training, drill, and exercise program as well as emergency first responders assigned to the facility. These two groups were the population of study.

Sampling Strategy

I recruited the participants for this study using a purposive sampling strategy. According to Palinkas et al. (2013), a purposive or purposeful sampling is a type of nonprobability sampling that involves identifying and selecting individuals or groups of individuals that have more knowledge about or are more experienced with the phenomenon of interest. This sampling technique was relevant to this study because it provided me with an opportunity to use sound judgement to select participants who were able to provide high-quality data, saving time and money. I purposively sampled participants by identifying and selecting all cases that met some predetermined criterion of importance, also known as criterion purposeful sampling strategy.

The inclusion criteria for recruiting key informants and facility staff included members of the plant's staff who are actively involved in the implementation of the training, drill, and exercise program and who have worked in the facility for at least 6 months prior to the data collection period. The facility identified employees that met these criteria ahead of data collection. Similarly, emergency first responders who are actively involved in the program were also purposively recruited into the study. Data

were collected from emergency first responders and facility staff using the questionnaires and from the key informants using interviews. The questions answered by the facility staff slightly differed from those answered by key informants and emergency first responders because they focused on the process of implementation, while those answered by emergency first responders and key informants focused on the embedding and integration of the program. Questions answered by emergency first responders and key informants were similar, with the only difference being in the data collection approach in that the key informants were interviewed while the emergency first responders completed the questionnaire. The interview questions appear in Appendix B and Appendix C, and the questionnaires are in Appendix D.

The number of participants in this study was not predetermined but was informed by the extent to which the research questions have been addressed (see Marshall, 1996; McLeod, 2011). According to Marshall (1996), the number of participants in a qualitative research is determined when the data collected reaches a saturation point, a point when new themes cease to emerge; hence, there is no need for more interviews. In this study, two emergency first responders were considered enough to provide sufficient information. For the key informants, the level of saturation was attained at three participants, while for the facility staff, saturation was reached with nine respondents. The sample size for this study was 13: one emergency responder, three key informants, and nine facility staff.

Before conducting this study, I sought approval from the relevant research bodies. I initially approached the facility under study who helped me identify the first potential

participants for both groups. The sample was then expanded by asking the already identified participants for referrals to other individuals who had the same characteristics. Marshall (1996) referred to this as snowball sampling. Therefore, purposive sampling was used to identify the first participants after which snowball sampling was employed to recruit other participants. Although snowball sampling was used to identify potential participants, I subjected them to the set inclusion criteria and purposively selected only those who met the requirements. All the eligible participants who were willing to participate in the study were given more information regarding the study, and a convenient time for the interview was scheduled for every participant.

Instrumentation

Qualitative interviews and questionnaires were the major instruments of data collection for this study. I used qualitative interviews to collect data among the key informants. Kwale (1996) identified interviewing as one of the best techniques to collect qualitative data, especially when studying a phenomenon that involves people's lived world. Additionally, Potter (1996) stated that interviews are an essential tool for data collection in qualitative research because they provide a one-on-one method that allows the researcher to observe nonverbal cues while the participants are responding, enabling the researcher to collect sufficient information through both verbal and nonverbal means. Qualitative interviews allow also room for interaction and, hence, are a better way of receiving new information that was unknown to the researcher. As such, the use of interviews to gather data from the key informants was appropriate because the key

informants were in charge of leadership roles and were in possession of crucial pieces of information that could best be expressed through interview responses.

The questionnaires were used to collect data from the plant's staff involved in the training, drills, and exercise program and the emergency first responders attached to the program. The questionnaires took a nonstructured approach and were conducted on a one-on-one basis. Nonstructured questionnaires were suitable for use in this study because they provided participants with the required flexibility in terms of the answers they can provide (Miles & Huberman, 1994). The questionnaire items were tailored to suit the situation of each of the two groups. Both the questionnaires for the emergency first responders and the program staff have been attached (see Appendix B and Appendix C).

The participants were taken through the consenting process with adequate explanation of the purpose of the research, procedures, and participant rights before the start of the interviews which lasted for about 45 minutes. With permission from the participants, the interviews were audio recorded to have a complete transcript and accompanying notes were taken for use at the data analysis stage (Merriam, 1998). To ensure credibility of the collected data, participants were given ample time to respond to questions and transcripts were carefully checked during the analysis.

Data Organization

Data organization and sorting was accomplished using Version 12 of the NVivo software. Analysis was carried out in four phases. In the first phase, the recorded interviews were transcribed. I used REV services to transcribe the audio recordings. In

the second phase, codes from the transcribed interviews together with the questionnaire responses were combined and themes developed. The goal of the second phase was to review the collected data for the recurring regularities to identify consistent themes and sub themes that reflect the specific research questions (Merriam, 1998). This was accomplished by reviewing the individual interview transcripts and re-reading interview notes to note similarities in terms of how the participants responded to every question and attach meaning to their responses using the three constructs of the NPT and themes identified in the literature review. The 'query' command feature in the NVivo tool was used to determine the number of times the identified themes emerged in the interviews. The command has the ability to identify the kind of words used by the participants and the number of times they are used. The third phase was to use the NVivo software to code the data into the NPT constructs and components. The responses for every research question were carefully checked to establish the NPT constructs they represent. Any responses that fell outside the constructs of the NPT were coded as others. The final phase of data analysis was to interpret the coded data. This was accomplished using the interpretation provided by the NPT.

Issues of Trustworthiness

Lincoln and Guba (1985) suggested that transferability, credibility, confirmability, and dependability are essential in achieving trustworthiness in a research study. They also noted that credibility and transferability in a research study can be achieved by collecting data from participants with adequate experience and knowledge of the phenomenon being studied. Only participants who have had experience dealing with

nuclear emergency situations were recruited for this study. This is an example of how trustworthiness was established in the study. In addition, credibility was achieved through triangulation of data. By using two methods of data collection, questionnaire and interviews, I was able to compare data from the different sources to establish validity.

Dependability in the context of research refers to the extent by which the findings of a research study can be replicated (Lincoln & Guba, 1985). Using a reliable methodology is one of the ways through which a researcher can increase reliability of a research study (Denscombe, 2002). I provided a complete description of the data collection process and the plan for data analysis. This audit trail will help in ensuring dependability of the research study. Finally, I attempted to achieve conformability by comparing data from different sources to eliminate biases.

Ethical Procedures

The researcher adhered to the principles of ethics at all stages of the data collection. An approval to conduct the research was obtained from the Institutional Review Board (IRB) and the participants were taken through the consent form to ensure that they had an adequate understanding of the entire process (Walden IRB #07-24-20-0621909). Participants could voluntarily participate, those who were not willing to participate were not treated with any prejudice.

Confidentiality of participants was given priority. For example, the identity of all the participants was coded and will only be accessible to me. Participant identification numbers, such as Participant 1, 2, 3 were used to refer to participants during data reporting. This was to protect the identity of all the study participants. The participants

who at any point, were not willing to continue with study could withdraw from the study. The data from the study will be kept for a period of 5 years before being destroyed.

Summary

The objective of this chapter was to outline the research method that will be used to address the research questions. The main concepts discussed in the chapter include the research design, the study population and study participants, the sampling method, data collection procedure, and the plan for data analysis. Also discussed in the chapter are issues regarding trustworthiness of data and ethical concerns. For this study I used a qualitative research methodology and adopted a case study approach. The data sources included key informant interviews with staff involved in the training, drill, and exercise program and individual interviews with emergency first responders. For this study I applied the NVivo software for data management and the analysis was done using the constructs of the normalization process theory. The results of the study will be presented in Chapter 4.

Chapter 4: Results

In this chapter, I present the key findings of this qualitative study based on the themes identified from the thematic analysis. The objective in this chapter is to present the outcomes that were obtained from the data analysis and to answer the following research questions:

RQ1: What key implementation problems experienced in the training, drill, and exercise program conducted by the nuclear plant arise from the three concepts (i.e., implementation, embedding, and integration) of the NPT?

RQ2: What are the experiences of emergency first responders and the staff involved in the trainings, drills, and exercises in nuclear emergency preparedness and response?

RQ3: What strategies used by the nuclear plant in the implementation of training, drill, and exercise program are effective in strengthening emergency preparedness and response?

RQ4: How does the training, drill, and exercise program at this nuclear facility address sustainability issues for adequate emergency preparedness and response?

The chapter is divided into five sections. The first section covers the demographics of the participants of the study. In the second section, I provide a description of how data were collected. Section 3 includes a description of the data analysis procedures, while Section 4 contains a discussion of the issue of trustworthiness and how it was achieved. In the final section of this chapter, I provide the results and a discussion of the themes as derived from the participants' responses.

Demographics

The population for this study included 13 men and women who were categorized into three groups (see Table 1). It is worth noting that the key informants (labeled as Participants 1–3) were interviewed and answered all questions asked. These questions were slightly different than the ones asked of the facility staff and emergency first responder via the questionnaire but addressed the same context. One emergency first responder was interviewed, while the other completed the questionnaire. The emergency first responder who responded to the questionnaire was labeled as such. Data were collected from informants using interviews, data were gathered from one emergency first responder and facility staff through a questionnaire. Due to the differences in the questions asked to Participants 1–3 compared to those given to the facility staff and emergency first responder, all answers may not appear in each of the question-by-question derivations of themes that follow, but the answers will appear in all three themes. Equally important, all nine facility staff (labeled as Facility Staff 1–9) answered all interview questions except Question 6. Strictly speaking, Question 6 was not an interview question because it basically asked the respondents if they had anything they would like to add.

Table 1

Participants' Demographics

Identifier	Gender	Ethnicity	Role	Data Collection
Participant 1	Male	Caucasian	First responder	Interview
Participant 2	Male	Caucasian	Management/ facility staff	Interview
Participant 3	Male	Caucasian	Facility staff	Interview (Zoom)
First responder	Female	African American	Management/ facility staff	Questionnaire
Facility Staff 1	Male	Caucasian	Facility staff	Questionnaire
Facility Staff 2	Male	Caucasian	Facility staff	Questionnaire
Facility Staff 3	Female	Caucasian	Facility staff	Questionnaire
Facility Staff 4	Male	Caucasian	Facility staff	Questionnaire
Facility Staff 5	Male	Caucasian	Management/ facility staff	Questionnaire
Facility Staff 6	Male	Caucasian	Facility staff	Questionnaire
Facility Staff 7	Male	Caucasian	Management/ facility staff	Questionnaire
Facility Staff 8	Male	Hispanic	Facility staff	Questionnaire
Facility Staff 9	Female	African American	Facility staff	Questionnaire

Data Collection

I collected data using two approaches. The first approach was the use of the self-administered questionnaire, which I distributed to the respondents and gave them 2 weeks to complete. Nevertheless, they were free to seek clarification from me at any time. Nine facility staff members and one emergency first responder completed and returned the questionnaires within the given timeframe.

The second approach was a face-to-face interview. I invited the participants for an interview in which I assumed the role of the interviewer. Data from two participants were collected through this approach. One of the participants was interviewed at Panera Bread

(which took 49 minutes), while the other was interviewed at my home (which took approximately 36 minutes). In both cases, the interview was audio recorded using my iPhone for later transcription. To adhere to the COVID-19 protocols, these interviews were conducted in spacious and well-ventilated areas. There was no body contact between the interviewees and me, and all social distancing and mask guidelines were adhered to throughout the interview sessions.

I conducted the other interview using Zoom video conferencing. This interview was also audio recorded on my iPhone. This interview was shorter than the other two, lasting only 26 minutes. This interviewee's responses were short and to the point, and they did not want to further elaborate on the answers given.

Data Analysis

I conducted data analysis in three phases. The first phase was the generation of codes from the questionnaires, the second phase involved generating codes from the interviews, and the third phase was the derivation of themes from the codes generated in the first two phases. After collecting data from the interviews, the first step of the analysis was transcription. The recorded data were transcribed using the REV service. After transcription followed data coding where I developed codes from the questionnaire responses and the transcribed interview texts. I first read the transcript to determine the flow of information from the responses. Next, I reviewed and reread the interviews to note the main arguments from the responses. Recurring regularities were then identified using the query command of NVivo, and the identified keywords were highlighted as the codes.

In the second phase, I first went through each individual questionnaire to familiarize myself with the responses. I then reread the questionnaires to identify the main arguments using line-by-line coding to identify the key words in each statement from the participant's responses. All the key words from individual questionnaires were listed, recurring regularities were then identified using the query command of NVivo, and the identified keywords were highlighted as the codes.

I combined the codes generated from the questionnaire and interview responses together for the third phase of the analysis, which was the creation of themes; a selection of coding is shown in Table 2. Codes that addressed similar constructs were grouped together into subcategories. Subcategories that addressed similar construct were also grouped together to form categories that were also grouped together to form themes. I used the themes to address the research questions. The codes of participation in drills, duties on the site, and conducting drills and exercises were used to address the first theme of implementation strategies. The codes of implementation challenges, impact of training, and weakness of strategies were used to create the theme of challenges faced in the implementation of policies and programs. The codes of sustainability of implementation strategies and improvement of strategies were used to generate the theme of sustainability. Responses that fell outside the constructs of the NPT were coded as others.

Table 2

Selection of Coding for Themes

Codes	Subcategories	Category	Theme
Participate	Department involvement	Involvement	Implementation strategies
Drill staff	Individual involvement		
Weekly	Participation frequency		
Monthly			
Develop and conduct drills	Department role	Role	
Develop scenarios			
Drill and command staff			
Evaluation	Individual role		
Standardize			
Lead controller			
Scenario writer			
Development then approval	Implementation challenge	Organizational challenge	Challenges
New team	Weakness of strategies		
Infant stage			
Dedicated joint information center (JIC)	Lack of dedication	Individual challenge	
Laid out expectations and criteria	Implementation procedures	Implementation	Sustainability
After action strength and procedures	Implementation procedures		
	Participants		
Facility rep., ERTEG, site EM			
Committee	Participants		
Trending and analysis	Functions		

I factored discrepant cases into the analysis by analyzing them on the basis of the theme they addressed. For instance, the emergency first responder indicated the job was a completely new role but at the same time indicated that, “This is similar to my role as a leader where I must gather and review information and ensure only relevant data is communicated to my team and management.” There was an overlap of themes in the interview questions, which means that some questions derived more than one theme, and

some themes were seen in more than one question as presented and discussed in the following paragraphs of this section. Since all the questions were open ended, a thematic analysis approach was the most appropriate for drawing the primary conclusions.

Several codes emerged given that they were generated by using only key words form the participants' responses. I grouped the codes into subcategories that were then grouped into categories. There were 13 categories that were grouped into three themes. The first theme was the theme of implementation strategies and was generated using two categories: involvement and role. The category involvement comprised codes that measure or indicate how the participant and their department were involved in the program. The category role comprised codes that speak to the role that the participants played in the program. The second theme was that of challenges faced in the implementation and was generated from two themes: organizational and individual challenges. The third theme was sustainability with which I sought to determine how much the program was sustainable. This theme was generated using the categories such as implementation. An excerpt of coding is listed in Appendix E.

Evidence of Trustworthiness

For qualitative research to be accepted as trustworthy, the researcher needs to demonstrate that the analysis was conducted in a precise, consistent, and exhaustive manner by way of recording, systematizing, and disclosing techniques of analysis (Nowell et al., 2017). This reporting of procedures should be detailed enough to enable the target audience to determine the credibility of the process. Having already conducted

the analysis, I provide portions of the transcript used to arrive at the results in the Results section where I discuss them in detail.

Four major aspects are looked at when trying to establish the trustworthiness of a study: credibility, transferability, dependability, and confirmability (White at al., 2012). Credibility is the act of establishing whether the findings of the research represent plausible information drawn from the participants' original data (Korstjens & Moser, 2018). Credibility in the interviews was established through prolonged engagement with the participants. I, the interviewer, took at least 2 to 5 minutes for each question, mainly probing the respondent to provide evidence for their answers to ascertain if the response they had given had been out of guesswork. For the questionnaires, confirmatory questions were asked to check if the responses given were consistent and credible. For example, after asking the participants about their role in the program, they were asked about their experience in the program of which the response was expected to relate to the role they had given in the previous question. The questionnaires were credible because data saturation was attained indicating that the respondents' viewed the constructs from a common perspective.

Transferability, on the other hand, is the degree to which the findings of a research can be transferred to other contexts or settings with other respondents (Ritchie et al., 2014). It relates to confirmability, which is the act of verifying whether the findings of a research can be confirmed by other researchers (Korstjens & Moser, 2018). I examined the transferability and confirmability of this study by comparing the findings of this study to those of previous researchers on the same topic. The outcome of the

comparison showed that this study was transferable given that it had the same findings as those of Onda et al. (2020), which was conducted in a different context and setting.

Finally, dependability refers to the stability of the findings over time (Korstjens & Moser, 2018). To establish the dependability of the current study, I carried out the analysis process following accepted standards for the current research design. The interpretations made were not based on my own preferences and viewpoints but were grounded in the data to ensure that the findings reflect the participants' views. This also ensured that if another researcher used the same methodology to conduct another study, they would likely obtain similar results.

Results

By employing thematic analysis, I uncovered three important themes. The first theme was the theme of implementation strategy which sought to gather information about how the implementation programs are put into practice. The second theme was about challenges and involved gathering information regarding participants' perception of the challenges facing the implementation process. The third and final theme was that of sustainability under which the investigator sought to gather information regarding participants' knowledge on long-term preparedness for emergencies.

Theme 1: Implementation Strategies

The theme of implementation strategies was addressed by participants' responses to Questions 1, 3, and 4. These questions were expected to highlight how long the participants have worked at the plant, their duties within their scope of work, and their experiences. The participants were expected to describe, to their understanding, what the

whole emergency preparedness and response concept entails and where they fit into the "picture." The code looked for in this question related to the participants' role. While all respondents recognized their level of participation and role, some did not appreciate the sufficiency of the training to improve proficiency. For example, one of the participants stated, "Normally, the training is barely sufficient, and the drill/exercise frequency is too low to ensure proficiency."

Analysis of the responses given to this question shows that even though not all participants have a direct role, they participate actively via the involvement of their departments. Necessarily, because of experiences, the level of involvement differed. Although there is a general finding that the interviewees participate in the preparedness and response programs, their participation is widely varied and have different motivations. This is a notable barrier to the effective and sustainable implementation of nuclear emergency preparedness and response at this nuclear plant. For instance, the approach towards training with multiple tasks across different departments can give rise to a distracted emergency preparedness task force.

Participants were expected to detail the processes of how the preparedness and response programs are put into practice. A knowledge of who is involved in what would signify an appreciable degree of the participants' understanding of the concept. The code looked at for this question related to the methodologies employed in the implementation strategies. The significance of the responses to this question is that they point towards flaws in the implementation processes and their potential consequences, which translate into challenges. It was anticipated that knowledge in the implementation processes can

help in pointing out how not only the processes but also strategies can be improved. Notably, some participants pointed out nonstandardization of the procedures. However, they all alluded to being evaluated after the drills. For instance, one participant stated as follows "Drills and exercises were implemented in a manner to ensure that all ERO personnel had at least one drill or exercise that they could participate in annually to maintain their qualification."

While it is acknowledged that participation in the training, drills, and exercises may be as a result of bureaucratic directives and not necessarily willingness, it was also anticipated that it reflects the fact that each individual gained some knowledge with each session attended. However, while some responses clearly indicated mandatory participation, others showed pure indifference. For instance, Facility Staff 7 simply indicated the number of training, drills, and exercises he is aware of in a year but made no indication as to how many he attends or how often. Another participant gave the following response. "I rarely participated in the training portion for my respective facility." Based on this response, it is evident that there is a gap in planning and implementation. The fact that this participant's absenteeism did not raise concerns shows that there was no strict adherence to the training sessions.

From these responses, it is noted that the frequency and level of participation vary significantly according to the role as well as department-wise. However, some responses also show low levels of motivation to participate while most show poor levels of departmental and individual coordination of the entire program. Ideally, as will be expounded in the discussion section, this poses a major challenge towards the effective

and sustainable implementation of nuclear emergency and preparedness response at this nuclear plant.

Theme 2: Challenges

Responses to Questions 2 and 5 demonstrated the participants' experiences in the drills, and exercises as well as the challenges they faced. The participants were asked to describe the impact of the emergency preparedness and response program. The code looked at for this question was the impact of training. The significance of this question is that the responses to it indicate whether the participants appreciate the initiative to train them in emergency preparedness and response and, hence, whether they view themselves as prepared after having participated in the training. The participants appreciated that the training increased their preparedness although some were also skeptical of their proficiency, pointing towards an area of improvement. For example, one participant responded, "Training allows participates to learn and use skills that would otherwise only occur in a real emergency."

The participants were asked to point out aspects of the emergency preparedness program that were not working towards helping this nuclear plant meet the threshold for real emergencies. The code looked at in this question was implementation challenges and weaknesses. In particular, the emergency first responders were able to link the underlying concept of Question 2 and Question 5 with regards to the theme of challenges. One participant pointed towards the inappropriateness (or complexity level) of the training and drill process for both the trainers and trainees. The participant commented that "We

don't need to make the training and drill process more difficult on the trainers and trainees."

Theme 3: Sustainability

The theme of sustainability was created based on the questions that examined the participants' knowledge about how the skills obtained can be improved or sustained for long-term emergency preparedness. The code looked at for this question was the sustainability of implementation strategies and improvement of the strategies. A common feature in the responses is that most pointed towards the "conservative" nature of the management and its lack of buy-in to modern and sustainable strategies. For example, one respondent noted that "The program is sustainable only through management buy-in." Some also pointed towards resources (financial and material) as the greatest threat to sustainability. For instance, one participant opined that "The entire program is sustainable as long as the appropriate resources are dedicated to the program." An important point that comes out of responses is that the management itself could be responsible for ineffective implementation, and this points towards poor leadership and direction.

One of the improvement strategies that was fronted by the participants was working together towards accomplishing a common goal. As Facility Staff 2 puts it, participation by all ERO groups working together towards accomplishing a common goal is a sustainable element but there is need to change the objective opinions of the program which they considered unsustainable. Facility Staff 3 on their part called for increase in the manpower employed to run the continuous drills and exercises. Based on the response

by Facility Staff 4, one of the measures that can be used to improve strategies and their implementation is by making the process simple and non-intimidating.

Summary

In this chapter I presented the findings of the study and a detailed discussion of the findings. The responses obtained addressed the four research questions. The first research question examined the implementation problems experienced in training, drill, and exercise program. Among the problems experienced in the implementation of strategies is skeptical staff who feel that the participation in training is as a result of the bureaucratic directives and not willingness to participate. Some staff also pointed to the non-standardization of procedures as a challenge to the implementation of the strategies. Another challenge to the implementation of training, drills, and exercise program strategies is the inappropriateness or complexity of the program.

The second research question explored the participants' experiences with respect to training, drills, and exercises. Some participants indicated that the training was not sufficient to ensure proficiency. The participants' involvement in the training, drills, and exercise program was through their departments and not as individuals. In as much as the participation was through departments, their level of involvement differed.

The third research question concerned the strategies used in the implementation of training, drills, and exercise program and their effectiveness in strengthening emergency preparedness and response. One of the strategies that is used is the use if simulation of conditions and anticipated outcomes in the target area. This is important as it helps the staffs to visualize what the real situation would look like and thus prepares them for the

real disaster. Another strategy that is used in the implementation of training, drills, and exercise program is running trend analysis to look for vulnerabilities and findings. The third implementation strategy was that each department conduct their own training, drills, and exercise program that suit their respective areas. The importance of this is that each department specializes in what is necessary for them in disaster management.

The fourth research question concerned how the training, drills, and exercise program at the nuclear facility address sustainability issues. One of the ways that was identified as a means through which the training, drills, and exercise program addresses sustainability issues was togetherness when working through these programs. The participants also indicated that training, drills, and exercises increase skills. They noted that training staff on these programs improves their skills and knowledge for long-term emergency preparedness.

The three themes of implementation, challenges, and sustainability have been identified and discussed, from which it was established that the nuclear plant needs a critical review of its emergency preparedness policy and plans if it is to be termed as meeting the threshold of a real emergency. It has generally been seen that for an emergency preparedness and response plan to be termed as effective, its implementation strategies must meet and address the identified challenges sustainably. The findings of this chapter will be used to draw the conclusions and recommendations presented in Chapter 5.

Chapter 5: Discussion

The purpose of this study was to explore the minimum planning requirements that address sustainable implementation of emergency preparedness and response as well as the associated challenges. In this chapter, I summarize the entire project by briefly highlighting the research problem, main findings, limitations, and presenting evidence-based recommendations. Preparedness has been identified as key and, functionally, the plant has to ensure that arrangements are in place for response operations to be managed appropriately, including the rapid identification and notification of an emergency, taking mitigation actions, protecting emergency first responders, and providing the public with necessary protective information.

Looking at the four main research questions alongside the interview questions, I readily inferred that while disasters and the hazards that result in disasters may largely be unpreventable, their effects can be minimized through disaster management efforts that focus on emergency preparedness and response. According to Yoon and Kim (2015), implementing effective disaster management programs in the nuclear industry becomes even more important because this industry is particularly vulnerable to accidents, natural disasters, or human-caused crises. From the Results section of Chapter 4, both barriers and deliverables for emergency preparedness and response managers that potentially mitigate the risk the impacts of a disaster can be deduced.

Interpretation of Findings

Theme 1: Implementation Strategies

The environment in which general organizations operate is increasing evolving, compelling senior management teams to strategize on how to realize their organizational visions and missions and, more importantly, survive while remaining socially responsible (Alamsyah, 2018). This calls for emergency preparedness and a response plan that meets a certain threshold and, according to the World Health Organization (2007), this is especially so in the nuclear industry. The more employees are involved in an emergency preparedness activity, the more they are prepared for the real emergency. Therefore, to understand the level of participants' preparedness for the emergency, I examined their involvement in the implementation. This study established that all personnel at the nuclear plant are involved in the implementation of the emergency preparedness and response programs, which is an indication that there exists a degree of emergency preparedness in the organization.

There are notable gaps in the implementation strategies at the nuclear facility study site that compromise efforts to meet the preparedness and adequacy threshold. These findings are consistent with the findings of Adalja et al. (2014) who established that effective emergency preparedness and response was hindered by lack of practicality and would not be applicable in real, occurring nuclear emergencies. According to IAEA (2005), an effective nuclear emergency preparedness program should incorporate training programs that have adequate theoretical and practical courses. Nevertheless, as explained by Facility Staff 2, there is an inadequacy of implementation strategies at the site. As an

organization that has existed for many years and offered continuing training, drills, and exercises to their first responders and the community in which they operate, the plant needs to harmonize its organizational policies to fully adopt to federal standards and international conventions regarding nuclear emergency preparedness and response.

In the event of a nuclear and radiological incident, the implementation of the protective actions prescribed in the preparedness plan should occur during the emergency phase as well as postemergency phase. However, without an explicit definition and division of roles and responsibilities, both phases can easily escalate into uncontrollable situations with devastating, long-term consequences (Cantone et al., 2018). One of the barriers that impact planning and implementation at the study site is lack of clear division of roles and responsibilities. This was raised by Participant 1 who agitated for the creation of a clear, written emergency preparedness and response communications plan. The lack of clear roles was also raised by Participant 2 who argued that the multiple roles of each facility staff may be a barrier to effective and proactive communication of the type of information needed by each department. This finding is consistent with those of Onda et al. (2020) who argued that with ambiguous or overlapping roles, translating knowledge gained from drills into practice can be difficult and complicate the emergency. Therefore, besides the training, drills, and exercise, it is critical that the plant defines each employee's role during a disaster as well as share expected responsibilities with relevant stakeholders.

Theme 2: Challenges

The major challenges in implementing emergency preparedness plans at the nuclear plant study site encompasses both the on-site and off-site domains. With regards to the on-site domain, the challenges include the attitudes of the staff towards training (and not the reality of the possibility of the occurrence of an emergency situation), development of effective internal systems within the emergency planning framework, and ensuring the adequacy of the training programs. With regards to the off-site domain, as revealed in the interviews, the challenges include conducting public awareness programs, training local authorities and populations, developing infrastructure within the emergency planning zone; and including simulation of all possible emergency scenarios in exercises (see Baciu & Stern, 2020; Tshelane, 2018). These challenges have also been documented by previous researchers, like Khairunnisa and Ashri (2017) who went further and classified them into plant emergencies, site emergencies, and off-site emergencies.

Site emergencies are accident situations in the plant that involve radioactivity transgressing the facility boundary but staying confined within the site. While the off-site consequences of site emergencies may be negligible, they are, similar to plant emergencies, potentially harmful to on-site personnel (Baciu & Stern, 2020). Off-site emergencies are accident situations involving excessive release of radioactive material from the facility into the public domain, ultimately requiring extensive intervention (Maskun, 2017). According to Participant 2, the ultimate goal of any emergency preparedness and response program should be preventing, or at least being prepared for, off-site emergencies. Notably, even though the plant is vulnerable to all three classes of

emergencies, the challenges in preparedness and response converge at role division and definition, adequacy of the current approach to implementing the training program, funding, and staff attitudes. This view was shared by the emergency first responder, Facility Staff 5, Facility Staff 7, and Participant 1 who were all concerned that even though emergency preparedness and response plans for the plant are periodically prepared, approved, and exercised, they are still inadequate, which echoes sentiments shared by DNFSB (2018) and OEA (2018).

Preparedness should necessarily entail the training of all personnel who will be involved in the implementation of emergency plans and procedures through exercises to ensure effective response to an emergency situation (Shindo, 2018). However, the involvement should be role specific and clearly reflect defined responsibilities, not only at the departmental, but also the individual level as opposed to the mass recruitment of participants in the program (Khairunnisa & Ashri, 2017). The participant interviews showed that the staff are appropriately qualified; however, the ambiguous and overlapping role allocation, financial resources, and managerial support have been pointed out by the interviewees as a challenge to the implementation of preparedness and response plans during an emergency situation. Therefore, the human resources management team should also match the staff's skills to the roles and responsibilities allocated to them. Additionally, some of the reasons provided by both the interviewees and the DNFSB (2018) and OEA (2018) as to why the emergency preparedness and response programs at the plant has not met the threshold for real emergencies included the inability to demonstrate that they can prevent the occurrence of health effects among

the staff and the public, that they can provide first aid and manage the treatment of radiation-related injuries, that they can protect property and the environment, and that they can take into account the need for resumption of normal economic and social activity.

Presently, as inferred from the interviews, the organization-specific challenges the plant is facing that complicate disaster management and potentially aggravate the situation include poor/unclear communication channels and coordination plans. While the experiences of the facility staff are not in question, the way they are matched to emergency-related needs creates disparities across the organization. For example, the personnel have been moved around departments and roles within the organization. This, according to career development experts, does not present a clear, measurable, and achievable career growth path (Savoia et al., 2017). According to Participant 3, this is not suitable for the coordination of mechanisms to facilitate activities of disaster management. Furthermore, Alamsyah (2018) showed that weaknesses and challenges also arise from the lack of a centralized system of data management for disasters and disaster management within the organization. Therefore, the plant should consider consolidating their risk profile for proper programming and planning. As alluded to by Facility Staff 9, the plant lacks an effective monitoring and evaluation mechanism to ensure that personnel are more engaged in responding to drills as if they were real events.

The funding and resources challenge is felt across the organization by a majority of the employees and could potentially fuel interdepartmental as well as personal conflicts if the plant does not implement appropriate measures. This finding is supported

by studies, such as that of Zwolinski et al. (2012). Therefore, the plant may require additional funding for organizational strengthening and the capacity development of staff so that it can demonstrate to the DNFSB (2018) and OEA (2018) that it can incorporate and implement disaster risk minimization strategies into programs. Rai et al. (2020) recommended that the strategic goals at the plant should include the more effective integration of disaster risk minimization into sustainable development policies; programming and planning at all organizational levels; and particular emphasis on disaster preparedness, prevention, mitigation, and vulnerability reduction.

Another strategic goal that could effectively address the implementation challenges is the strengthening of all departments, mechanisms, and capacities at all organizational levels, particularly at the management level, that can systematically contribute to building resilience to hazards and emergency situations (Tshelane, 2018). Then, as recommended by Kutkov (2019), the plant should consider the systematic incorporation of risk minimization approaches into the design and implementation of emergency preparedness, response, and disaster recovery programs. The priority action areas, therefore, should be ensuring that emergency preparedness and response is an organization-wide priority with a strong departmental basis for implementation; identifying, assessing, and monitoring disaster risks and enhancing early warning; using knowledge, innovation, and education to inculcate and nurture a culture of safety and resilience across all departments; minimizing underlying risk factors; and strengthening disaster preparedness for effective response across all departments. The implication of all

these recommendations, supported by literature, is that focusing on departments helps organizations address specific hazards at their most basic level.

Theme 3: Sustainability

The availability of affordable energy is the essence of modern economies; therefore, ensuring a sustainable supply of energy is a major government responsibility. At the company level, there are also responsibilities of ensuring sustainable operations besides the sustainability of the end product, which is energy itself (Baciu & Stern, 2020). A major characteristic of nuclear power is the long-life cycle of a nuclear power plant project, ranging from planning through to siting; designing; building; operating; and commission, including, most importantly, the response to emergencies and managing radioactive waste (Tshelane, 2018). While the emergency plan is expected to provide an additional protection layer by specifying response actions to be taken during a serious accident or event, decisions around it should also be framed in terms of environmental, resource, human, and social impacts for the long term (Cho et al., 2018). The significance of the theme of sustainability is that it is the culmination of the themes of implementation and challenges. According to Rai et al. (2020), for an implementation strategy to be effective, it must be sustainable, and for it to be sustainable, it must effectively address and mitigate the challenges. This is comprehensively summarized by Facility Staff 8 who noted that the elements were sustainable but needed to be combined under one organization.

Interestingly, while the interviewees reported wide-ranging qualifications and experiences in their duty roles, Facility Staff 1 identified the procedures and drill-

manship as the only sustainable element of the program while identifying experience as the unsustainable element. On the other hand, Facility Staff 2 identified the participation by all ERO groups working together towards accomplishing a common goal as a sustainable element but pointed out that objective rather than subjective opinions of the program were unsustainable. Similarly, Facility Staff 3 pointed out that the number of employees required to run the continuous drills and exercises is neither sufficient nor sustainable. According to Facility Staff 4, complicating drills to the point that they are dreaded by personnel who would rather take a vacation than participate and be subjected to the controllers, observers, and evaluators makes the implementation unsustainable. This example is opposed to simple and realistic scenarios in which essential objectives can be evaluated and personnel can actually learn, which was supported by Kutkov (2019). However, Kutkov's suggestion contradicts the NRC guidelines that endorse hostile, action-based emergency response drills. It is worth noting that Facility Staff 5 supports the hostile, action-based emergency response drills and points out the constant use of the same scenario during drills/exercises and the senior management's propensity to blame processes rather than people when something goes wrong is not sustainable.

The interview-based arguments above suggest that the plant needs to find a balance between what works but is unsustainable and what does not fully achieve the expected results but is sustainable. For example, Facility Staff 6 acknowledges that all the program elements are sustainable so long as they receive the necessary funding and resources. However, Facility Staff 6 also points out that the most unsustainable element is the ability to conduct a drill/exercise that progresses from the initial response through to

the recovery phase and not as a single continuous event. Additionally, Facility Staff 5 also notes another unsustainable element in the form of prolonging drills to the point that they negatively affect the plant's mission and production schedules. According to Carr et al. (2018), it is a federal requirement that nuclear operating organizations develop and maintain emergency preparedness plans for their nuclear power facilities to protect the public. However, as noted by Cho et al. (2018) in the introductory sentence to this theme, decisions around emergency preparedness must consider long-term environmental, resource, human, and social impacts. This is as opposed to basing decisions on short-term gains such as the earnings report for the next quarter.

With specific regards to nuclear energy generation, the focus in recent years has been on outpacing the drawdown on other existing sources of energy such as hydro and geothermal electricity generating plants. However, sustainability has emerged as a corporate ethics component in response to the perceived public discontent over the long-term damage that results from the focus organizations have place on short-term gains (Onda et al., 2020). Therefore, it is imperative that the plant plans and implements its emergency preparedness programs in consideration of how it can meet its current needs without compromising the ability not only of the company in future but also the community to meet their needs. There are two key components contained within this assertion by Onda et al. (2020): first, the concept of "needs," particularly the essential needs to which overriding priority should be accorded and, second, the concept of "limitations" imposed by technology and social organization on the ability of the plant and the environment to meet present and future needs.

While the definition of sustainability in the above context may seem simplistic in the first instance, it is worth noting that the complexities of implemented technology and systems of nuclear energy including the multiple supporting institutions is not always straightforward. This is because many of the studied approaches typically meet only one part of the three outlined in the test above as demonstrated by (Yamaguchi et al., 2018). With specific regards to tis plant, a simple strengths, weaknesses, opportunities, and threats analysis reveals both barriers and deliverables for emergency preparedness and response. Notable strengths include the existence of programs for capacity building and sensitization of the staff and policies to anticipate needed technology while weaknesses include poor attitudes of maintenance and adoption of new training regimes and unwillingness to participate in intensive training.

The opportunities include support from bodies such as DNFSB and OEA and the availability of international-standard guidelines from agencies such as the NRC. Weaknesses include natural disasters, terrorism, militancy, and corruption, although these are not unique to the plant; they universally affect other players in the industry. Maskun (2017) noted that safety culture is a critical factor to measure nuclear emergency preparedness and particularly with regards to sustainability. Further, a strong association has been found between “staff beliefs and representations” and safety operations, the significance of which is that staff beliefs can negatively impact on sustainability of behavior (Cantone et al., 2018). To ensure sustainability, therefore, the plant must ensure that, at its most, emergency response is rendered effective by the involved personnel’s technical and behavioral preparedness. To ensure that they meet the threshold for a real

emergency and in line with sustainability requirements, the plant must review its organizational policies and interdepartmental coordinating mechanism to ensure they are functional at the preparedness stage. The polices and mechanism need to be coherent with the national emergency management system which ensures consistency between emergency arrangements of response agencies, nuclear facility operators, and the regulatory bodies at local, national, and regional levels.

Interpretation of the Findings in the Context of Theoretical Framework

Theme 1: Implementation Strategies

Even though not all participants have a direct role, they participate actively via the involvement of their departments. Necessarily, because of experiences, the level of involvement differed. Although there is a general finding that the interviewees participate in the preparedness and response programs, their participation is widely varied and have different motivations. This is a notable barrier to the effective and sustainable implementation of nuclear emergency preparedness and response at the plant. For instance, the approach towards training with multiple tasks across different departments can give rise to a distracted emergency preparedness task force. According to Baciu and Stern (2020), a better approach would involve enlisting a technical expert, either on a part-time or volunteer basis, to coordinate the organization-wide preparedness. The significance of this approach is that it creates a single center of command, so to speak, through which all activities can be coordinated.

The most important point noted in the responses to Question 3 was that the drill program must meet federal orders. Therefore, all implementation strategies are prescribed

at the national level but are executed according to organization-specific needs. The problem, therefore, as to why the plant does not meet the threshold of a real emergency is inferred to be at the organization/practice level and not the policy level. Since there are already national guidelines and international conventions in place, the plant should develop an organization-specific solution to their below-par emergency preparedness and response.

Theme 2: Challenges

From the responses, it is noted that one challenge that the implementation process faces is a lack of appreciation by those the process is intended for. Those who the training, drill, and exercise programs target do not appreciate them as much as those who develop such programs, i.e., there is a disconnect between the stakeholders with regards to the significance of the programs. Essentially, as pointed out by Participant 2, that training gives them skills that are only applicable to real emergencies, it is noticeable that the participant sees the training as nonhelpful when there are no real emergencies. Organizational management studies acknowledge resistance to change as a major barrier towards achieving organizational goals (Hagman & Glimskog, 2015). In an industry like nuclear, this can have legal consequences given the adverse effect that lack of proper management training can cause.

Participants in this current study acknowledged that some areas need attention if the exercises are to meet the threshold for real emergencies. Again, these areas of improvement pointed out by the participants are within the organization and do not in any way reflect a shortage of national guidelines or international conventions. Since these

views are directly from internal stakeholders, it is inferred that they represent a legitimate estimation of performance quality that warrants the senior management's and decision-makers' attention.

Theme 3: Sustainability

The responses suggest the current strategies cannot serve the long-term purpose, hence are largely unsustainable. This, as alleged by Participant 3 and as seen under the theme of "Challenges," is contributed to by the culture and structure of the organization. Any initiative that can rightfully be labeled as sustainable should be able to satisfy current needs without compromising the capacity and ability to satisfy the needs in the future. Yamaguchi et al. (2018) noted how the responsibility of emergency preparedness, response, and disaster relief has evolved slowly and haphazardly since the end of World War II into the essential mission it has become today for federal, state, and local governments. Presently, according to Yamaguchi et al. (2018) the efforts to optimize emergency preparedness cannot be left to governments anymore; rather, it is time that industry players and key stakeholders moved to the forefront to ensure safety in the nuclear industry. This case study reveals that, despite all its efforts and the existence of a training, drills, and exercises regime, the plant needs to critically review its implementation strategies to satisfy regulatory standards and international conventions.

The above results (from all the questions and theme-wise) indicate that the implementation of full regulatory compliance at the plant disaster management mechanism will need the buy-in and full support of the senior management before the rest of the staff can fully appreciate and contribute towards its success. The success or failure

not only of regulatory compliance but also of actual emergency preparedness and response will largely depend on the readiness and willingness of all the actors (Tshelane, 2018). Looking at the responses to the interview questions especially with regards to what is not sustainable, it may readily be inferred that readiness and willingness to accept and implement responsibility at the plant is questionable.

Some of the barriers to the effective implementation of emergency preparedness and response plan as reported by Onda et al. (2020) include issue salience, absence of a dedicated technical expert among the human resources, a non-focused emergency preparedness task force, and diverting resources to other projects. From the transcripts, these barriers are all present at the plant. A major problem, however, is that the senior management and program controllers have not identified (or at least addressed) the barriers which are preventing critical revisions and/or additions that can make the organization meet the threshold of a real emergency. While this could be a top-down problem at the organization, a bottom-up problem could be that the employees are not communicating the problems and their lived experiences to the senior management and program controllers.

Limitations of the Study

The main limitation of this study is that it was limited to a single organization; hence, the results cannot be generalized to the larger industry. However, it provides a practical starting point for organizations operating under similar situations and emergency preparedness and response programs to gauge their adequacy, identify gaps, and strategize on improvements. Further, since the primary data was collected directly

from the key stakeholders at the plant, the results are directly and relevantly applicable to the organization. However, this limits the generalizability of the findings to other organizations.

Another limitation of this study is that it used two different techniques of data collection. Some data were collected using interviews while the others were collected by the use of questionnaires. The use of two different techniques makes it difficult to identify and minimize error in collection. Each data collection technique has its limitations and thus using two techniques makes it difficult to minimize the errors arising from collection. It may not be easy to identify the technique that is more reliable than the other or the one that is causing more variation than the other. The decision to use these two techniques together was based on the ongoing challenge of the COVID-19 pandemic. Qualitative interviews were chosen but due to the need for minimum human interaction, the idea of using questionnaires was conceived. Interviews were conducted on the key informants since they were believed to possess more information on the subject hence the need to gather more through interviews. Evidently, the use of questionnaires limits the findings of this study in that it does not support collection of more insightful information as would be collected through probing during the interviews.

Recommendations

Based on the results above and the limitations, this study recommends that future studies should consider using only one of the two data collection techniques used in this study. Combining two data collection techniques in the same study makes it difficult to determine the validity and reliability of the results. For example, even though the validity

of the questionnaires were determined, it is not known how valid or reliable the use of questionnaires was. Nevertheless, this study recommends that future studies should use qualitative interviews since it gives the researcher the opportunity to probe the respondent for succinct and valid answers. It also allows the respondent to seek clarification on areas that are not clear hence reduces the number of invalid responses.

Data was collected from three different types of respondents: the emergency first responders, the key informants, and the facility staffs. Though each group of respondents have varied views and perceptions about emergency management which may be influenced by their positions and status at the plant, the data was analyzed together. Some questions were answered only by given group of respondents, yet the results were generalized to reflect response of the entire group of respondents. For instance, the challenge that facility staffs face may not be the same as that of key informants, but since the facility staffs were many, it is easy to generalize that that is challenge the firm is facing. Future studies should analyze the data facility staff, emergency first responder and key informants independently to obtain their opinions and perceptions per their categories.

Implications

Previous studies had addressed four main areas which include the need to adopt a multidisciplinary approach, adequate emergency preparedness, applicability of the normalization process theory in implementation process and effectiveness of training, drills, and exercises in addressing nuclear or radiological emergencies. The aim of this study was to understand the situation surrounding the implementation of preparedness

and response plans during an emergency situation in the event of a nuclear and radiological incident. The practical contribution of this study is that it will provide the information about the areas that need improvement as far as comparting incidences of nuclear and radiological events are concerned. The implication of this study is that it highlights the shortcomings in the existing system and policies and as such will create the need for policy makers to update policies that strengthen nuclear emergency preparedness and response. This study being a qualitative one, only offers an exploration to the situation without looking into the causal effects of the problem. As such, the implication of this study to the future research is that it offers an opportunity for future researchers by laying the foundation for them to investigate and validate given concepts.

Another implication of this study is that it has identified areas where future researchers can focus on so as to address the challenges facing the drill, train and exercise program. The results revealed that among the problems that are faced in the implementation is skeptical staff and complex programs. Future researchers should investigate ways through which the drill, train and exercise programs can be smoothly implemented. They should also investigate to find ways of simplifying the programs and identify strategies that can facilitate the implementation of these programs. The findings further indicate that some staffs complain of bureaucratic directives and as a result do not show the willingness to participate. Based on this findings, future researchers should investigate other factors that may hinder the willingness of staffs to participate and also ways through which staffs can be encouraged to participate in drill, training and exercise programs.

It is imperative to contextualize the significance of these findings within the provisions of the NRC so as to emphasize the need for improvement and to highlight the areas that require improvement. In order to ensure safety, even before licensing for operations, elaborate precautions are undertaken in line with NRC guidelines with regards to site selection, design, and construction of nuclear power facilities. These are usually done per the concept of defense-in-depth, which helps in reducing not only the probability but also the consequences of nuclear accidents (Baucher et al., 2018). Additionally, to address events of small probability that bear potential impacts on the safety of facility staff, the environment, and the public, all nuclear facility operators require a detailed emergency preparedness and response plan, which is the focus of this study.

Conclusion

The continuous availability of affordable and sustainable energy is the essence of modern economies not only in the developed countries but also in developing countries. Therefore, it has become a major government responsibility and priority to ensure a sustainable supply of energy for the people as well as foreign investors. Many important lessons can be taken or learned from previous nuclear facility incidents including the development of a nuclear emergency preparedness and response system. Many countries are embarking on nuclear energy and they need to further develop their disaster management systems taking into consideration each and every lesson learned from previous nuclear facility incidents. There is a wide variety of documents to be developed, coordinated, and harmonized both nationally and internationally. The main lesson learned

during this research is the need for policymakers to come up with policies that consider a wide variety of scenarios in order to inform the decision making of people who are charged with running and managing nuclear facilities.

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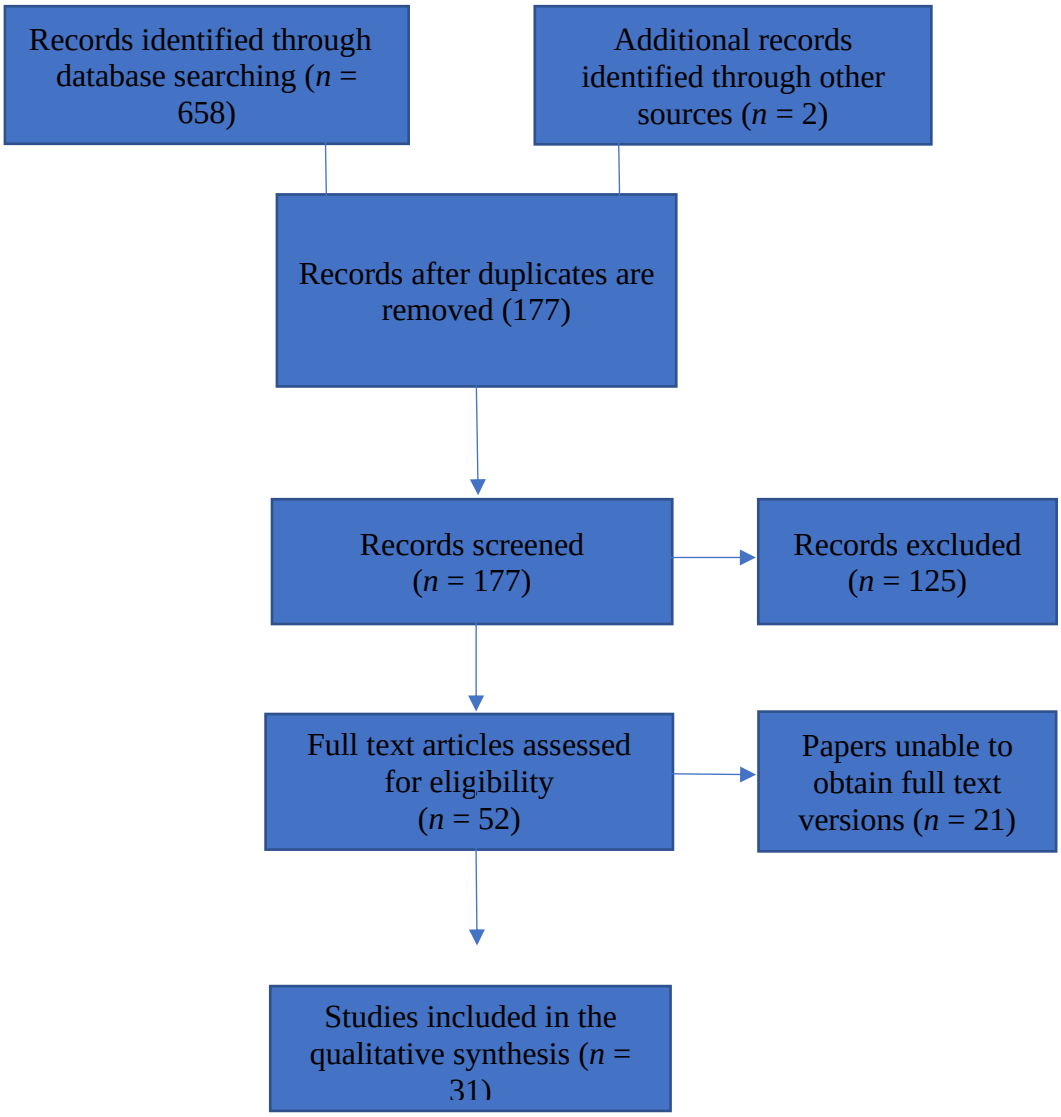
Appendix A: Literature Search Strategy



Appendix B: KII Guide for Facility Staff

Examining the perception of individuals regarding the processes involved in the implementation of the training, drills, and exercises at a nuclear plant in the southeastern United States

Key Informant Interview for Staff involved in the Training, Drill, and Exercise Program

Date of interview _____ Respondent's Gender _____

Respondent's Name _____ Interviewer's Name _____

Department _____

Start time _____ End time _____

Introductory Statement

Good morning, XXX. Thank you for participating in this interview. As stated in my invitation, this interview is strictly voluntary and confidential and should not take more than 45-60 minutes. If, at any time during the interview, you wish to no longer participate, please let me know and we will terminate the interview.

Ice Breaker Question

How long have you been working on Site and what functions/duties do you perform within your work scope?

Main Discussion Points

1. How has your department been involved with the training, drills, and exercise program?
    - What has been your role in the program?
    - Tell me about your experience with this program (using training, drills, and exercises to strengthen emergency response)?
2. In What ways do you think the training, drill, and exercise has been helpful in strengthening nuclear emergency preparedness and response?
    - What has worked well for the program?
    - What are the challenges?
3. How are training, drills, and exercises implemented at the plant?
    - What processes are involved in the implementation?
    - Who are involved in the implementation?
    - How are trainings, drills, and exercises conducted?
4. How have the trainings, drills, and exercises made difference for?

    Probe.
    - For emergency first responders?
    - For Site personnel?
5. How often do you participate in emergency response (training, drills, and exercises)?
    - What does this training consist of?

- How is it beneficial to you?

6. In what ways can the training, drill, and exercise program be improved?

   Probe.

   - What elements of implementation require improvement?
   - What elements of the program are sustainable?
   - What elements of the program are not sustainable?

7. Is there anything more you would like to add?

Concluding/Closing Statement

This concludes my interview. Thank you for the information that you have given me. Your knowledge and insights will be very helpful to me. If you have any follow up questions/comments, please feel free to contact me. Thanks again for your time and have a good day.

Appendix C: Individual Interview with Emergency First Responders

Examining the perception of individuals regarding the processes involved in the implementation of the training, drills, and exercises at a nuclear plant in the southeastern United States

Individual Interview Guide for Emergency First Responders

Date of interview _____ Respondent's Gender _____

Respondent's Name _____ Interviewer's Name _____

Start time _____ End time _____

Introductory Statement

Good morning, XXX. Thank you for participating in this interview. As stated in my invitation, this interview is strictly voluntary and confidential and should not take more than 45-60 minutes. If, at any time during the interview, you wish to no longer participate, please let me know and we will terminate the interview.

Ice Breaker Question

How long have you been working on Site and what functions and/or duties do you perform within your work scope?

Interview

1. In What ways do you think the training, drill, and exercise program has been helpful in strengthening nuclear emergency preparedness and response at the plant?
    - What has worked well for the program?

- What are the challenges?

2.How are training, drills, and exercises conducted?

- What procedures are involved?
- Who conducts the training, drills, and exercises?
- In what ways are the training, drills and exercises relevant to your role?

3.How have the training, drills, and exercises made a difference for?

Probe.

- Yourself?
- Other emergency first responders?
- Site personnel?

4. In how many Emergency Preparedness Drills & Exercises have you participated in thus far?

- What was your function/role?
- How prepared were you for this function/role?
- How well do the facilities respond?
- How is the level of preparedness measured?

5.How frequently are you trained in emergency responses?

- What does this training consist of?

6.How are corrective actions developed?

- Who participates in the development of the corrective action plan (CAP)?
- How is the CAP shared with the stakeholders?

7.How likely are the corrective actions selected to prevent recurrence?

8. In what ways can the training, drill, and exercise program be improved?

   Probe.

   - What elements of the program are sustainable?
   - What elements of the program are not sustainable?
   - What would you like to see improved?

Concluding/Closing Statement

This concludes my interview. Thank you for the information that you have given me. Your knowledge and insights will be very helpful to me. If you have any follow up questions/comments, please feel free to contact me. Thanks again for your time and have a good day.

Appendix D: Questionnaires

Questionnaire for Facility Staff

Examining the perception of individuals regarding the processes involved in the implementation of the training, drills, and exercises at the nuclear plant

1. How has your department been involved with the training, drills, and exercise program?

What has been your role in the program?

What are your experiences with the training, drills, and exercises?

2. How is the training, drill, and exercise program useful in strengthening nuclear emergency preparedness and response at the plant?

What has worked well for the program and what are the challenges?

3. How are training, drills, and exercises implemented at the plant?

   What processes are involved in the implementation?

   Who is involved in the implementation?

   How are the training, drills, and exercises conducted?

4. How often do you participate in training, drills, and exercises?

5. In what ways can the training, drill, and exercise program be improved?

   What elements of implementation require improvement?

   What elements of the program are sustainable?

   What elements of the program are not sustainable?

6. Is there anything more you would like to add?

Closing Statement: Thank you again for your time. I am very grateful for the information that you have given me**.** Please feel free to contact me if you have any follow up questions/comments.

Questionnaire for Emergency First Responders

Examining the perception of individuals regarding the processes involved in the implementation of the training, drills, and exercises at the nuclear plant

1. In what ways do you think the training, drill, and exercise program has been helpful in strengthening nuclear emergency preparedness and response at the plant?

What has worked well for the program and What are the challenges?

2. How are training, drills, and exercises conducted?
What procedures are involved and who conducts the training, drills, and exercises?

In what ways are the training, drills and exercises relevant to your role?

3. How has the training, drills, and exercise program made a difference for yourself, other emergency first responders and Site personnel?

4. How many trainings, drills & exercises have you participated in?

What was your function/role?

How prepared were you for this function/role?

How well do the facilities respond?

How is the level of preparedness measured?

5. How can the training, drill, and exercise program be improved?

What elements of the program are sustainable?

What elements of the program are not sustainable?

What would you like to see improved?

Closing Statement: Thank you again for your time. I am very grateful for the information that you have given me**.** Please feel free to contact me if you have any follow up questions/comments.

Appendix E: Excerpt of Coding

Open code	**Subcategory**	**Categories**	**Participants' Identifier**	**Excerpts**
Participate	Department involvement	Involvement	Facility staff 1	*My department participates in drills and exercises*
Part of drill staff	Individual involvement		Facility staff 1	*Now I'm part of the drill and the command staff*
Weekly	Participation frequency		Facility staff 1	*Before COVID-19, I was participating weekly in a drill or exercise*
			Facility staff 6	*Prior to the suspension (COVID-19), drill and exercise participation averaged one per week*
			Facility staff 9	*4-5 times a month*
			Emergency first responder	*Between 5-6*
Often			Facility staff 3	*As often as needed, however, I am involved daily in the development of drills and exercises*"
Monthly			Facility staff 2	*I participate in drills every month of the year*
Several times a year			Facility staff 7	*SRNS will conduct the 2S Drills approximately 200+ per year* *Let's go with 70 a year*

			Participant 3	
Rarely			Facility staff 8	*I rarely participated in the training portion for my respective facility. As for drills and exercises, I participated in every event for my respective facility and nearly every drill or exercise for other facilities*
			Participant 2	*So, in the last few months, not at all. We did a virtual tabletop*
Controllers	Department role	Role	Facility staff 1	*My department participates as role players or controllers*
Develop and conduct drill exercise			Facility staff 8	*My team was responsible for developing and conducting drills and exercises for multiple facilities at the site*
Develop scenarios			Participant 3	*One (group) writes scenarios, you know develops them. Puts them together, writes them. And the other group, the lead*

				controllers, they oversee the conducting on the drills and exercise from the facilities"
Drill and command staff				
Evaluation	Individual role		Facility staff 2	*I evaluate drills and ensure procedure compliance*
Standardize			Facility staff 2	*I created a standardized briefing for drill Controllers to use at each drill*
Lead controller			Facility staff 9	*As Lead Controller, I am responsible for planning, coordinating, executing the conduct of drills/exercises, and writing effective lessons learned and/or after-action reports* *My primary role was Joint Information Center Assistant, but*

			Emergency responder	*have served in the role of Controller once or twice*
Scenario writing			Facility staff 6	*I have held two primary roles as a Scenario Writer and Lead Controller*
Oversight and coordination			Facility staff 7 Participant 2	*I have the oversight and coordinator role of this program* *My department, we coordinate the training and the drills*