Barriers, Enablers, and Strategies Influencing Female Leaders' Career Advancement in the Nuclear Industry

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BARRIERS, ENABLERS, AND STRATEGIES INFLUENCING FEMALE LEADERS' CAREER ADVANCEMENT IN THE NUCLEAR INDUSTRY

by

Anesa Young Davis

A Dissertation
Submitted to the Graduate School,
the College of Business and Economic Development
and the School of Leadership
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

Approved by:

Dr. Heather M. Annulis, Committee Chair
Dr. H. Quincy Brown
Dr. John J. Kmiec
Dr. Dale L. Lunsford

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ABSTRACT

Women entering science, technology, engineering, and math (STEM) occupations increased by 19% between 1970 and 2019, but at 74% of the STEM workforce, men still dominate the field (Martinez & Christnacht, 2021). In the nuclear industry, this disparity is most apparent with few women holding leadership roles within nuclear organizations (Kovaleski, 2014; Gaspar & Dubertrand, 2019). While research suggests that companies with women leaders in the manager level through the board level excel in organizational performance (Catalyst, 2007), a problem exists for women when trying to promote to leadership positions, especially to the C-suite in STEM fields (Warner, 2014).

Findings from previous studies provide conclusions; however, female employees remain underrepresented in leadership positions in male-dominated industries (Huang et al., 2019). Therefore, the purpose of this study was to explore and identify female leaders’ perceptions of barriers, enablers, and strategies that influence career advancement in the nuclear industry. Female leaders, who hold senior manager or above positions and have employment in the nuclear industry, served as the population for this study.

Through the use of interpretative phenomenological analysis (IPA), the researcher explored, identified, and interpreted the experiences of women in the nuclear energy industry to determine the barriers, enablers, and business strategies that influence career advancement. To capture the lived experiences, the researcher facilitated virtual semi-structured, one-on-one interviews to identify recurring themes. Study participants \((n = 6)\) suggest the creation of a formal mentoring program, an increased focus on diversity recruiting, and exposure to developmental opportunities enhance females’ career
advancement. A focus group, used for triangulation, validated the study’s findings.

Recommendations for nuclear industry leaders offer business strategies to promote the advancement of female careers.
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A special thank you to Tamara May, Regional Women in Nuclear President, and the Women in Nuclear who participated in the study. With all that you do each day, I appreciate the time you took from your busy schedules to share candid feedback, which will serve to improve gender diversity and career advancement for women.

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I am forever thankful for my family, friends, cohorts, and colleagues. Thank you for pushing me to be my absolute best, no matter what came my way. Your prayers and encouragement inspired me to finish what I started.
DEDICATION

All praises to God for his love, kindness, mercy, and grace. “I will give thanks to you, LORD, with all my heart; I will tell of all your wonderful deeds.” Psalms 9:1.

Throughout this journey, He has been my rock and my strength.

To my mother, Betty Young, I dedicate this dissertation to you and thank you for always believing in me. You have always made me feel like a superhero who can tackle the world. To my children, Remy Young and Dr. Jeremiah Davis, I dedicate this dissertation to you. Thank you for encouraging me and having confidence in me. Also, I dedicate this dissertation to my late father, Ronald Young, and late aunt, Dr. Gloria H. Bryant. I miss you dearly and know that you are smiling down at me from heaven full of pride. I love you all.

Lastly, I dedicate this dissertation to my other family members and close friends who refused to let me fail. Each of you knows who you are, and I am grateful for your tenacity, love, kindness, and support.
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<tr>
<td>kWh</td>
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CHAPTER I – INTRODUCTION

It was like a new world opened to me, the world of science, which I was at last permitted to know in all liberty.

—Marie Curie

The nuclear industry’s creation and advancement benefit from the contributions of women throughout history. However, women remain underrepresented in science, technology, engineering, and math (STEM) fields. Even with a focus on increasing the number of women pursuing STEM careers, the current outlook for women in the nuclear industry reflects a gender gap (Green, 2018). Even though women generally achieve high levels of academic achievement with the potential to earn higher salaries, women proficient in STEM fields are more likely to choose careers outside of STEM (Ceci et al., 2009; WGU Information Technology, 2019). Women in STEM fields earn 33% more than their female peers in other jobs; however, women in STEM typically advance at a slower pace and transition to other positions outside of STEM more so than their male peers (Valian, 1998). As women progress to leadership positions, the higher the likelihood of gender discrepancies which creates a pattern of underrepresentation across industries (Trower & Chait, 2002).

Research indicates that a diverse workforce with a gender balance improves innovation, decision-making, and leadership abilities (Bagshaw, 2004; Dessler, 2001; Diaz-Garcia et al., 2013, Govindji, 2014; Torchia et al., 2011; Wittenberg-Cox, 2019). According to the National Research Council (2012), overlooking women in the STEM workforce may lead to reduced innovation, which can limit productivity and profitability. Highly engaged, gender-diverse organizations can improve a company’s financial
performance and create a competitive advantage against others in their industries (Govindji, 2014). Dainty et al. (2000) report that for female employees to endure in the STEM industry, women must think through three possible choices: (a) behave like their male counterparts, (b) lower their aspirations and assume subordinate positions, or (c) concede and transition to work somewhere else. In addition, Dainty et al. (2000) contest that female employees have trouble reaching senior-level leadership roles for two main reasons: (a) the intentional social isolation by male employees and (b) the downplay of female employees’ contributions by male employees to maintain their roles in male-dominated industries. Despite the importance of the value of a gender-diverse workforce, women still struggle to advance in male-dominated STEM industries (Moss, 2019).

While women continue to gain more undergraduate, graduate, and professional degrees, a problem persists when aspiring to promote to leadership levels, especially within the executive levels in STEM fields (Warner, 2014). Huang et al. (2019) report that over the past five years, female representation improved in senior leadership roles, but female employees remain underrepresented at all levels. The glass ceiling characterizes the obstruction to career growth, especially senior leadership roles, in organizations where female employees and minority employees experience a failure of progression into higher-level roles within an organization (Yukl, 2012). In some industries, the glass ceiling shows a decline, and women in leadership roles increase; however, this does not reflect the same trend in the nuclear industry and other male-dominated industries (Herrera et al., 2012).

According to the 2019 Women in the Workplace report from McKinsey & Company and LeanIn.org, females’ most significant workplace obstacle remains the
broken rung (Huang et al., 2019). The broken rung theory explains that at every stage of the career ladder, women progress in lower numbers as compared to their male counterparts, especially early in their careers. At every career progression, the number of female leaders decreases. Women hold just 38% of manager-level positions, while men hold 62% (Huang et al., 2019). Training industry research shows that leadership development training offered to male employees and female employees varies significantly in quality. This creates a self-perpetuating cycle that keeps women behind in career progression because a higher percentage of men hold leadership positions who make the decisions on promotions and successions (Oesch, 2020). Female employees represent nearly 50% of the United States workforce, holding less than 30% of the positions within science, technology, engineering, and mathematics (STEM) (National Science Board, 2015; U.S. Census Bureau, 2020). The Office of Nuclear Energy (2021) and the International Atomic Energy Agency report that less than 25% of women make up the nuclear industry workforce worldwide, which impacts workplace diversity and limits the industry’s competitiveness to grow as new technologies enter the market (Gaspar & Dubertrand, 2019). Of the women working in the nuclear industry, very few serve in leadership positions (Jais & Hassan, 2018; Kenney, 2016; Kovaleski, 2014).

Background of the Study

The history of women in science and technology begins with acknowledging the struggles many women endure to pursue educational goals and careers in science, which include “obstacles based on outdated traditions, culture and outright prejudice” (Neadle, 2016, p. 4). Despite these struggles, women have made important discoveries and contributions through game-changing research (Cowen, 2021; Rigby, 2021). Research
suggests that the work, research, and accomplishments of women in science often remain untold or buried in footnotes or acknowledgment sections rarely read (Yong, 2019). Recent projects provide insight into many of these stories to highlight the untold history of women in science. One project, *Hidden Figures*, shares the story of “three black female mathematicians who assisted NASA win the space race in the 1960s” (Yong, 2019, p. 3). Another project highlights the work of Margaret Wu, who worked with G. A. Watterson to create a statistical tool for estimating the correct amount of genetic diversity needed to make up a population of a specified size. The statistical tool, now known as the Watterson Estimator, has no reference to Wu. She did not receive any authorship for the paper (Yong, 2019).

Conversely, historical references point to early male advocates of female scientists during the time when female scientists were not welcomed in scientific fields. The French Academy of Science nominated Henri Becquerel and Pierre Curie for the Nobel Prize in Physics in 1903, thereby overlooking the contributions of Marie Curie to the research on radioactivity the trio performed (American Institute of Physics, n.d.). However, a member of the nominating committee – who was also an advocate for female scientists – Swedish mathematician Magnus Goesta Mittag-Leffler, advised Pierre Curie of the omission, which he was able to have corrected to have Marie Curie nominated and awarded with them in 1903 (American Institute of Physics, n.d.). Most notable of the female scientists, Marie Curie, a Polish chemist and physicist, was the first female scientist awarded a Nobel Prize and the first individual in history to achieve the accomplishment of being awarded a Nobel Prize twice (Pospieszny, 2019; Sanz, 2015). Curie’s accomplishments remain notable as she faced considerable challenges in
pursuing her education in the late 1800s. Women born in Warsaw, Poland, which was a part of the Russian Empire, could not pursue a university education, so Curie left Poland to pursue her university degrees in France at the University of Paris (Atomic Heritage Foundation, 2021). Her work and contributions to the fields of chemistry and physics contributed significantly to the conception of the atomic bomb and understanding of radiation in uranium and other elements (Atomic Heritage Foundation, 2021; Rutherford, 1935; Spalluto, 2017).

Curie, along with other women, plays a pivotal role in the history and progression of the nuclear industry. The list includes female scientists: Lise Meitner, Harriet Brooks, Jessie Mabel Wilkins Slater, Ellen Gleditsch, Marietta Blau, and Irene Joliot-Curie. These women made significant contributions to nuclear physics in the early decades of the twentieth century; still, many of their achievements remain understated or overlooked (Cook, 2018; Taylor, 2000). Also, these female scientists were among the first to receive doctorate degrees in their fields of study, and many cared for a family while doing so. As pioneers in their fields, the scientists faced opposition and were viewed as outcasts for their scientific stances (Cook, 2018). Lise Meitner, also called the "Mother of Nuclear Power," discovered nuclear fission, the method of how the nucleus of a heavy atom splits, which releases enormous quantities of energy (Exelon Corporation, 2020, p. 3). The uncovering of this technology guided the growth and expansion of nuclear power plants that provide carbon-free electricity worldwide.

Nuclear power serves as the most reliable energy source in the world. The United States Department of Energy asserts that this energy source generates approximately twice as much reliable energy as natural gas and coal-fired plants and approximately
three times more reliable energy than solar and wind plants (Mueller, 2021). This reliable energy source production comes from nuclear power, and in 2020, the nuclear power plants in America operated at full capacity more than 92% of the time (Office of Nuclear Energy, 2021). Nuclear power plays an integral role in the United States electric power generation framework even as the industry experiences changes (Donovan & Fisher, 2020; Goldberg & Rosner, 2011; World Nuclear Association, 2021). In 2021, research highlighted that the United States accounted “for more than 30% of worldwide nuclear generation of electricity” (World Nuclear Association, 2021, p. 1).

In the United States in 2019, 58 nuclear power plants, which operate commercially, with 96 nuclear reactors produced 809 million kilowatts per hour (kWh), which makes up roughly 20% of the total electric output for the United States (World Nuclear Association, 2021; U.S. Energy Information Administration, 2020). According to the Nuclear Energy Institute (2020), nuclear energy generates electricity without releasing “harmful pollutants like nitrogen oxide, sulfur dioxide, and particulate matter or mercury” (p. 1); this output from nuclear energy also accounts for 55% of the nation's carbon-free electricity, which shields our air quality (Nuclear Energy Institute, 2020). The United States' reliance on nuclear power continues to grow and supports the powering of businesses and homes in 28 U.S. states (Office of Nuclear Energy, 2021). With this reliance, the industry must continue to employ a sustainable workforce to safely operate and maintain nuclear plants.

Statement of the Problem

Ideally, the nuclear power industry maintains a balanced and diverse workforce that provides leadership opportunities for qualified women. Hewlett et al. (2013) delivers
convincing evidence that diversity increases and inspires innovation and propels market growth. These findings should strengthen efforts from companies to ensure that diversity exists within the executive ranks, as well as throughout the entire organization.

According to Census.gov, women made up eight percent of the STEM workforce in 1970, and in 2019, women make up 27% of the STEM workforce (U.S. Census Bureau, 2020). With this increase of women entering STEM fields, an increase should occur in women holding leadership positions in the nuclear industry. This increase could improve the diversity of thought, play a critical role in innovative capacity, and increase global competitiveness (Martinez & Christnacht, 2021).

Conversely, few female employees hold senior-level leadership roles within the nuclear power industry (Jais & Hassan, 2018; Kenney, 2016; Kovaleski, 2014). The lack of women in leadership does not reflect the broader trend of more female employees in leadership roles in other industries. According to research from McKinsey & Company and LeanIn.org, conducted in corporate America, the representation of female employees trends upward, especially in senior level roles. (Thomas et al., 2020). Challenges of the glass ceiling and broken rung continue to serve as major barriers even with the gains of women represented in leadership roles (Thomas et al., 2020).

According to Gaspar and Dubertrand (2019) of the International Atomic Energy Agency, a gap in gender diversity exists in the nuclear workforce worldwide, which hinders not only diversity but also global competitiveness in the industry. This lack of diversity makes the industry vulnerable to decreased innovation, which may limit effectiveness and efficiencies, particularly as the nuclear industry aims to harness talent and expertise to contribute to eradicating global issues such as access to clean energy and
clean water (Harvey, 2020; Nuclear Innovation Clean Energy Future, n.d.). Leaders must create a strong, gender-diverse workforce to increase and invigorate development and sustainability in nuclear (Harvey, 2020).

Purpose Statement

The purpose of this study is to explore the lived experiences of female leaders in the nuclear industry to determine factors that influence career advancement. Female leader insight provides first-hand knowledge of the opportunities, challenges, and business strategies that hinder or enhance their career progression working in the nuclear industry. Understanding the factors that contribute to career advancement may also assist in decreasing the gender diversity disparity in the nuclear workforce. Moreover, understanding the barriers, enablers, and business strategies that influence career advancement remain integral to recruiting and retaining women in the nuclear industry (Gasper & Dubertrand, 2019).

Research Objectives

This study focuses on factors that influence female leaders’ career advancement in the nuclear industry. A necessary step and important element in the completion of a successful research study compels the researcher to design a set of well-defined and clearly stated research objectives (Farrugia et al., 2010; Roberts, 2010). Accordingly, research objectives help define the considerations for what the researcher aims to achieve, which influences the methodology design, data collection, and analysis (Creswell, 2013; Farrugia et al., 2010). Therefore, the following research objectives guide the study:
RO1 - Describe the demographic characteristics of the participants, including degree level, degree focus area, years of experience in the nuclear industry, and years of experience in current position.

RO2 - Explore barriers to career advancement as perceived by female leaders in the nuclear industry.

RO3 - Explore enablers to career advancement as perceived by female leaders in the nuclear industry.

RO4 - Determine business strategies that hinder career advancement as perceived by female leaders in the nuclear industry.

RO5 - Determine business strategies that enhance career advancement as perceived by female leaders in the nuclear industry.

Significance of the Study

This study aims to provide leaders in the nuclear industry insights into the perceived enablers and barriers of career advancement of female leaders. Moreover, this information serves to provide current and future women in the nuclear workforce with information on the factors that may influence career growth. The research findings will provide additional context to the conversations on gender representation in STEM industries. The research contributes to the understanding of factors that may have an influence on women’s decisions to choose the nuclear industry as a career. The results of this study may help to improve the hiring practices, retention, and internal promotion strategies for nuclear organizations and their leaders.
Conceptual Framework

A conceptual framework visualizes the main constructs, variables, components, postulates associations among them (Miles & Huberman, 1994) and provides the researcher with assistance on understanding the appropriate methodology for the study (Corbin & Strauss, 2008). This study uses Figure 1 to illustrate the factors that influence female leaders’ career advancement in the nuclear industry. The conceptual framework exhibits the perceived barriers and enablers to career advancement, the business strategies that hinder or enhance career advancement, and the foundational theories of the research.

Figure 1. Conceptual Framework
Four theories, including (a) human capital theory, (b) path-goal theory, (c) work empowerment theory, and (d) the broken rung theory function as the foundation for this study.

**Human Capital Theory (HCT)**

According to Schultz (1961), the knowledge, skills, and abilities that an employee contributes to an organization represent human capital, which can then generate earnings in the labor market. Becker (1993) introduces training and education as additional investments in human capital that influence earnings. In this study, human capital aspects will provide a view into the insights of the participant inputs to explore the factors influencing career advancement.

**Path-Goal Theory**

House’s path-goal theory (1971) specifies that a leader’s style or behavior can affect the motivation and performance of a group by rewarding employees for achieving goals, clarifying paths toward those goals, and removing obstacles to perform. The path-goal approach builds upon the expectancy motivational theory, which states that the degree of a job leads to various outcomes, and the evaluation of these outcomes can predict an individual’s behavior or attitude (House & Mitchell, 1975).

**Work Empowerment Theory**

Kanter’s work empowerment theory (1977) describes the structure of opportunity and the structure of power as the two primary empowerment structures in organizations (Laschinger et al., 2010). Management’s responsibility includes providing employees with the tools “to maximize their ability to accomplish work in a meaningful way” (Laschinger et al., 2010, p. 2). Kanter (1977) advocates for work settings that provide
autonomy, opportunities for training, developmental roles, job experiences, mentorship, support groups, flexible and flat organizational structures, and employee discretion (Kanter, 1977; Laschinger et al., 2010).

**Broken Rung Theory**

The broken rung theory explains that women face broken rungs at the bottom of the career ladder leading to senior positions in organizations (Engelmeier, 2020; McKinsey & Company & LeanIn.org, 2019). For every 85 female employees promoted to leadership positions, 100 male employees are promoted, which results in female employees remaining outnumbered in leadership positions (Coury et al., 2020). This early imbalance and disparity create a long-standing effect on the talent pipeline resulting in substantially fewer female employees promoting to senior managers (Guy, 2020).

The literature sections study participant experiences into barriers, enablers, and business strategies that either contribute to career advancement or hinder career advancement for women in the nuclear industry. Research highlights mentoring and individual development, which improves work engagement and builds relationships, as potential enablers. According to research by the International Atomic Energy Agency, work-life balance, gender bias, and stereotypes appear as potential barriers for women entering the nuclear industry, and women who work in the nuclear industry experience limited career advancement (Gaspar & Dubertrand, 2019).

**Delimitations**

A delimitation represents a decision by the researcher that may impact the study (Shadish et al., 2002). Roberts (2010) concludes that delimitations inform the reader on what the researcher will include, how the study is summarized, and what the researcher
will exclude. Two delimitations exist for this study. The first delimitation of the study relates to the selection of participants, female leaders in the nuclear industry. As increases in career advancement for women in other industries improve, this trend remains stagnant for women in the nuclear industry. The study does not include men, as women remain the minority in the nuclear industry. The objectives chosen by the researcher serve as the second delimitation for this study. The objectives allow the researcher to gain insight into factors relating to the career advancement of women through the lived experiences of participants. The research objectives center on participants’ lived experiences and drive the research.

Assumptions

Assumptions include the elements of a study acknowledged as accurate or at least credible by peer researchers and then become the operational requirements of the study (Pyrczak, 2016). According to Creswell (2013), assumptions include viewpoints the researcher connects to the study. This research considers three assumptions: (a) reliable and valid data collection tools will be used to ascertain the perceived barriers and enablers from the participants; (b) the participants will provide factual and honest responses to the survey questions; (c) and all participants understand the purpose of the study and do not feel pressured to provide or withhold information regarding their experiences.

Definition of Terms

The below definitions clarify the terms that occur in this study.

1. *Career advancement* occurs when employees have opportunities to grow their careers through upward progress (McKay, 2018).
2. *Exclusion bias* refers to the “exclusion of members of the workforce from experiences and opportunities for which they are qualified… and can prevent businesses from leveraging the talents and perspectives of all members of their workforce” (Bodin, 2020, p. 1).

3. *Gender bias* refers to the different treatment of someone because of their perceived or actual gender identity (Legal Information Institute, 2020, p. 1).

4. *Gender inequality* occurs when the cultural, social, and legal state defines the rights for an individual, displayed in the forms of unequal access, as well as in the supposition of stereotypical cultural and social roles (European Institute for Gender Equality, 2004)

5. *Gender wage gap* is the pay inconsistency between male and female employees (Fleming, 2018).

6. *Human capital* is the “knowledge, information, ideas, skills, and health of individuals” (Becker, 2002, p. 3).

7. *Mentoring* refers to the relationships of senior-level or experienced employees with entry-level or less experienced employees to provide coaching, counseling, and support (Dunbar & Kinnersley, 2011).

8. *Nuclear energy* occurs as atoms split in a reactor and water heats and changes into steam. Then the steam turns the turbine, which generates electricity without carbon emissions (Nuclear Energy Institute, 2021).

9. *Perception* occurs as a response to a stimulus or stimuli caused by a person’s past experiences and knowledge, which play vital role in determining how the person responds (Montz, 2004).

11. *Work engagement* refers to a full-filled work-related frame of mind that exemplifies positivity and embodies drive, absorption, and commitment (Schaufeli et al., 2002).

12. *Work-life balance* is an employee’s capability to balance family and work responsibilities and commitments, while also managing other non-work obligations (Delecta, 2011).

Organization of the Study

This study comprises of five chapters. Chapter I offers an introduction and the study’s background, purpose, and conceptual framework. Also, this chapter presents the research objectives, delimitations, assumptions, and definitions of terms. In Chapter II, the researcher presents a theoretical review and synthesis of the literature and fundamental supportive theories to improve comprehension of the participant’s experiences. Chapter II also presents a literature review and relevant research related to the topic. Chapter III explains the qualitative research methodology and includes the proposed process to collect data for the study. Chapter IV outlines the results of the research and details the participant demographics and identified themes. Chapter V discusses the findings, conclusions, and recommendations from the research.

Summary

This study explores factors that influence female leaders’ career advancement in the nuclear industry. The researcher seeks to explore the factors using the theories of Schultz, Becker, House, and Kanter to identify the enablers and barriers that lead to
career advancement for women in the nuclear industry. This study may assist nuclear
industry leaders and women in the nuclear industry by providing insights on ways to
improve efforts to promote initiatives to advance female careers. The research adds to the
current literature on women in leadership in STEM in male-dominated industries,
specifically the nuclear industry.
CHAPTER II – LITERATURE REVIEW

The purpose of this chapter is to provide a review of literature and theories relevant to female career advancement in the nuclear industry. The review explores the existing literature on women in science, women in leadership, and women in nuclear energy leadership. Further, this chapter focuses on enablers and barriers to career advancement that women encounter in a male-dominated industry. The researcher also provides a review of the various theories and includes historical perspectives, as well as current perspectives to provide insight on perceived factors influencing female leaders’ career advancement in the nuclear industry.

Women in Science

To understand the current barriers to career advancement faced by women in the nuclear industry, a historical review of women in science provides insights into challenges women face throughout the years. Condé (2019) reflects on the past narratives concerning women’s history in science, acknowledging that while women made extraordinary contributions to scientific knowledge, much was concealed by a male-controlled culture that dramatically impeded women’s integration into scientific activity. Schiebinder (1987) points out that individuals who read about the lives of women in science become acutely aware of the struggle that female scientists have had to battle in order to gain appreciation, support, and recognition within the scientific community. According to Kohlstedt (2004), participation by women in science and technology persists but inconsistently due to intellectual, economic, and social barriers. Research indicates an increase in the number of women in science over the past half-century; however, quantitative studies and individual narratives suggest that the gender gap
presents a challenge – especially regarding salaries, career advancement, and opportunities (Kohlstedt, 2004; National Science Board, 2014; STEM Women, 2021).

History of Women’s Influence on Science and Technology

Prior to the civilizations of early Greece and Rome, women practiced medicine in ancient Egypt (Ferry, 2019). According to the Science and Technology Facilities Council (2017), Merit Ptah, who lived around ca. 2700–2500 B.C.E., was “the chief physician” as inscribed on her tomb. Ptah is the first woman named in the history of science, and many consider her the first female physician in history (Herzenberg et al., 1991). When the Roman Empire neared the end of its reign in the 4th century, a female astronomer, Hypatia of Alexandria, emerged (Clement et al., 2009; Herzenberg et al., 1991). Also recognized as a well-respected mathematician, Hypatia lived from 370 to 415 and became a professor of mathematics and philosophy at Alexandria’s Neoplatonist School of Philosophy (Science and Technology Facilities Council, 2017). Hypatia remains symbolic of the worst forms of professional struggle that women endured in history due to her tragic death at the hands of a mob in 415 (Clement et al., 2009; Herzenberg et al., 1991).

During the Middle Ages, the church-controlled learning in the West and the convents became the chief sources for learning opportunities for women (Herzenberg et al., 1991; Schiebinger, 1993). Zeuber (1987) provides a perspective in Medieval Callings of how men in the Middle Ages thought of women as a category, but only late in the period did they perceive differences in the expected behavior of women by directing standards such as professional activities to their model. Additionally, Zeuber (1987) highlighted how women were seen as a country-dweller, a saint, or the lady of a castle,
and women were characterized by their physique, gender, and family relationships. Women’s personas and the ethos they lived by each day related in some way to a man (Zeuber, 1987).

With the birth of modern physics in the 17th century, scientific societies and academies replaced the domination of learning by monasteries and universities. Among these academies were the Akademie der Wissenschaften in Berlin, the Acadamie des Sciences, and the Royal Society of London (Schiebinger, 1993), and although there were no formal statues that barred admittance of female scientist, an engrained practice of prohibiting women occurred for more than three centuries (Petrovich, 1999). Nevertheless, during the seventeenth and eighteenth centuries, several women were active in science and made significant contributions.

In Germany during the early 18th century, women represented 14% of the German astronomers (Schiebinger, 1993). Caroline Herschel, an astronomer at that time, strategically included comet sightings into her home life and exhibited her discoveries in socially appropriate ways (Winterburn, 2015). She learned astronomy and mathematics from her brother, William Herschel, who discovered the planet Uranus in 1781 (Winterburn, 2014). Another astronomer during this period, Maria Winkelmann Kirch, learned astronomy from her father and uncle, who believed that she deserved an education equivalent to that taught to boys (Schiebinger, 1987). Winkelmann Kirch and her husband, Gottfried Kirch, worked in the field together, and Maria published astronomical observations under his name when he became ill. After her husband’s death, Winkelmann Kirch petitioned the Berlin Academy in 1710 for an appointment as an assistant astronomer and calendar-maker; however, the Berlin Academy denied her
request even with the support of the academy’s president (Schiebinger, 1987; Schiebinger, 1993). With this denial, officials at the Academy established a significant adverse precedent for women’s involvement in scientific organizations and institutions (Schiebinger, 1993). Lise Meitner became the first working female scientist member to join the academy, and in the 1940s, she discovered the process of nuclear fission (Cook, 2018; Schiebinger, 1993; Taylor, 2000).

Throughout the past centuries, women scientists excelled in math-based sciences. In 1738, Italian mathematician, Marie Agnesi, became well-known for her contributions to differential calculus (Dalmédico, 1991; Schiebinger, 1993). Dalmédico (1991) details how Sophie Germain overcame the prejudices of the French society to create a lasting oeuvre in number theory and the theory of elasticity. During the 19th century, notable female scientists continued to emerge and contributed to new findings and discoveries within their fields of study. Russian-born Sofya Kovalevskaya studied abroad to overcome the challenges she faced living in a country where women could not attend the university in Russia (Audin, 2011; Schiebinger, 1993). During this time, Russia denied women the ability to travel across Russia’s borders unless accompanied by their husbands or parents. To pursue her education, Kovalevskaya took the radical step of a marriage contract, known as a white marriage, which allowed her freedom of movement (Schiebinger, 1993). Kovalevskaya completed her doctorate with Weierstrass in Berlin, but since that university did not grant degrees to women, Kovalevskaya pursued and earned a doctorate from the University of Gottingen in 1874 and ultimately became a professor of mathematics at the University of Stockholm and the first woman to serve as editor of a scientific journal (Audin, 2011).
Most notable of the female scientists, Marie Curie, a Polish physicist and chemist, faced challenges to pursue her education in the late 1800s. In her home country of Poland, which was under Russian rule, Curie could not pursue a university education and had to travel to France, where she completed her studies at the University of Paris (Pospieszny, 2019; Sanz, 2015). As was the case with many women in science during this period, Curie's legitimization in the field came through her husband, Pierre. The Curies and Henri Becquerel’s joint research on the radiation phenomena led to the award of a Nobel Prize in Physics in 1903 (Fröman, 1996; Pospieszny, 2019). After Pierre Curie’s death, Marie Curie assumed his professorship at Sorbonne University – the first woman to receive a teaching appointment at this institution (Fröman, 1996; La Chancellerie des Universités de Paris, 2021). In 1911, Marie Curie received her second Nobel Prize in Chemistry for her discovery and isolation of the element’s radium and polonium.

Following Marie Curie, female scientists continued to make significant contributions in STEM fields ranging from astronomy, mathematics, chemistry, and nuclear physics. Canadian physicist Harriet Brooks, a graduate student who worked briefly under Marie Curie, was the first woman to earn a master’s degree from McGill University in Quebec (Klus, 2020). Austrian physicist, Lise Meitner, received a doctorate degree from the University of Vienna in 1905 (Bradford, 2018). In 1938, while working with fellow physicist Otto Frisch, the pair discovered nuclear fission, the process by which the nucleus of an atom splits into smaller parts, releasing large amounts of energy (Tretkoff, 2007; Exelon Corporation, 2020; Klus, 2020). This breakthrough led to the development of harnessing nuclear power as a source of energy to generate electricity. The second woman to win the Nobel Prize, Irene Joliot-Curie, daughter of Pierre and
Marie Curie, showed that radioactive materials could be created artificially, and in 1938, Joliot-Curie and nuclear physicist Paul Savitch created an element that was a step towards uranium fission, but the onset of World War II disrupted their research (Klus, 2020). After the war, Joliot-Curie joined the Radium Institute in 1948 and helped construct the first French nuclear reactor (Klus, 2020). In addition to the breakthrough findings within nuclear physics, women continued to advance in science and contributed to other STEM areas.

A pioneer in molecular biology, Rosalind Franklin, in 1952, played a meaningful role in understanding the double helix structure of DNA (Klus, 2020; Percec & Xiao, 2021; Zielinski, 2011). Dorothy Hodgkin, a British chemist, won the 1964 Nobel Prize in Chemistry for her work to identify the structures of insulin, vitamin B12, and penicillin using X-ray crystallography (Zielinski, 2011). American computer scientist, Grace Hopper, became Director of the Navy Programming Languages Group in 1967 and pioneered the use of standards for early computer programs like COBOL and FORTRAN (Klus, 2020; Norwood, 2017). In 1972, Willie Hobbs Moore became the first black woman to receive a Ph.D. in Physics in the United States and served as an executive at Ford Motor Company (Stith, 2018). In 1983, Sally Ride became the first American female astronaut in space serving as a mission specialist in 1983, only preceded by Russian astronauts Valentina Tereshkova in 1963 and Svetlana Savitskaya in 1982 (Harnett, 2013; Sherr, 2014). Italian particle physicist, Fabiola Gianotti, began working at the Large Hadron Collider (LHC) in 1993 and on January 1, 2016, became the first woman appointed Director-General of Conseil Européen pour la Recherche Nucléaire (CERN) currently still holding this position being reappointed in 2019 to start a new term.
on January 1, 2021 (Banks, 2019; CERN, 2019; CERN, 2021). While women continue to play an integral role in scientific findings and advancement, the United States seeks ways to capture scientific knowledge, especially the knowledge applied to wartime problems, with applicability during peacetime (National Science Board, 2015). On May 10, 1950, Congress passed the National Science Board and established the United States National Science Foundation.

**Overview of STEM**

The United States National Science Foundation (NSF) began using the acronym SMET when referring to curriculum and areas in the disciplines of science, math, engineering, and technology (Hallinen, 2015). In 2001, Dr. Judith Ramaley served as the assistant director of education and human resources at the NSF and found SMET to be an unappealing acronym and rearranged the letters to form the STEM acronym (Bybee, 2013; Hallinen, 2015; Loewus, 2015). While the acronym gained attention during the early 2000s, history indicates United States STEM education began as early as the 1950s (Powell, 2007). In 1957, the Soviet Union launched the Sputnik satellite beating the United States into space, which placed a spotlight on education as a national problem (Powell, 2007; Herman, 2019).

According to Baum et al. (2013) and Powell (2007), President Eisenhower established the National Aeronautics and Space Agency (NASA) in 1958, to answer the Soviet Union’s launching of their satellite to gather intelligence. The federal government also passed the National Defense Education Act in 1958, which provided $1.4 billion over four years in education funds for gifted students studying science, mathematics, engineering, or modern foreign language (Title II, Sec 204). The act specifically
addresses the use of the funding to ensure underprivileged students could participate and would be included in the talent pool (Title I, Sec 101). Additional legislation promoting STEM education followed as the 1960’s Presidential candidates included a focus of a successful launch of an American astronaut into space fueled the nation’s interest in science. The Patsy Mink Equal Opportunity in Education Act, also known as Title IX, followed in 1972, which required parity in financial support for both girls and boys in federally subsidized educational programs. The Science and Technology Equal Opportunities Act became law in 1980 when President Carter signed the act to provide funding to the NSF for programs to assist female scientists.

The STEM agenda in the United States primarily focuses on economic and vocational goals sponsored by the government and endorsed by politicians (Blackley & Howell, 2015; Williams, 2011). According to Burke and Mattis (2007), continued improvements in STEM remain critical for improved living standards, future economic prosperity, and a better quality of life. Since World War II, innovations in STEM serve as major contributors to the United States’ economic growth (Berezdivin, 2009). Over the past few decades, American influence on the global economy expanded due to the existence of a skilled and educated STEM workforce; however, other countries began to strategically position themselves to gain control by educating their STEM workforce to compete with the United States (United States Chamber of Commerce, 2005). Coble and Allen (2005) exert that the United States’ position as the front-runner in the world’s economy and its ability to create capital and valued, quality work for its future citizens is contingent specifically on the capability of our education system to develop high-
performing students prepared for the future needs in the math and science-dominated industries.

The State of the American Business Annual Report released by the United States Chamber of Commerce (2005) acknowledges that the United States’ competitive position is threatened due to the rapidly developing economies of China, India, and East Asia, and in response, America must “take strong action now to create a more competitive American economy and secure our nation’s leadership in the 21st century” (p. 4).

Since 2008, the current state of STEM education shows that enrollment of American citizens in STEM-focused studies continues to decline while the enrollment of international students increases (Herman, 2019). Kuenzi (2008) suggests that the United States struggles to graduate the volume of STEM students as compared to other nations. Among all nations, when comparing 24-year-old students who earn engineering or natural science degrees, the United States ranks 20th (Kuenzi, 2008). As shown in Figure 2, the State of the U.S. Science and Engineering 2020 report produced by the National Science Foundation’s National Center for Science and Engineering Statistics (NCSES) reports that the United States awarded 800,000 science and engineering university bachelor’s degrees in 2016 (Appendix A). However, 28 European countries produced nearly 1 million science and engineering degrees, and China produced 1.7 million of these degrees. In 2007, China exceeded the United States as the world’s leading country of doctoral degrees in the natural sciences and engineering, and China remains ahead of other countries in these areas (Khan et al., 2020).

George et al. (2001) underscores that the current makeup of the United States’ workforce, which is highly represented by White, non-Hispanic men, is shrinking and
causing worker shortfall in STEM jobs. White men accounted for most of the STEM workforce in 1995, and projections show that numbers will continue to decrease until the year 2050 (George et al., 2001). To address this potential gap, education for all future STEM workers must occur, especially for female and minority students who aspire to work in STEM (Gilmore, 1999; National Academies of Sciences, Engineering, and
In addition to equal access to STEM education, organizations must also create gender equality in the workplace to attract women to STEM roles and retain talent by ensuring equal pay and development opportunities for growth (Riedel, 2020).

*Gender Inequality in STEM*

Between 1940 and 1945, as explained by History.com (2020), the age of “Rosie the Riveter” emerged due to the widespread male enlistment in World War II, which diminished the industrial labor force and defense industry. Santana (2016) suggests that this introduction of women aided the war efforts and served as a critical factor in the economic stability of the United States. Even while serving in these critical roles, women’s pay lagged their male counterparts (Aldrich, 1989) – rarely earning more than 50% of male wages (History.com, 2020). Following the war, the number of women in non-traditional fields declined as returning soldiers reclaimed positions (Baxandall et al., 1976; Striking Women.org, n.d.). Men continue to dominate jobs in the manufacturing, engineering, and technical industries (Fletes, 2016), resulting in a strong imbalance in underrepresented minorities and women (Gibbs, 2014). Table 1 captures research from Catalyst (2020), which details a breakdown in the percentage of women representation in those occupations and industries in the STEM workplace. These male-dominated industries encourage masculine stereotypes that limit women’s ability to excel (Catalyst, 2020).

The domination of men in STEM jobs limits the ability of the United States to be competitive and hinders the ability of the United States to grow as other countries experience increased economic shifts to STEM (National Science Board, 2010). A 2015
report from the National Science Board offers a different perspective by revisiting the
STEM workforce and the growing need for STEM knowledge and skills in the economy.

Table 1

**Women in Male-Dominated Occupations and Industries**

<table>
<thead>
<tr>
<th>Total Employed-Percent Women</th>
<th>All Women</th>
<th>White Women</th>
<th>Black Women</th>
<th>Asian Women</th>
<th>Latinas</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States Occupations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil Engineers</td>
<td>13.9%</td>
<td>10.7%</td>
<td>0.8%</td>
<td>2.3%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Computer Programmers</td>
<td>20.3%</td>
<td>13.9%</td>
<td>2.2%</td>
<td>4.2%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Construction Managers</td>
<td>10.0%</td>
<td>7.8%</td>
<td>0.5%</td>
<td>0.7%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Driver/Sales Workers and Truck Drivers</td>
<td>6.7%</td>
<td>4.9%</td>
<td>1.3%</td>
<td>0.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Mechanical Engineers</td>
<td>6.6%</td>
<td>4.8%</td>
<td>0.6%</td>
<td>1.1%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Software Developers, Applications and Systems Software</td>
<td>18.7%</td>
<td>7.5%</td>
<td>1.5%</td>
<td>9.4%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

| United States Industries    |           |             |             |             |         |
| Mining, Quarrying, and Oil and Gas Extraction | 15.7% | 12.7% | 1.2% | 1.2% | 2.7% |
| Construction                | 10.3%     | 9.0%        | 0.5%        | 0.4%        | 1.9%    |
| Transportation and Utilities| 24.1%     | 16.0%       | 5.9%        | 1.3%        | 4.2%    |


The diversity of employees in STEM fields must increase, and educational institutions must find ways to attract and encourage women and underrepresented minorities to engage in order to gain a competitive advantage. Researchers stress the significance of differentiating the STEM field since diversity continues to be critical to excellence,
global competitiveness, and long-term economic growth (Gibbs, 2014); however, retaining women in STEM-related fields remains challenging (Van Oosten et al., 2017).

Over the past 25 years, research in STEM explores the underrepresentation of women in STEM careers (Kanny et al., 2014). Research suggests STEM’s achievement does not indicate significant gender differences (Freeman, 2004); however, the gender gap remains (Kanny et al., 2014; Wang & Degol, 2013). The 2017 Women and Stem report from the National Coalition for Women & Girls in Education (NCWGE) provided this reflection on gender equality in STEM asserting that both research and practice show that women and girls are as proficient at science, technology, engineering, and math (STEM) as men and boys. Women and girls have the capability to excel in STEM fields when provided equal opportunity (NCWGE, 2017). With global competition increasing with the need for a stronger technologically adept workforce, focusing on women and girls and guaranteeing equal access to STEM education is critical for the United States’ economic growth in the future (NCWGE, 2017). According to the American Association of University Women (AAUW), the factors that serve as barriers for female employees in STEM include the working environment, family responsibilities, and gender discrimination (Hill et al., 2010). Similarly, the NCWGE (2017) reports gender bias, compliance with Title IX, and family-friendly programs as key findings from recent research. Kanny et al. (2014) also identify themes that provide insights into the gender gap by reviewing 324 peer-reviewed texts, which highlight five common rationales:

1. background characteristics of individuals
2. fundamental obstacles presented in K-12 education
3. emotional and mental dynamics, preferences, and individual values
4. family expectations and influences

5. individual’s perceptions of STEM occupations and industries

Since numerous dynamics contribute to the underrepresentation of women in STEM, no one approach can correct the imbalance. Research suggests neutralizing stereotypes about girls’ math and science achievements in early school years, which removes the stigma of women feeling inadequate to their male peers (Hill et al., 2010; National Coalition for Women & Girls in Education, 2017). Removing the stereotypes and stigma will encourage and lead more women to pursue STEM-related education and STEM careers in the future. In recent years, women’s representation in STEM-related jobs reveals an increase, which is consistent with more women receiving STEM-related degrees (Hill et al., 2010). According to the National Science Board (2015), women make up fewer than 13% of engineers in the United States; conversely, in 2017, the interest and achievement in STEM for high school girls reached an all-time high (National Coalition for Women & Girls in Education, 2017). Organizations must foster and promote environments to attract female talent, especially as more girls continue to excel in STEM in education. Attracting and retaining female talent requires improved leadership focused on empowerment and development (Center for Creative Leadership, 2020).

Women in Leadership

Hunt and Fedynich (2018) postulate that one singular leadership style for all employees is no longer viable and defining a leader and the qualities that demonstrate leadership has evolved over time. Leadership research reveals a staggering number of books and articles (Buell, 2012; Fairholm, 2002; Van Maurik, 2001) that provide varying insights on leadership definitions, concepts, traits, qualities, and theories. Stogdill (1974)
argues that defining leadership with its complexities in one sentence is nearly impossible; however, Field Marshal Sir William Slim (1957) postulates the difference between leaders and managers stating, “managers are necessary; leaders are essential” (p. 144). Slim (1957) also posits that leadership embodies vision and character where management focuses on tactical and methodical functions. Leaders express the need to find managers who possess organizational skills and can inspire others to compete for higher ranks. This definition remains relevant. With the competition for talent and the constant changes organizations face in today’s global, competitive environment, organizations must identify future leaders among groups that have traditionally been overlooked – particularly women and minorities (Hunt & Fedynich, 2018).

According to the Bureau of Labor Statistics, women’s participation in the workforce rose rapidly during the second half of the 20th century peaking at 60% in 1999 yet currently decreasing to 57.1% (Toossi & Morisi, 2017). Of the women in the workforce, 52% account for all workers in professional and management occupations (United States Bureau of Labor Statistics, 2019). The trend toward gender diversity in leadership continues due to the increased attention and visibility of gender equality in the workplace (Kim & Shin, 2017). While women in leadership increases within some organizations (Haack, 2014), substantial disparity in quantity exists between male leaders and female leaders serving as managers or above within many organizations (Kenney, 2016; Schuh et al., 2014). Herrera et al. (2012) expect that female leaders in manager or above roles will improve over the next decade as organizations focus on executing recommendations and strategies designed for improving women’s opportunities (Haack, 2014). Virick and Greer (2012) explain the relevance of female leadership and gender
diversity as a critical component for an organization to maintain a competitive and strategic advantage for future growth. However, companies must work to remove organizational barriers, such as the leadership labyrinth that twists and turns women through roles, the glass ceiling that limits progressions to higher levels, and the broken rung that hinders progression into entry-level management, faced by women to close the leadership gap to career progression (Sharma & Kaur, 2019).

Glass Ceiling

In 1986, the theory of the glass ceiling became a social issue. The Wall Street Journal printed a story written by C. Hymowitz and T. D. Schellhardt where the commentary described the invisible barriers that female employees encounter when progressing to senior level leadership roles (United States Federal Glass Ceiling Commission, 1995). Chisholm-Burns et al. (2017) discuss how the glass ceiling limits organizations and women and decreases the chances of both to reach their highest achievements. Additionally, Chisholm-Burns et al. (2017) argue that the glass ceiling prevents the benefits of gender diversity in leadership. Huang et al. (2019) report that over the past five years, female representation improved in senior leadership roles, but women continue as underrepresented at all levels. The glass ceiling describes the obstruction or obstacle to progressively increasing levels of leadership positions in an organization that female employees and other minority employees confront during their career journey. The glass ceiling remains a critical construct in comprehending female employees’ advancement into leadership positions (Yukl, 2013). The glass ceiling remains in some industries and organizations, but signs of improvements appear as more women advance to leadership roles (Haack, 2014). Still, this breaking of the glass ceiling
occurs in some, but not all, industries and organizations (Kenney, 2016), especially for women working in male-dominated industries (Herrera et al., 2012).

Leadership Labyrinth

Goethals and Hoyt (2017) and Martin (2007) suggest that female leaders traverse a far more complex web of challenges than men as they move through their leadership journeys. Because of this, recent research coined a new metaphor for the glass ceiling, now also referred to as the leadership labyrinth (Goethals & Hoyt, 2017). The leadership labyrinth expresses the concept of an intricate path forward in hope of a target worth the aim, and passing through requires determination, persistence, the ability to self-reflect and maintain self-awareness to prepare for what exists ahead on the path (Eagly & Carli, 2012). Female leaders aspiring to progress to senior-level leadership must take paths that consists of twist and turns that can occur unexpectedly, but because labyrinths contain a possible path to the center, the attainability of meeting goals are understood which can provide some encouragement for a successful transition into senior-level leadership (Eagly & Carli, 2012). Within the leadership labyrinth, women face complex obstacles (Eagly & Carli, 2012; Martin, 2007) “that not only result in lack of numerical parity between women and men in leadership, but also critical gender differences in the nature of leadership positions” (Goethals & Hoyt, 2017, p. 6).

Broken Rung

According to the Women in the Workplace report from McKinsey & Company and LeanIn.org, females' most significant workplace obstacle remains the broken rung (Huang et al., 2019). The broken rung theory explains that women move up the career ladder in smaller numbers than males at every stage in career progression but lose the
most ground early in their careers. At every career level increase, the number of women in leadership positions decreases. Crager (2020) discusses how the first step up from entry-level fragments equality in the workforce and how women are less likely to get promoted from entry-level positions. Women hold just 38% of manager-level positions, while men hold 62% (Huang et al., 2019). Guy (2020) calls to attention the magnitude of this issue in the State of the Women in Engineering report because male leaders substantially outnumber female leaders at the management level. The number of female leaders declines at every successive level until the Chief Officer-level. Even as hiring and promotion rates improve for female leaders at senior levels, the number of women at this level may not be able to close the gap until more women occupy roles within the organization.

Training industry research shows that the quality of leadership development provided to men and women remains significantly different. This creates a self-perpetuating cycle that keeps women behind in career progression because a higher percentage of men are in leadership positions who make the decisions on promotions and successions (Oesch, 2020). Women represent nearly half of the United States workforce (Amon, 2017), making up less than 30% of the positions within science, technology, engineering, and mathematics (STEM) (Martinez & Christnacht, 2021; National Science Board, 2015). Research from the Office of Nuclear Energy (2021) and the International Atomic Energy Agency (2019) shows that less than 25% of women make up the nuclear industry workforce worldwide, which hinders diversity and limits the industry's competitiveness to grow as new technologies enter the market.
Women in Nuclear Energy Leadership

To progress into leadership in the nuclear industry, one must possess knowledge of nuclear power operations or earn a reactor operator’s license, which includes cognitive ability to comprehend all of the difficult complexities required to operate a nuclear power plant (Schumacher et al., 2011). Cognitive ability and increased nuclear power plant knowledge can only be built through work experience gained over time, working in the industry (Schumacher et al., 2011). Leadership in nuclear energy, especially within nuclear power plants, provides vital support to ensure that all employees operate the nuclear plants at the highest level of safety standards (Martínez-Córcoles et al., 2013). Safety remains the primary responsibility of leaders within nuclear power plants, and leaders must understand and leverage a participative leadership style when making safety-related decisions and assessments (Martínez-Córcoles et al., 2013).

According to Gaspar and Dubertrand (2019) and Harvey (2020), the nuclear industry must focus on increasing diversity which can improve innovation and competitiveness in the industry. Ruiz de La Illa (2019) suggests that mentoring and networking initiatives, awareness-raising, and changing the narrative can help recruit and retain qualified women to the nuclear industry. As the nuclear industry addresses global issues, such as clean energy, attracting top female talent can improve the effectiveness and efficiency of the organization (Harvey, 2020; Nuclear Innovation Clean Energy Future, n.d.). Harvey (2020) asserts that a more diverse workforce can fuel improvements and drive sustainability in the nuclear industry; however, leaders must commit to addressing the gap that exists in gender diversity.
The Nuclear Innovation Clean Energy (NICE) Future Initiative (n.d.) partnered with Women in Nuclear (WIN) Global to articulate the concern for gender parity in nuclear energy leaders and encourage partner organizations and businesses to adopt practices to promote gender inclusivity. The partnership developed a framework to show the importance of women leaders in the future workforce for nuclear energy. The key elements of the framework appear below:

- **Representation matters.** Women become role models to new and less experienced employees, especially young women, who enter the nuclear workforce. The visibility of women in the workforce provides a visual message of belonging and can inspire young women to stay the course. Some young women choose to enter the nuclear industry do to observing the representation of women, which enhances the ability to bring in top talent.

- **High-potential talent pool is expanding.** Research conducted by the World Bank suggests that the academic performance of girls is on par or better than boys in STEM subjects. Globally, women graduate at higher rates from universities than men and enroll at higher rates, also. Conversely, more women will transition from the STEM workforce than men, which reduces the representation and visibility of female leaders to new and less experienced female employees. Female leaders can support and drive the changes in talent pool reviews and champion the focus on high-potential female employees in the organization.

- **Diverse perspectives are necessary.** The nuclear industry makes and executes decisions that can potentially affect millions of people in a variety of
industries, (from healthcare and food security to climate change and energy security, to name a few), and in a world with progressively complex global networks, the importance of a diverse perspective heightened

- Risk-awareness heightens. Industries, such as the nuclear industry, face stress and change because of the type of work performed. A gender-balanced workforce provides advantages by leading with openness and transparency and discussing organization risks with all employees.

- Organizational performance increases. Research highlights the advantages and benefits of having female leaders in decision-making roles. Reports by organizations, such as Catalyst 2007 or Finnish Business and Policy Forum EVA 2007, indicate that having female leaders in roles at the manager and board level results in better organizational performance.

- Competitors lose out. Organizations with more female leaders in role to build focused, competitive gender-balanced leadership teams who drive for innovation and improved profitability.

- Empathy for future generations. In general, women show more empathy with others, and bring empathy to the decision-making process. The empathetic quality allows women to understand the perspectives and concerns of future generations who want to see climate change and more sustainable renewable products in organizational long-term strategies. (NICE Future, n.d.)

The components of the framework outline the practices that can promote gender inclusivity but also serve as foundational principles, which align with strategies identified in research that promote career advancement for women (PwC, 2018).
Strategies for Female’s Career Advancement in the Nuclear Industry

When asked about the role of gender parity to create a stronger, equal, and more diverse workforce in nuclear, Rafael Mariano Grossi, International Atomic Energy Agency (IAEA) Director-General, responded: “It is not just important, it is key” (Harvey, 2020). Green (2018) argues that despite the noticeable differences in general support of nuclear energy, women still face difficulties in reaching leadership positions. Women in the field of STEM or male-dominated industries face greater obstacles than their male counterparts, oftentimes receiving less pay, lacking mentorship, and enduring gender bias (IEEE Innovation, n.d.). Dagorn (2018), Gaspar & Dubertrand (2019), Harvey (2020), and Ruiz de La Illa (2019) propose individual development for career growth, work-life balance programs, awareness of gender bias, employee engagement, and mentoring relationships as career advancement strategies organizations should implement to attract and retain more women to male-dominated careers like those in the nuclear industry. Innovative, individual development plans for women provide knowledge, tools, and supportive learning environments, which assist women in navigating and flourishing in male-dominated organizations and positively impact the increase in advancement of women in STEM careers (National Research Council, 1994; Van Oosten et al., 2017).

Individual Development for Career Growth

Preister (2019) suggests that creating employee development goals encourages employees and motivates them to enhance their skillsets, which remains critical to the success and engagement of the employee. According to the Society for Human Resources Management (SHRM) (2017), a career development path for individuals makes the employee feel more engaged. When employees believe their leader cares about their
growth, they trust that the leader will provide the best opportunities to reach career goals while fulfilling the company’s mission. Hansen (2020) suggests that leaders develop well-defined strategic plans to foster cultural shifts in organizations to ensure that women have access to developmental opportunities and sufficient paths to progress in their careers. Leaders who effectively manage the talent of their employees understand the importance of recognizing individuals’ skills (Gomez, 2014) and aligning their strengths to help the employees gain more confidence and strive for success in the organization.

Gomez (2014) explains that leaders can integrate individual development for career growth in the workplace by incorporating:

- formal career pathing or mapping,
- leaders encouragement of personal accountability to lead projects,
- succession planning, or preparing current employees to fill higher positions,
- online learning options to develop additional skills without placing extra pressure on employees to be present at work.

According to research from SHRM (2017), 21% of employees note a lack of career progression and professional development as reasons to leave their current position, and only 32% of employees view their organization’s focus on individual career development as satisfactory. The relationship between individual career development and work-life balance also plays an integral role in the career advancement of women in STEM careers. Irungu (2017) suggests that work-life balance influences career development choices of employees, and Haar et al. (2014) and Najam et al. (2020) posit that employees achieve career success when organizations provide a work environment that promotes work-life balance.
Work-Life Balance

Meenakshi et al. (2013) discuss the coining of the phrase, work-life balance (WLB), in 1986. However, the concept of work-life programs existed as early as the 1930s and remains a critical workforce concern today. Researchers view the concept of WLB differently as the definitions suggest conflicting thoughts. Hilbrecht et al. (2008) propose that work-life imbalance results from the desertion of critical connections and commitments as well as the detrimental increase of emotional, mental, and physical quality of life problems. Gregory and Milner (2009) explain WLB as the intrinsic and cultural bond between non-work and work time and space, while Carlson et al. (2009) add that WLB suggests that effective WLB occurs when employees uphold jointly agreed-upon expectations in each role, meet critical area requirements within each role, and release the need to be perfect. Clark (2000) defines WLB “as satisfaction and good functioning at work and at home, with a minimum of role conflict” (p. 751). While definitions may vary, research shows WLB as a valuable tool to attract and retain top talent (Brue, 2019; Newman, 2008).

Research conducted by the Hay Group and reported on HR and Employment Law News found that employers who support WLB experience lower employee turnover (HR.BLR.com, 2013). The survey also identifies that WLB for employees boosts their productivity and loyalty. The relationship between women in leadership positions and WLB stands as a multifaceted, and at times intricate, coordination that should be explored to identify barriers that limit female career advancement in male-dominated industries (Kalysh et al., 2016; Loeffen, 2016). Chang et al. (2010) argues that WLB traverses the harmony and intrusion that occurs between paid work and non-work time.
According to Inamdar and Nagendra (2017) and the 2007 study by Lyons et al., women are more likely than men to experience the intrusions of work and non-work time oftentimes because women devote more hours to non-work activities and have the primary responsibility for unpaid labor such as childcare, care for aging parents, or home chores. Research conducted by The Institute for Gender and the Economy reports that gender norms contribute to expectations of women at home and in the workplace, which creates work-life conflict more so than work-life balance (Williams, 2017).

**Awareness of Gender Bias**

Research shows that a diversified workforce with gender balance will improve management abilities, decision-making, and innovation (Bagshaw, 2004; Dessler, 2001; Diaz-Garcia et al., 2013, Govindji, 2014; Torchia et al. 2011; Wittenberg-Cox, 2019). Gender bias in the STEM workforce may lead to a decline in innovation, limiting the productivity and profitability of an organization (National Research Council, 2012). Furthermore, research argues that highly engaged, gender-diverse organizations can improve a company’s financial performance and create a competitive advantage against others in their industries (Govindji, 2014).

In the *Women in the Workplace* report published by McKinsey & Company and LeanIn.org, Huang et al. (2019) provide key focus areas that assist companies in bringing awareness to the challenges and gender bias women face in the workforce:

- Manager support impacts how employees view their opportunities,
- Sponsorship can open doors and accelerate career progression,
- Inclusive and unbiased hiring and promotions. (p. 21-24)
Moreover, leaders who are aware of gender bias and challenges faced by women in the workplace can play an influential role in improving employee engagement (Osborne & Hammoud, 2017) to ensure female leaders have a positive teamwork environment and feel motivated by their leaders (Kouzes & Posner, 2012; Yukl, 2012.)

*Employee Engagement*

Shuck and Wollard (2010) describe employee engagement as an employee’s behavioral, cognitive, and emotional mindset focused on desired organizational outcomes. Employee engagement refers to the attitude and behavior of an employee (Ghani et al., 2018). In common practice, employee engagement and employee disengagement represent opposite behaviors; however, research compares engagement with non-engagement instead of engagement with disengagement (Harter, 2020). Research measures engagement using employee surveys (Brown, 2020; Fuller, 2014; Mann & Harter, 2016). However, developing questions more in line with engagement and non-engagement generate robust data aligned with attitudes and behaviors as compared to a line of questioning that focuses on withdrawal (Macy & Schneider, 2008).

Engaged employees demonstrate initiative, innovation and proactively contribute to organization objectives (Menguc et al., 2013; Vance, 2006). Brimeyer (2016) suggests that engaged employees know and understand the organization’s mission, vision, values, and goals, which strategically enhances the output the employee provides to their organizations and promotes the sense of belonging and achievement the employee feels knowing they contribute to the organization’s success. Shuck and Reio (2014) posit that low employee engagement can be damaging to organizations because of the subsequent decline in employee overall health and work results. For practitioners, Harter et al. (2002)
discuss how employee engagement translates into a measurement that positively correlates with increased sales, productivity, customer satisfaction, and employee retention. Management also plays an integral part in employee engagement, where managers play a role in energizing and supporting employees (Gruman and Saks, 2011; Harter et al., 2002; Vance, 2006).

Leaders who successfully impart a clear mission and vision have informed employees who take pride in working with their company to achieve success (Osborne & Hammoud, 2017; Souba, 2011). These employees feel empowered and take ownership in their work and roles (Nicholas & Erakovich, 2013). Companies that fail to communicate and clarify the organization’s mission and goals experience elevated turnover rates as compared to companies that openly share organizational goals (Soyars & Brusino, 2009). Research completed by Mastrangelo, and colleagues finds that employee engagement is driven in both the micro-level and the macro-level (2012). The drivers of engagement at the micro-level include personal growth, perceptions of supervisors, and performance feedback. In contrast, the drivers of engagement at the macro-level include company leadership, honest communication, and the belief in future company success (Mastrangelo, 2012).

Engagement’s impact on employee turnover links to the level of investment and dedication an employee has in his or her position. Highly engaged employees can find it challenging to disconnect from the job, in part because they have devoted so much time and energy in the job and because they identify and enjoy the work they perform (Halbesleben & Wheeler, 2008). An engaged employee encompasses the employee’s investment in their work and the employee’s contribution to the organization’s success.
(Anitha, 2014). According to Soyars and Brusino (2009), three components contribute to employee engagement and should be deep-rooted in a company’s culture for employee engagement to thrive; those components include connections, contributions, and advancement and growth. Leaders actively engaged in the development and growth of employees can serve as a mentor or support employees by helping them secure a mentoring relationship for professional growth, which provides a positive effect on employee engagement (Backaitis, 2020; Cole, 2018; Reeves, 2021).

**Mentoring Relationship**

As defined by the NIH Office of Research on Women’s Health, a mentor is a trusted guide, tutor, coach, or counselor, while a mentee is the one who is being mentored or the protégé (Guise et al., 2012). Dunbar and Kinnersley (2011) and Ragins (2012) define the act of mentoring as the coaching from more experienced individuals to newer or less experienced individuals to cultivate and develop their leadership skills. Prior research advocates mentoring relationships afford significant advantages to individuals who participate (Rhodes, 2018; Miller, 2021). Effective mentoring requires practice and patience and is more than just professional generosity, as the mentors also benefit from the mentoring relationships (Guise, 2012; Rhodes, 2018). Ragins and Kram (2007) assert the key features that differentiate mentoring from other work relationships include the mentoring relationship that exists within the career context and that mentoring relationships progress through stages that can result in the relationship either terminating or transforming to a peer relationship.

Workplace mentoring provides a cost-effective option for organizations to transfer knowledge from well-trained employees to less-experienced employees, which
can lead to improved employee retention and create more diversity (Miller, 2021). Prior studies show that same-gender mentorships typically outnumber cross-gender mentor relationships (Allen & Eby, 2003; Ragins & Cotton, 1999; Sosik & Godshalk, 2000), which could present an issue for women in male-dominated industries, like the nuclear industry. While the literature contends naturally developed mentoring relationships tend to add more value and produce a better connection than those assigned through a formal mentoring program (Dunbar & Kinnersley, 2011), the nuclear industry can use a formal mentoring program as an attraction tool for top female talent highlighting leaders focus on career growth, employee engagement, and employee success (International Atomic Energy Agency, 2015).

Foundational Theories

Theories provide a generalized assertion of ideas that explain or predict relationships between or among phenomena (Abend, 2008; Kivunja, 2018). According to Cherry (2020), theories arise through repeated observations and thorough testing and then become accepted among scholars. Grant and Osanloo (2014) explain that the theoretical framework provides “a grounding base, or an anchor, for the literature review, and most importantly, the methods and analysis” (p. 12). Four theories – human capital theory, path-goal theory, work empowerment theory, and broken rung theory – serve as anchors for this study.

*Human Capital Theory*

During the 1960s, the concept of human capital surfaced from United States economists Gary Becker and Thomas Schultz. Human capital theory (HCT) developed out of education and economic fields, suggesting that the higher the education, the higher
the economic returns (Sweetland, 1996). Tan (2014) offers this theory as a broad and strategic approach to analyze a range of human affairs and not just a theory in economics. HCT provides an understanding of how employees view their employer’s investment in their learning and growth, which provides a practical implication for determining the value of training and education (Tan, 2014). Human capital research heavily focuses on educational investments and returns (Baum & Ma, 2007; Becker, 1975; Benson, 1961; Mincer, 1958; Schultz, 1971); however, research links HCT to skills and knowledge in the current workforce.

HCT’s advancement and application to the labor workforce occurred through continued research on human capabilities that increase investments. Schultz (1961) analyzed factors that economists were drawn to and viewed as human investments:

- Health services and facilities formulated to incorporate all expenses that impinge on life span, vigor and fortitude, and the vitality and strength of people,
- Apprenticeship and on the job training,
- formally structured education at all levels,
- studies of adults outside of work, including agriculture extension programs
- movement of individuals and families to consider job opportunities. (p. 9)

Theorist Becker (1993) added to the human capital literature as it relates to return on investment and used the idiom, human capital, to define a company or organization’s “investment in a person’s knowledge, skills, and abilities” (p. 386). Ehrenberg & Smith (1997) argue that the skills possessed by the employees belong to them and can be leased to companies. The ability of individuals to increase their skills through continued
education and training aligns with the underlying view of human capital (Thomas & Moye, 2015).

**Work Empowerment Theory**

Kanter (1993) defines power as the “ability to mobilize resources to get things done” (p. 210). The work empowerment theory suggests a high level of structural empowerment exists in work environments with these structures:

- Access to opportunity suggests the chance for development and growth in a department and provides an opportunity to gain experience and new skills,
- Access to resources indicates one's capability to obtain the financial processes, supplies, and time required to do the work,
- Access to information represents having informal and formal knowledge required to be successful in the workplace,
- Access to support includes receiving critique and assistance from leaders, colleagues, and subordinates. (Kanter, 1993; Laschinger et al., 2001, 2004)

According to Kanter (1977), organizations should create working conditions that encourage effectiveness by ensuring employees have access to the necessary resources needed to successfully accomplish goals and provide opportunities for growth. Employees who believe they possess this access to feel empowered (Greco et al., 2006; Kanter, 1993; Mendoza-Sierra et al., 2013; Wong & Laschinger, 2013). When employees feel empowered, they have a level of organizational commitment, higher employee engagement, trust in management, and take ownership in work and organizational goals.
Path-Goal Theory

The path-goal theory originates in a more general motivational theory that preceded it called the expectancy theory, which states that an individual’s attitude or behavior can be predicted from expectancy or degree to which the behaviors lead to outcomes, and valences, or the evaluations of the outcomes (Evans, 1996; House & Mitchell, 1997). According to House (1996), path-goal theory consists of two propositions for leader’s:

- Behavior remains satisfactory and appropriate to employees to the level that the employees observe the behavior as a source of fulfillment or as contributory to future fulfillment,
- Behavior motivates to the level that (1) such behavior plays a part in the fulfillment of employees’ needs depending on effective performance, and (2) such behavior complements the atmosphere of employees’ by delivering appropriate guidance, support, feedback, and recognition needed to drive top performance. (p. 4)

Northouse (2013) observed that the path-goal theory encompasses a leader’s talent to understand the culture of the workplace and adapt to various workplace situations to help subordinates reach their highest potential. The path-goal theory consists of four types of leadership behaviors and styles: directive, supportive, participative, and achievement-oriented (Northouse, 2013). As described by Northouse (2013), the four leadership styles include:
● Directive leader confirms that employees have clear guidelines, knows what is expected of them, schedules work, and provides rules to follow,
● Supportive leader focuses on building relationships with employees demonstrating sincere interest and care,
● Participative leader involves employees in decision-making and asks for suggestions,
● Achievement-oriented leader emphasizes the accomplishment of responsibilities at high-performing levels and sets challenging goals. (Northouse, 2013)

Path-goal theory’s fundamental goals directly relate to the improvement needed to progress the career advancement of females in the nuclear industry. Leader behaviors are integral to successful work performance because employees connect within their workplace based on the actions and behaviors of their leader (Malik, 2012). Leaders must adapt their styles to support the necessary actions required to drive the improvements for women in male-dominated industries. House (1996) and Northouse 2013) highlight the accomplished leader recognizes that leadership behaviors and styles are most helpful when they complement the social aptitude of the leader, meet the needs of the employees, and adapts to the work environment.

Broken Rung Theory

The broken rung theory explains why women lag in leadership roles (Crager, 2020; Huang, 2019). The Women in the Workplace report by McKinsey & Company and LeanIn.org supports that many companies understand the value of women in senior leadership roles, but the biggest challenge women face begins at the first step of the
career rung leading to management (Huang et al., 2019). Women move up the career ladder in smaller numbers than males at every stage in career progression but lose the most ground early in their careers (Huang et al., 2019). The 2020 *Women in the Workplace* report by McKinsey & Company and LeanIn.org identified that for every 100 men promoted to a leadership position, only 85 women are promoted, which results in women remaining outnumbered in leadership positions (Coury et al., 2020).

**Summary**

Chapter II provides a review of literature reflecting on a historical perspective of the challenges faced by women in science. While history presents accomplishments of women who made lasting contributions to society, women remain underrepresented in the workforce, especially male-dominated industries (Huang et al., 2019). The literature includes insights from the National Defense Education Act (1958) and the Patsy Mink Equal Opportunity in Education Act (Title IX) (1972) to highlight the engagement of the federal government exists to address the deficit of women in the workplace by ensuring educational opportunities for women. Previous research on approaches to advance women leaders in the nuclear industry includes individual development for career growth, work-life balance programs, awareness of gender bias, employee engagement, and mentoring as possible strategies. According to research by the IAEA (2020), mentorship provides the best advantage. Chapter II closes with a review of the human capital theory, path-goal theory, and work empowerment theory.

Given the limited research that exists for female leaders’ career advancement in the nuclear industry, additional research should continue to explore the factors that contribute to the underrepresentation of women in this STEM field (IAEA, 2015; IAEA,
2019). Chapter III describes the use of the qualitative methods planned to explore the enablers and barriers influencing the career advancement of female leaders in the nuclear industry. Chapter III outlines the methodology that will guide the study, including a description and explanation for the study, the sampling procedure, and the data collection procedure. The chapter concludes with the steps to ensure credibility of the study and a chapter summary.
CHAPTER III – METHODOLOGY

This qualitative study explored the barriers, and enablers that influence the career advancement of female leaders in the nuclear industry. The researcher used a qualitative, phenomenological approach to delve into the career opportunities and challenges of female leaders in the nuclear industry. Utilizing a qualitative approach allowed the researcher to build a rapport with the participants and gain knowledge and understanding of their lived experiences firsthand (Merriam & Tisdell, 2015). Additionally, the study explored the business strategies that influence career advancement as perceived by female leaders in the nuclear industry.

The purpose of this study was to explore the lived experiences of female leaders in the nuclear industry to determine factors that influence career advancement. Previous literature identifies influences on career advancement for female leaders (Dagorn, 2018; Gaspar & Dubertrand, 2019; Harvey, 2020; Irungu, 2017; Preister, 2019; Ruiz de La Illa, 2019); however, this study explored factors specific to female leaders who work in the nuclear industry in the southern region of the United States. Research objectives, population and sample, research design, selection of participants, informed consent, instrumentation, data collection procedures, and data analysis make up the chapter.

Research Objectives

The following research objectives guided the study:

ROI - Describe the demographic characteristics of the participants, including degree level, degree focus area, years of experience in the nuclear industry, and years of experience in current position.
**RO2** - Explore barriers to career advancement as perceived by female leaders in the nuclear industry.

**RO3** - Explore enablers to career advancement as perceived by female leaders in the nuclear industry.

**RO4** - Determine business strategies that hinder career advancement as perceived by female leaders in the nuclear industry.

**RO5** - Determine business strategies that enhance career advancement as perceived by female leaders in the nuclear industry.

**Research Design**

The study utilized a qualitative phenomenological approach to explore perceptions that influence the career advancement of female leaders in the nuclear industry. Creswell (2003) suggests a qualitative research method for studies that involve exploring and comprehending participant behaviors and attitudes. The phenomenological approach provides extensive details and places importance on exploring meanings individuals attach to lived experiences. Moreover, Creswell (2014) and Miles et al. (2018) provide additional support confirming qualitative research focuses on understanding the lived experiences of study participants.

Pietkiewicz and Smith (2014) suggest that people are self-interpreting beings – they actively engage in constructing meaning for people, objects, and events relevant in their lives. Berg and Lune (2012) and Corbin and Strauss (2008) suggest interviewing provides the researcher a better opportunity to comprehend the perceptions of participants or understand how participants attach certain meanings to phenomena or events, which allow the researcher to experience a deep connection with participants. Moreover,
Merriam and Tisdell (2015) postulate that one-on-one interviews stand out as the most used method of qualitative research, and Krueger (2014) explains that focus groups, which should consist of four to 12 participants, provides further exploration of a discussion that intends to obtain perceptions of participants on a given topic. Qualitative research explores a “problem in a group or population to identify ideas and variables beyond the pre-determined information in previous literature” (Creswell, 2013, p. 48). Therefore, for this study, the researcher used the Interpretative Phenomenological Analysis (IPA) approach to explore the enablers and barriers to career advancement for female leaders in the nuclear industry as IPA provides insights into experiences through the lens of the participants (Pietkiewicz & Smith, 2014). According to Pietkiewicz and Smith (2014), IPA employs the key elements of phenomenology, hermeneutics, and idiography.

Introduced by Edmund Husserl, the first key element, phenomenology, focuses on how experiences appear from the participant’s perspective (Creswell, 1994; Pietkiewicz & Smith, 2014). Husserl infers that phenomenology seeks the participant’s awareness and meaning of experiences (Behnke, 1994; Creswell, 1994; Neubauer et al., 2019). Phenomenological researchers seek to capture rich, detailed descriptions of lived experiences (Finlay, 2009). The phenomenological approach requires the researcher to bracket or separate personal understandings and assumptions when interpreting participants’ experiences (Finlay, 2009; Madill & Gough, 2008; Moustakas, 1994). The idea of bracketing subjective biases allows the presentation of clear narratives and meanings in their richest forms while providing additional rigor and validity of the research (Finlay, 2009; Moustakas, 1994).
Husserl’s student, Heidegger, developed the second key element of IPA, hermeneutics. Rennie (1999) defines hermeneutics as the practice of the interpretation of the participant’s experiences. According to Pietkiewicz and Smith (2014), the foremost goal of hermeneutics enables the researcher to translate and explicate participants’ experiences. Building upon Husserl’s descriptive method, Heidegger fused interpretations into the process (Reiners, 2012) to make sure that the readers wholly and intensely comprehend the text’s meaning (Moustakas, 1994). Hermeneutics and phenomenology allow study participants to illustrate feelings and experiences and then ruminate about the meanings of those experiences.

The idiographic approach serves as the third key element of IPA. Eatough and Smith (2008) and Smith et al. (2009) posit that the idiographic approach explores the distinct experiences of participants individually and generalizes participant responses. Pietkiewicz and Smith (2014) explain that an idiographic focus allows researchers to construct studies by analyzing the experiences of participants individually before moving to the next participant. The focus on each study participant offers key insights to understand the population (Smith et al., 2009). In this study, the researcher explored variables common to the participants in the nuclear energy industry. Interpretative phenomenological analysis allowed the researcher to explore the lived experiences of the study participants and capture and translate how each participant defined their experiences to offer insights to readers. The process of conducting IPA research takes a two-step approach with the participants describing lived experiences to the researcher and then the researcher interpreting the experience described (Osborn & Smith, 2008).
The primary objective of this study was to improve the understanding of perceived barriers, enablers, and business strategies influencing the career advancement of female leaders in the nuclear industry from the perspective of the participants. McMillan (2012) stresses qualitative researchers should not insert their perspective or biased ideas into the study but should allow the patterns, meanings, and themes to emerge from the participants. Then the research can seek to comprehend those meanings and how they influence the behavior of the participants (McMillan, 2012). IPA was appropriate for the study because the approach offers the ability to explore and understand the lived experiences of participants and offers insight from their perspectives.

Population and Sample

According to Trochim (2006), a research population consists of a group of individuals or objects, which have similar features and are the central focus of the study. Salkind (2010) refers to a research population as the collection of entities one seeks to understand or from which to draw an inference. With the qualitative, phenomenological approach, an integral factor is to ensure each participant’s description is fully valued and respected, which is better accomplished when sample sizes are not large; therefore, sample sizes in phenomenological studies are typically small (Pietkiewicz & Smith, 2014). This study’s population consisted of female leaders who work in the nuclear industry. The sample population included members of the target population. For this study, the researcher selected the participants who currently work in the nuclear industry, utilizing purposeful sampling. Creswell (2014) contends purposeful sampling provides assurance that the researcher selects participants who meet the study’s criteria, and
Palinkas et al. (2015) describe purposeful sampling as a method in qualitative research to identify and select information-rich cases related to the phenomenon of interest.

Founded in 1993, Women in Nuclear (WIN) Global creates a forum to support and encourage women who work in the nuclear industry throughout the world. WIN Global operates in over 109 countries with approximately 35,000 members (Women in Nuclear Global, n.d.). United States Women in Nuclear (U.S. WIN) participates as an affiliate of WIN Global with over 65 active chapters. The U.S. WIN chapters reside in four regions. The researcher selected participants from the southern region of the U.S. WIN organization, which has approximately 400 members, to participate in one-on-one interviews and in a focus group interview. The members of WIN work for nuclear power facilities located in the southern region of the U.S. The researcher sought support and sponsorship from the Regional President for access to the southern region membership list and to encourage participation in the study (Appendix B). The criteria for inclusion to participate in the one-on-one interviews for the study sought female leaders who are at the senior manager, director, or vice president levels in their organizations and who are members of the U.S. WIN organization, southern region. The criteria for the focus group sought women employed in the nuclear energy industry who are members of the U.S. WIN organization in the southern region of the U.S but do not hold senior management roles. Participants of one-on-one interviews did not participate in the focus group interview.

The researcher coordinated with the U.S. WIN organization to invite participants who are in senior managers or above positions within the nuclear industry in the southern region of the United States to ensure a proper sample size for the one-on-one interviews.
Pietkiewicz and Smith (2014) recommend a total between six and eight as an appropriate range of study participants for a qualitative IPA, while Creswell (2013) recommends five to 20 as the appropriate range. Merriam and Tisdell (2015) contend that the range of participants needed depends on the objectives directing the research, data collected, analysis progression, and availability of resources to support the research. Lincoln and Guba (1985) propose sampling must continue until saturation occurs. Redundancy or saturation occurs when continuing to interview new study participants generates no new data. The researcher established a target participant population of more than five but less than 20, as suggested by Creswell (2013) for the one-on-one interviews. The researcher received sponsorship from the WIN Regional President, who emailed requests for participation to senior leaders and above for the one-on-one interviews and to members who are not senior leaders and above for the focus group interview. Krueger (2014) and Krueger and Casey (2002) explain that focus groups should consist of four to 12 participants. Focus groups provide further examination of a discussion that intends to obtain perceptions of participants. The researcher set a target participant population of at least four and up to 12 for the focus group interview, as suggested by Krueger (2014). This study employed a developed instrument that guided the participant to discuss their experiences.

Instrumentation

Individuals participating in interviews express sensitive concerns and initiate dialogues about a range of topics (Kaplowitz, 2001). Smith et al. (2009) suggest that researchers leading a phenomenological study should collect data directly from the individuals experiencing the event, and Creswell (2013) advises researchers to use in-
depth interviews to gather data for phenomenological studies. The researcher served as
the primary instrument for this study and used researcher-developed open-ended, semi-
structured interview questions to gather descriptive accounts of the lived experiences of
female leaders in the nuclear industry.

According to Smith et al. (2009), interview questions should encourage a relaxed
environment for study participants to openly share past experiences. The researcher
designed the interview questions by developing a survey map that aligned the interview
questions with the five research objectives of the study. This alignment process
represents mapping, which ensures that each question of the instrument connects to a
research objective and also ensures content validity (Phillips et al., 2013). Table 2
provides the alignment of the one-on-one interview questions with the research objectives
for this study. The researcher began with interview questions that explored the
participants’ background in their chosen role within the nuclear industry to build rapport
with the participant. The one-on-one interviews consisted of nine semi-structured, open-
ended questions (Appendix C) that progressively moved into deeper questioning
regarding experiences of career advancement in the nuclear industry. Questions 1–3
related to the participant demographics. Questions 3, 4, 5, 7, and 9 inquired about barriers
to career advancement, and questions 3, 4, 5, 6, and 9 inquired about the enablers to
career advancement. Questions 8 and 9 probed business strategies that hinder and
enhance female career advancement.

The focus group interview questions (Appendix D) consisted of six semi-
structured, open-ended questions that connect with the one-on-one interview questions
for comparison of the lived experiences related to career advancement.
Table 2

*Research Objectives Mapped to One-on-One Interview Questions*

<table>
<thead>
<tr>
<th>Research Objectives (RO)</th>
<th>Interview Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>RO1</em> – Describe the demographic characteristic of the participants, including their degree attainment, work experience in the nuclear industry, and years of experience in their current position.</td>
<td>Q1, Q2, Q3</td>
</tr>
<tr>
<td><em>RO2</em> – Explore barriers to career advancement as perceived by female leaders in the nuclear industry.</td>
<td>Q3, Q4, Q5, Q7, Q9</td>
</tr>
<tr>
<td><em>RO3</em> – Explore enablers to career advancement as perceived by female leaders in the nuclear industry.</td>
<td>Q3, Q4, Q5, Q6, Q9</td>
</tr>
<tr>
<td><em>RO4</em> – Determine business strategies that hinder female advancement in the nuclear industry</td>
<td>Q8, Q9</td>
</tr>
<tr>
<td><em>RO5</em> – Determine business strategies that enhance female advancement in the nuclear industry</td>
<td>Q8, Q9</td>
</tr>
</tbody>
</table>

Table 3 provides the alignment of the focus group interview questions with the research objectives for this study. The researcher gained participant demographic and background information for their chosen role within the nuclear industry during the interview protocol before going through the interview questions. The researcher acknowledged each participant to capture this information to build rapport with the participants before starting the interview questions. Questions 2, 3, 4, and 6 inquired about barriers to career advancement, and questions 1, 2, 4, and 6 inquired about the enablers to career advancement. Questions 5 and 6 probed business strategies that hinder and enhance female career advancement.
### Table 3

**Research Objectives Mapped to Focus Group Interview Questions**

<table>
<thead>
<tr>
<th>Research Objectives (RO)</th>
<th>Interview Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RO1</strong> – Describe the demographic characteristic of the participants, including their degree attainment, work experience in the nuclear industry, and years of experience in their current position.</td>
<td>Interview Protocol</td>
</tr>
<tr>
<td><strong>RO2</strong> – Explore barriers to career advancement as perceived by female leaders in the nuclear industry.</td>
<td>Q2, Q3, Q4, Q6</td>
</tr>
<tr>
<td><strong>RO3</strong> – Explore enablers to career advancement as perceived by female leaders in the nuclear industry.</td>
<td>Q1, Q2, Q4, Q6</td>
</tr>
<tr>
<td><strong>RO4</strong> – Determine business strategies that hinder female advancement in the nuclear industry</td>
<td>Q5, Q6</td>
</tr>
<tr>
<td><strong>RO5</strong> – Determine business strategies that enhance female advancement in the nuclear industry</td>
<td>Q5, Q6</td>
</tr>
</tbody>
</table>

The researcher followed an interview script (Appendix E) for one-on-one interviews and an interview script (Appendix F) for the focus group interview. The researcher followed a one-on-one interview protocol (Appendix G) for each interview to ensure that each participant received the same interview questions. The researcher followed an interview protocol for the focus group interview (Appendix H). The one-on-one interviews lasted from 45-60 minutes for each participant, and the focus group interview lasted 60 minutes. The researcher asked questions that encouraged detailed responses and provided an opportunity for the participant to add related information not asked by the interviewer. Each interview question connected to one of the five research objectives used to guide the study; however, the researcher utilized the flexibility...
provided by qualitative research to modify questions, when necessary, to capture responses related to aspects of the questions. The researcher also used probing to gain relevant information. The researcher used the focus group interview for triangulation of the data to increase the study’s validity.

Validity of the Study

According to Golafshani (2003), “the concept of validity is described by a wide range of terms in qualitative studies” (p. 602). Roberts (2010) explains researchers who conduct qualitative studies typically use the term trustworthiness when referring to the validity and reliability of a study and describes “trustworthiness as a credibility factor, which then provides the reader confidence in the investigator’s data analysis” (p. 161). Moreover, Creswell (2013) posits that validity develops credible studies. Creswell (2013) and Creswell and Miller (2000) also discuss the following eight strategies for validity:

- Rich, thick descriptions – “Detailed description enables readers to transfer information to other settings and to determine whether the findings can be transferred "because of shared characteristics" (Erlandson et al., 1993, p. 32); allows readers to make decisions regarding transferability (Erlandson et al., 1993; Lincoln & Guba, 1985; Merriam, 1988).
- Triangulation – Denotes the use of varying sources of data or methods to formulate a logical explanation for themes. Identifying evidence of themes can increase the study’s validity.
- Member checking – The researcher provides participants an opportunity to review their interview transcript for accuracy (Miles & Huberman, 1994).
• Clarifying researcher bias – The researcher states bias relating to the topic and comments on past experiences that relate to the bias to help the reader understand the perspective of the researcher. Ortlipp (2008) suggests journaling to identify and minimize preconceived ideas and assumptions to combat potential researcher bias.

• Negative case analysis – Researchers present information that opposes the commonly agreed-upon perspectives of developed themes if that information exists.

• Prolonged time in the field – The researcher focuses on gaining insight into the information shared by the participant.

• Peer review – Provides an external check and keeps the researcher honest in reporting data. Individuals with knowledge of the study, but not participants, provide a review of the data collection to ensure the absence of bias, which adds to the validity of the study.

• External audit – Individuals with no past knowledge of the study provides an unbiased examination of the findings, interpretations, and conclusions.

For this study, the researcher used four of the eight strategies to ensure the validity of the study. The following strategies were appropriate for the design of this study: member checking, triangulation, clarifying researcher bias, and rich, thick descriptions.

*Member Checking*

According to Merriam (2002), member checking ensures accuracy in data reporting and allows the researcher and the participants the opportunity to confirm the accuracy of transcribed data before the data becomes part of the study’s findings.
Moreover, Lincoln and Guba (1985) postulate that member checking serves as a critical technique for demonstrating credibility by providing participants the opportunity to respond to the researcher’s interpretative narrative of their responses. After each one-on-one interview, the researcher provided transcripts to the participants to verify the accuracy of the interview content. The researcher requested that each participant review the transcript and note discrepancies.

Creswell and Miller (2000) explain that the researcher can revise and provide a more accurate description of the participant’s response if the descriptions are not correct. The researcher provided participants with three days to respond. As noted in the member check email (Appendix I), each participant received a copy of the summarized transcript. Creswell and Miller (2000) also explain that providing participants a review period increases credibility and allows participants the opportunity to validate the transcript. After the designated three-day period, two of the participants returned comments, which the researcher corrected on the corresponding transcript. The other four participants did not return comments within the three-day period. The researcher then continued to the next step of the analysis of the data.

Triangulation

According to Patton (1999), triangulation represents the use of different methods to increase the understanding and depth of the study to establish validity. Creswell (2013) and Creswell and Miller (2000) suggest that using varying sources of data or methods to articulate a logical account for themes and identifying evidence of themes increases the study’s validity. Triangulation requires a minimum of two perspectives (Flick, 1992), which allows the researcher the opportunity to remove biases by employing another
perspective to validate the study. The researcher collected data from a focus group after facilitating the one-on-one interviews. The focus group consisted of six participants who work in the nuclear industry and are also members of the southern region U.S. WIN organization. These six participants consisted of women who are not senior managers and above and did not participate in the one-on-one interviews. According to Creswell (2013), triangulation requires the researcher to identify common patterns and themes from different data sources to validate findings. The researcher compared the themes from the one-on-one interviews and focus group interviews as the two perspectives for validating the findings. Each validation perspective offers a strategy for potential ethical concerns that may arise during all phases of the study (Creswell, 2013). After conducting all one-on-one interviews and the focus group interview, the researcher sent all participants a thank you email (Appendix J).

*Clarifying Researcher Bias or Journaling*

Merriam (2002) recommends the use of reflective journaling to remove researcher bias regarding the study. The phenomenological approach expects the researcher to bracket or separate personal understandings and assumptions when interpreting participants’ experiences (Finlay, 2009; Madill & Gough, 2008; Moustakas, 1994). The concept of bracketing subjective biases grants the presentation of clear narratives and meanings in their richest forms while providing additional rigor and validity of the research (Finlay, 2009; Moustakas, 1994). The researcher maintained a journal to minimize bias and assumptions that may influence the research, as recommended by Ortlipp (2008). The journal allowed the researcher to document and collect reflections of interviews throughout the data collection process.
Rich, Thick Description

According to Creswell and Miller (2000), the rich, thick description provides readers a backdrop that allows them to relate and associate their feelings to a situation or experience. Researchers using this method provide additional details of an experience that gives readers information that allows them to mentally paint a picture that connects them to the place of the occurrence (Denzin, 1989). Additionally, Creswell (2003) asserts that rich, thick description allows the researcher to explain results in a way that mentally describes the experience. Rich, thick description enhances the validity of the study by providing the researcher an opportunity to describe the emotions of participants and detail their interactions with the focus of the study, which allows readers to better comprehend the research (Denzin, 1989). Descriptive, penetrating details add credibility to the study (Creswell & Miller, 2000). The researcher captured the details of the responses from interview transcripts to summarize and accurately describe participant experiences.

Institutional Review Board (IRB)

According to Roberts (2010), the main purpose of the IRB is to protect those participating in a research study, specifically concerning ethical issues such as confidentiality, informed consent, and protection from harm. Furthermore, the IRB provides protection for participants’ privacy and protects their rights. This study involved human research participants and required IRB approval from The University of Southern Mississippi’s IRB committee. The committee reserves authority to approve, require modifications or disapprove research proposals. The researcher submitted the proposed study to The University of Southern Mississippi’s IRB committee after the dissertation
committee approved the proposal. IRB approval (Appendix K) occurred before data collection began.

Data Collection Procedures

Once the proposal for the study gained approval from the Dissertation Committee and IRB, the researcher obtained information from the participants as highlighted in the Data Collection Plan (Table 4). The researcher executed three phases of data collection. Phase I began with sending the WIN Regional President an email for one-on-one interview participants to forward to senior managers and above (Appendix L) to request participation in the study. The researcher also provided the WIN Regional President with a focus group email to send to members who do not hold senior manager positions (Appendix M) to request participation in the study.

The emails detailed the purpose of the study. Upon receipt of returned replies from targeted participants acknowledging willingness to participate in the study, the researcher scheduled virtual interviews using the Webex platform.

Table 4

Data Collection Plan

<table>
<thead>
<tr>
<th>Week</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Study</td>
<td>Receive approval from The University of Southern Mississippi's IRB.</td>
</tr>
<tr>
<td>Week 0</td>
<td>Conduct Pilot Study with Regional President.</td>
</tr>
<tr>
<td>Phase I</td>
<td>Send invitational emails to Regional President to forward to</td>
</tr>
<tr>
<td>Week 1-3</td>
<td>prospective participants, detailing the purpose of the study.</td>
</tr>
<tr>
<td></td>
<td>Receive emails from targeted participants acknowledging their</td>
</tr>
<tr>
<td></td>
<td>willingness to participate in the study.</td>
</tr>
</tbody>
</table>

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### Data Collection Plan continued

<table>
<thead>
<tr>
<th>Week</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase II</td>
<td><strong>Week 4-8</strong></td>
</tr>
<tr>
<td></td>
<td>Begin scheduling interviews.</td>
</tr>
<tr>
<td></td>
<td>Send an email confirming the Webex interview date and time.</td>
</tr>
<tr>
<td></td>
<td>Send an interview reminder email to participants. Send informed consent with a reminder email and request participants to submit a signed form to confirm interview participation.</td>
</tr>
<tr>
<td></td>
<td>Conduct all interviews and download audio recordings and transcribed data to the end of each interview. Conduct member checking.</td>
</tr>
<tr>
<td></td>
<td>Review the transcribed data and identify relationships and themes after each interview. Determine saturation.</td>
</tr>
<tr>
<td></td>
<td>Document self-reflection regarding each interview in a journal. Continue journaling reflections throughout the analysis process.</td>
</tr>
<tr>
<td></td>
<td>Send invitational emails to prospective focus group participants.</td>
</tr>
<tr>
<td></td>
<td>Send post-interview thank you emails to participants one-on-one participants.</td>
</tr>
<tr>
<td></td>
<td><strong>Week 9</strong></td>
</tr>
<tr>
<td></td>
<td>Conduct a focus group session. Send post-interview thank you emails to focus group participants.</td>
</tr>
<tr>
<td>Phase III</td>
<td><strong>Week 10-11</strong></td>
</tr>
<tr>
<td></td>
<td>Conduct data analysis in NVIVO, code, and determine themes from interviews.</td>
</tr>
<tr>
<td></td>
<td>Complete data analysis.</td>
</tr>
<tr>
<td></td>
<td><strong>Week 12-16</strong></td>
</tr>
<tr>
<td></td>
<td>Finalize results and research conclusions.</td>
</tr>
</tbody>
</table>

The researcher sent each one-on-one participant an email reminder the day before the scheduled interview (Appendix N). In addition, the researcher sent each focus group participant an email reminder the day before the scheduled interview (Appendix O). The
researcher sent the informed consent form (Appendix P) via email and asked for each participant to sign and return the form before the interview date. The emails also notified the WIN Regional President and each participant that they would receive a copy of the study results. This task marked the beginning of Phase II of the data collection process. The informed consent served as proof of the participant’s willingness to participate in the study and informed the participant of the potential benefits and minimal risks that exist for participating in the study. The interviewer then conducted all virtual one-on-one interviews following the interview script, protocol, and questions mapped to the research objectives.

*One-on-One Interviews*

The researcher conducted semi-structured, one-on-one interviews for this study. Babbie (2016) highlights semi-structured interviews as structured conversations driven by a set of pre-planned questions. The researcher will follow the one-on-one interview script and one-on-one interview protocol guide to lead the interview process and ensure each participant receives the same information during the interview. The one-on-one interviews were approximately 45-60 minutes for participants. Additionally, the researcher recorded all interviews in Webex and downloaded the audio transcripts at the end of each interview. The researcher reviewed the transcripts to correct wording, spelling, and punctuation errors. The researcher emailed transcribed data to participants for verification of accuracy, also known as member checking.

After the three-day period for member checking, the researcher reviewed the transcribed data and identified relationships and themes after each interview to determine saturation. After the fourth interview, the researcher reached saturation and completed
two more interviews to ensure certainty of saturation. Kerr et al. (2010) define saturation as the moment when further data collection provides no new additional information. The researcher documented self-reflection regarding each interview in a journal and continued to journal reflections throughout the analysis process. Each one-on-one participant received a final thank you email upon completion of interviews. In conjunction with the one-on-one interviews, the researcher conducted a focus group to increase the validity of the study.

*Focus Groups*

The researcher conducted a focus group for this study to collect and triangulate the data. The researcher followed the focus group interview script and focus group interview protocol guide. The focus group consisted of six participants and lasted approximately 60 minutes. Additionally, the researcher recorded the interview in Webex and downloaded the audio transcript at the end of the interview. The researcher reviewed the transcribed data and identified relationships and themes. The researcher compared the themes from the focus group with the themes from the one-on-one interviews to identify patterns, occurrences, and commonalities. Upon the completion of the focus group interview, all participants received a final thank you email for participating in the study. After collecting all data, Phase III, the data analysis process began.

*Data Analysis*

Researchers, who utilize IPA for data analysis, possess flexibility and some independence within the process to adjust depending on their research objectives (Pietkiewicz & Smith, 2014). IPA arranges the information provided in the data collection phase and groups analyzed information as described by study participants (Creswell, 2013).
Merriam (1998) explains data analysis as a comprehensive strategy that involves the researcher circling from real data, conceptual ideas, then to interpretation and description. IPA searches for the fundamental organization of a phenomenon (Merriam, 1998). Utilizing the various techniques of bracketing, imaginative variations, horizontalization, and phenomenological reduction, the researcher can use the IPA approach to analyze experiences (Merriam & Tisdell, 2015). IPA research, as related to data analysis, focuses on identifying themes and linking the significance of those themes to the study (Merriam & Tisdell, 2015). Table 5 illustrates the data analysis plan the researcher utilized during the study. The analysis process for this research included semi-structured, open-ended interview questions.

Table 5 Data Analysis Plan

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Data to Collect</th>
<th>Data Category</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO1</td>
<td>Degree level, degree focus area, years of experience in the nuclear industry, years of experience in current position</td>
<td>Nominal/Ordinal</td>
<td>Descriptive statistic</td>
</tr>
<tr>
<td>RO2</td>
<td>Barriers to career advancement as perceived by female leaders in the nuclear industry</td>
<td>Text</td>
<td>Content analysis Recurring themes</td>
</tr>
<tr>
<td>RO3</td>
<td>Enablers to career advancement as perceived by female leaders in the nuclear industry</td>
<td>Text</td>
<td>Content analysis Recurring themes</td>
</tr>
<tr>
<td>RO4</td>
<td>Business strategies that hinder career advancement as perceived by female leaders in the nuclear industry</td>
<td>Text</td>
<td>Content analysis Recurring themes</td>
</tr>
</tbody>
</table>
Data Analysis Plan continued

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Data to Collect</th>
<th>Data Category</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO5</td>
<td>Business strategies that enhance career advancement as perceived by female leaders in the nuclear industry</td>
<td>Text</td>
<td>Content analysis Recurring themes</td>
</tr>
</tbody>
</table>

The researcher recorded and transcribed the responses using the Webex platform. Then, the researcher analyzed the transcribed data using the NVIVO qualitative software, which finds common themes and insights from text. Utilizing IPA, the researcher anticipated rich, deep descriptions to assign meaning and identify themes. The researcher incorporated guidance from Creswell (2014), which recommends no more than six themes when preparing the narrative. In addition to the data analysis plan, the researcher followed the data analysis process developed by Smith et al. (2009).

The guide developed by Smith et al. (2009) provides an outline for the researcher to analyze the data in six steps. The first step involves reading and re-reading the transcribed data, which allows the researcher to capture inconsistencies. During this process, the researcher highlighted inconsistencies in the transcribed data and audio recording and updated the transcript to reflect the correct information. This step also allowed the researcher to detect voice inflections, pauses, and subtleties from the participant. The second step is the initial coding of the transcribed data, where the researcher searches for the meaning in the participant’s responses. The researcher coded each interview individually by reading responses to highlight similarities and differences in the data. The third step involves reviewing the transcribed data for themes, which
requires the researcher to listen for repeated cues expressed by the participant. The researcher tracked codes and themes in a color-coded table. The fourth step links themes identified in step three. The linking or connection process highlights clusters (Smith & Osborn, 2007). The researcher categorized the themes using the clustering process, and this allowed the researcher to remove irrelevant and uncommon themes.

The fifth step takes the researcher through the first four steps for the remaining study participants. Smith et al. (2009) and Smith & Osborn (2007) explain that the researcher can review the transcripts individually or use the themes from the previous analysis. To increase the study’s credibility and rigor, the researcher reviewed the transcripts individually to determine themes for comparison amongst participants. The final step requires the researcher to review the data to identify patterns from all the data captured in the interviews. This step allows the researcher to cluster the experiences common to all participants as the researcher deems significant to the study (Smith et al., 2009).

Role of the Researcher

In this IPA study, the researcher served as the primary instrument for data collection and data analysis. Merriam (2002) explains that the researcher must remove subjectivities and personal viewpoints to understand the participant’s view. The role of the researcher encompasses the self-awareness of subconscious thoughts that hide in daily conversations (Merriam, 2002). According to Creswell (2003), qualitative researchers methodically cogitate on personal awareness throughout the study and maintain sensitivities on the influence of his or her personal experience, which creates a connection between the personal self and the researcher-self. The researcher captured rich
data to provide an authentic assessment of career advancement for female leaders in the nuclear industry through the identification of themes and participant lived experiences.

Austin and Sutton (2014) and Greenbank (2003) encourage researchers, who conduct qualitative studies, to articulate the basis for the research, including biases and assumptions, so that readers understand the topic. The researcher for this study works in the utility industry in the southern region and holds a position in human resources. Serving as a human resources professional in the utility industry that includes the nuclear industry, the researcher engages with leaders and educational institutions to improve female representation and promote career advancement for women. The researcher strives to create a work environment where women in the nuclear industry have opportunities for career advancement by adding to literature that supports women in male-dominated STEM industries. The researcher proposed proper validation strategies to ensure objectivity in reporting, including member checking, triangulation, clarifying researcher bias, and rich, thick description. According to Taylor-Power and Renner (2003), validation strategies ensure neutrality in discovering and analyzing the collected data.

Summary

Chapter III outlines the research methodology the researcher utilized for this study. The researcher used the IPA approach to collect data about the lived experiences of female leaders in the nuclear industry. Chapter III also provides information on the target population and sample, participants, instrumentation, data collection, and data analysis. The researcher conducted semi-structured, open-ended questions to obtain the data to identify the factors that influence career advancement for women in the nuclear industry. Semi-structured interviews
allow the participant and interviewer to partake in real-time discussions (Pietkiewicz and Smith, 2014) and establish a rapport which helps to capture rich data (Smith et al., 2009). Chapter IV discusses the study’s results, while Chapter V presents findings from the study including the conclusions and recommendations for future research.
CHAPTER IV – RESULTS

This study explored the lived experiences of female leaders in the nuclear industry to determine factors that hinder or enhance career advancement. The interpretative phenomenological research design allowed female leaders to provide first-hand knowledge on their perceptions of the barriers and enablers that presented challenges and opportunities through their career journey. The researcher used one-on-one, semi-structured interviews to capture participant data. The research objectives that guided the data collection include participant demographics, perceptions of barriers to career advancement, perceptions of enablers to career advancement, perceptions of business strategies that hinder career advancement, and perceptions of business strategies that enhance career advancement. The researcher analyzed the data using the process as outlined in Chapter III.

This chapter presents the results collected from the semi-structured one-on-one interviews, the focus group interview, and the researcher’s reflective journaling. According to Austin and Sutton (2014), qualitative research provides unique opportunities for synthesizing complex, nuanced situations where interpersonal uncertainty and multiple understandings exist. The researcher begins the chapter with a detailed explanation of the data analysis process for this study. The chapter will also provide a brief description of the participants included in the one-on-one interviews and the focus group interview. The validation strategies outline the basis of the validity and reliability of the data collected. Each participant discussed their perceptions of factors influencing career advancement for female leaders in the nuclear industry.
Data Analysis

This qualitative study used an IPA data analysis approach to explore the lived experiences of the participants. Study participants outlined their career journey and discussed experiences that influenced their career path into senior leadership. Smith et al. (2009) postulate that the IPA approach examines how people make sense of their life experiences while also allowing the researcher the ability to simultaneously comprehend the experience through his or her perspective. IPA data analysis allows the researcher to explore the data from an outsider’s perspective and grants the researcher some flexibility to adapt based on the researcher’s objectives (Pietkiewicz and Smith, 2014). The researcher conducted six one-on-one, semi-structured interviews with female leaders in the nuclear industry and implemented the IPA process outlined by Smith et al. (2009). Webex served as the platform for the researcher to record and download transcribed data from each interview.

Utilizing the IPA process, the researcher began by reading and rereading each transcript to become familiar with the details of participants’ lived experiences. After each review, the researcher highlighted common word occurrences and keywords while analyzing the transcribed data (Creswell, 2013). This step allowed the researcher to determine the overall tone of the interview, keywords, and meanings. For step two, the researcher began the initial coding of the transcribed data by individually coding each participant’s interview, searching for connections with the data and research objectives. After each coding, the researcher journaled her reflections on the interviews. Step three requires the researcher to review the transcribed data for themes. The researcher reviewed the highlighted keywords, tone, and meanings from the coding in step two. The common
and recurring keywords or repeated cues expressed by the participants became emergent themes. The fourth step links themes identified in step three to the research objectives of the study. The researcher conducted the analysis using NVIVO to categorize codes and identify key reoccurring phrases or words from the text to develop clusters. The clustering process allowed the researcher to link common themes to research objectives (Smith & Osborn, 2007).

Step five in the IPA process is the completion of the first four steps for each of the remaining participant data. According to Smith et al. (2009) and Smith & Osborn (2007), the researcher can review the transcripts individually or use the themes from previous analysis to determine commonalities. The researcher chose to analyze each transcribed interview individually to maintain the authenticity of each interview. The researcher then continued to use NVIVO to complete the coding of each interview for comparison to identify emergent themes. The code summary report from NVIVO (Appendix Q) provided the recurring keywords and phrases from the data analysis. The codes from the summary report provided the framework to create a table to develop the emergent themes (Appendix R) that linked to each research objective.

A data analysis plan describes the connections between the research objectives, data to collect, and the data analysis method. The research objectives provide demographic information and explore the barriers, enablers, and business strategies that influence female leaders’ career advancement in the nuclear industry. Upon completion of the data analysis, the researcher organized the data into four categories: (a) barriers, (b) enablers, (c) business strategies that hinder career advancement, and (d) business strategies that enhance career advancement. The analysis generated 13 themes: (a) three
barriers, (b) four enablers, (c) three business strategies that hinder career advancement, and (d) three business strategies that enhance career advancement.

Participant Demographics

ROI1. Describe the demographic characteristics of the participants, including degree level, degree focus area, years of experience in the nuclear industry, and years of experience in their current position.

The researcher satisfied the goal of the first research objective by attaining the demographic information of the one-on-one interview participants and focus group participants through the initial email to the participants and through the interview questions aligned to the research objective. The researcher obtained study participants from the nuclear industry located in the southern region of the United States with the support of the Regional Women in Nuclear (WIN) President. Eight participants received invites to participate in the one-on-one interviews, and 14 participants received invites to participate in the focus group interview. Six of the eight female senior managers or higher in the nuclear industry participated in the one-on-one interviews, and six of the fourteen females, who are not senior managers or higher in the nuclear industry, participated in the focus group interview. The participants for the one-on-one interview work in several different departments within the nuclear industry with experiences that range from providing on-site field operations support to providing an off-site center of excellence operations support. The participants for the focus group interview also work in several different departments and work locations within the nuclear industry, with experiences that range from supporting operations, direct field operations, and operations performance oversight.
After interviewing four of the six one-on-one participants, responses became similar and consistent, indicating saturation. The researcher conducted two additional interviews to ensure that there was not any additional new information to capture. Table 6 displays the demographics of one-on-one interview participants, which includes degree level, degree focus area, years of experience in the nuclear industry, and years of experience in the current role within the nuclear industry. To protect the participants’ anonymity, the researcher assigned a pseudonym to each person to maintain confidentiality.

Table 6

One-on-One Participant Demographics

<table>
<thead>
<tr>
<th>Participant</th>
<th>Degree Level</th>
<th>Degree Focus Area</th>
<th>Years of Experience in Nuclear Industry</th>
<th>Years of Experience in Current Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cora</td>
<td>Masters</td>
<td>Engineering Management</td>
<td>19</td>
<td>1.5</td>
</tr>
<tr>
<td>Zoe</td>
<td>Masters</td>
<td>Economics</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Camille</td>
<td>Masters</td>
<td>Organizational Leadership</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>Sandra</td>
<td>Bachelors</td>
<td>Business Management</td>
<td>27</td>
<td>3</td>
</tr>
<tr>
<td>Julianna</td>
<td>Bachelors</td>
<td>Mathematics</td>
<td>32</td>
<td>1.5</td>
</tr>
<tr>
<td>Vanessa</td>
<td>Masters</td>
<td>Engineering Management</td>
<td>25</td>
<td>0.5</td>
</tr>
</tbody>
</table>

For triangulation, the researcher conducted a focus group interview with the six participants who work in the nuclear industry in various roles outside of senior manager or higher (See Table 7). The participants did not participate in the one-on-one interviews. The focus group participants work in many of the same areas as the one-on-one interview participants and possess a range of 6-28 years of experience in the nuclear industry.
Table 7

Focus Group Participant Demographics

<table>
<thead>
<tr>
<th>Participant</th>
<th>Degree Level</th>
<th>Degree Focus Area</th>
<th>Years of Experience in Nuclear Industry</th>
<th>Years of Experience in Current Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>Masters</td>
<td>Construction Engineering</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Participant 2</td>
<td>Some College</td>
<td>NA</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Participant 3</td>
<td>Associates</td>
<td>Electronics Technology</td>
<td>10.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Participant 4</td>
<td>Bachelors</td>
<td>Nuclear Engineering</td>
<td>27</td>
<td>1.5</td>
</tr>
<tr>
<td>Participant 5</td>
<td>Bachelors</td>
<td>Business Administration</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>Participant 6</td>
<td>Masters</td>
<td>Accounting</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>

The focus group responses aligned with the senior manager or higher one-on-one interview responses. After capturing demographic data for one-on-one and focus group participants, the researcher collected data exploring the factors influencing career advancement in the nuclear industry, which produced 13 emergent themes.

Themes

In this study, participants provided responses to a set of open-ended, semi-structured questions focused on their lived experiences as a female leader in the nuclear industry. The data analysis and theme development identified 13 themes that relate to the research objectives for this study. The following themes developed from the transcribed Webex interviews and researcher’s reflective journal include:

- Theme 1 *Exclusion Bias*
- Theme 2 *Lack of Technical Experience*
- Theme 3 *Lack of Flexible Work Schedules*
RO2. Explore barriers to career advancement as perceived by female leaders in the nuclear industry.

The second research objective explored and identified the barriers to career advancement as perceived by female leaders in the nuclear industry. Study participants provided their insights through discussion with the researcher, which led to the identification of the three themes as barriers to career advancement (see Figure 3). The themes that emerged from the interviews included exclusion bias, lack of technical experience, and lack of flexible work schedules. Table 8 provides a representation of how many of the participants referenced the three barriers during the interview. As shown in Table 8, four of the six participants highlighted all three of these barriers to career advancement for women in the nuclear industry in their responses; five of the six
Figure 3. Barriers to Career Advancement

participants provided their insight on how the lack of flexible work schedules are barriers for women in the nuclear industry, and all six participants discussed how exclusion bias could negatively impact the career advancement of women in the nuclear industry. Other subthemes uncovered during the interviews include lack of diversity, stereotypes, confidence, opportunities, and no career map.

Theme 1. Exclusion Bias

When discussing experiences that were barriers in their career progression or for women in the nuclear industry, all participants highlighted exclusion bias, which implies that qualified employees cannot participate in certain experiences and opportunities because of not being included or invited to internal or external activities that result in business discussions and can prevent businesses from leveraging the talents and perspectives of all members of their workforce (Bodin, 2020).
Table 8

*Identified Perceived Barriers*

<table>
<thead>
<tr>
<th>Perceived Barrier</th>
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<tbody>
<tr>
<td>Exclusion Bias</td>
<td>6</td>
</tr>
<tr>
<td>Lack of Technical Experience</td>
<td>4</td>
</tr>
<tr>
<td>Lack of Flexible Work Schedules</td>
<td>5</td>
</tr>
</tbody>
</table>

The study participants recognized this through the lack of diversity in the workforce and in the challenges of women to work through the demands of operations training, especially during a time when they may be growing their families or caring for younger children. Another discussion point addressed was that most of the decision-makers in the nuclear industry are men. Women must overcome the exclusion bias and continue to push through these challenges to continue forward in their careers while dealing with the stereotypes in the nuclear industry. All six participants shared their insights about their experiences from their career progression.

Zoe reflected on barriers as a whole for the nuclear industry. She described the challenges of working in a male-dominated industry.

For the industry, I think there are a lot of barriers. There are people who want to hire someone who looks just like them and is going to fit in just like them. Then [there is the] perceptions of women know or not know about maintenance and what women know or not know about instrument and controls. [We] have to just get over those [perceptions] and get over those things that have been a challenge for us for a long, long time in male-dominated fields of work.
Similarly, Camille provided insight on how the rigor of the industry can provide a greater hardship on women than men.

You also must have an operating license and have worked on shift. That is a barrier to a lot of men, as well. However, this is more of a barrier primarily for women, particularly because this is a position that you would take earlier in your career. We’ve got to rethink how women get [qualifications] for a position because it kind of self-selects out women. This is simply because of the timing and the path that it requires.

Sandra’s response provided a passionate emphasis on what she feels the problem is regarding a lack of diversity. Sandra stated:

There's also something to say for men to engage in mentorship and step up. We need [men] to say, let me help guide you through your career. What I'm describing is not rocket science. What I'm describing is just my experience, and it’s sad that many of our male leaders can't describe that on their own, which I think is the problem. It’s a problem because they're the main ones at the top, [who are] making decisions, which can help [drive] change and promote women into higher roles.

Julianna discussed how exclusion bias could deter relationship building, even away from the work environment. She shared this insight from her experience:

[It is] probably just the stereotype in our industry. There are a lot of the people who have moved up in our industry with a certain profile, and [they] get a voice. There are a lot of people who bond after work – hanging out, going to play golf, or meet at the bar. Sometimes you're here because you're not part of that group.
That is what I've seen, in my view, as a barrier because it's a relationship that they're building, and that relationship plays a part in their connection. One time, there was a group of managers who would go out after work to have beers and hang out, but there were just a few of us that weren't in that group. We would notice when the group went out together that they would make decisions and come back with decisions that impacted us.

Vanessa provided a pointed and thought-provoking perception of exclusion bias and the lack of diversity in the nuclear industry. She stated:

There's the underrepresentation of women and the underrepresentation of cultural minorities. You still have people who are people, and people say different things. That's always a barrier, but you learn to overcome those [barriers]. I would say that biases can be barriers, but you must decide how to overcome and deal with those barriers. It's put in your house, and it’s on you [to decide] how you want to deal with those [biases].

During her response, Cora touched on how exclusion bias over time has created a leadership paradigm in nuclear where most of the leaders and decision-makers are not female. Cora shared:

And in some people's minds, the facts are that white men are the most qualified. So, it's going to take some reframing, and that's a barrier. Also, the egos and the history of experience are barriers [especially as you consider] the back history of why certain people don't have certain experiences. Everyone wants to feel like they fit in, and oftentimes it’s uncomfortable. Oftentimes, I feel most comfortable when I'm in a room with people that look like me. I think that's probably natural
[for women], but it's natural for men, too. When it's mostly men at the top [and] mostly men making the decisions, I think that they're probably going to make decisions based on what's going to make them feel the most comfortable.

In addition to exclusion bias, participants discussed that the lack of technical experience also served as a barrier to career growth and progression for women in the nuclear industry.

**Theme 2. Lack of Technical Experience**

Lack of technical experience was a discussion point for four of the six participants during the discussion of barriers to career advancement. The participants reflected on how most of the jobs in the nuclear industry reside in the plant environment and are technical in nature. Progressing with the industry requires technical knowledge with a heavy influence and strong focus on employees who possess a reactor operator's license.

The four participants shared the following insights. Camille provided her thoughts on why a lack of technical experience can limit career progression for women in nuclear. She pointed out that, “You also must have an operating license and have worked on shift. And that is a position that you would take earlier in your career.” Not understanding the plant can limit career progression. Julianna explains that the “fundamental knowledge of the plant and how it works is important. A lot of times, people are hesitant to attend engineering systems classes or operations training.”

Vanessa also shared insights into why gaining technical experience is a barrier for women. She stated:

[Women must] understand how technical [the nuclear industry] is, especially in operations. When we think about shift work, it's a pain, but it’s a bigger barrier
than it needs to be. There are many people who work differently, and there are women who work and figure it out, but you must get your license, and then you must spend three years on shift, so that's a five-year commitment.

Sandra also spoke of the time commitment related to gaining technical experience:

If a woman [decides to be] an operator, she’s going to be at the top of everyone’s list, but that’s a two-year commitment…. Some women may think it is boring, and I know that it can be boring. However, they [will learn and experience] in two years what it took me 20 years to get little bits at a time. The historical method for achieving senior management and executive-level success has been through that long path I described of becoming an operator and putting in your time in the operations control room.

The discussion on the lack of technical experience also led to a discussion on the inflexibility and strict nature of the nuclear industry, which becomes a barrier to career advance for women.

Theme 3. Lack of Flexible Work Schedules

While the nuclear industry does have positions that are administrative in responsibilities and job opportunities where the employee works in an office environment, many of the positions exist at plant sites where the coverage is year-round, day and night. During the interviews, five of the six participants pointed to inflexible work schedules as a barrier for women in the nuclear industry. Some of the examples provided detailed the amount of time an employee would have to devote to train for a reactor operator license and then the time commitment to working shift work to gain the experience. Similarly, another participant spoke to the challenges of not being able to
work from home or in a hybrid capacity like other employees outside of the nuclear organization. The five participants provided the following thoughts based on their experiences.

Julianna pondered the current work conditions; especially as other organizations consider hybrid work schedules. She stated:

The inflexible work schedules are going to create more inflexibility in nuclear. The remote work policy in nuclear and how we're not going to have the hybrid opportunities like [others] throughout the rest of the company is going to hurt. I think that hurts women more than it does for our male counterparts. I think people have found it's a much easier way to be more efficient at work and at home. I personally never thought I would enjoy working remotely. Now that I have been working from home, I've found [that] I don't lose any efficiency from work. Since everyone that reports to me is not in the same building as [I am] anyway (some are spread across the entire company), I think that being able to work remotely has helped me a lot. I think that inflexibility is going to have a very negative impact. It's going to be a barrier.

Sandra spoke to how demanding working in nuclear can be:

We haven't been historically as flexible as some. It is just nuclear in general that has always had the inability to be flexible with work schedules and the inability to be flexible with working remotely. An [example is the] start time for plant operations. We start very early in the morning, [and] things like that are demanding.
Camille highlighted that inflexible work schedules are barriers for women as they plan to start families or have small children:

You also must have worked on shift which is a position that you would experience earlier in your career, and that's typically when a woman might be starting a family or have smaller children. That step can be a put-off for women. Also, they won't take that opportunity to go to license class, and as a result, they are then eliminated from several positions.

Work-life balance is difficult to maintain when you work in an environment where schedules are inflexible. Zoe discussed how “we have to recognize that the time for people who are balancing family might be a little bit different. We have to give a little bit more work flexibility.” In the nuclear industry, operations also referred to as ops, is the typical path to gain technical knowledge and progress in your career. Vanessa discussed how this is different for some employees. She shared, “… there are folks that want to go into ops, [work] in ops, and stay in ops. There are men and women who love shift work, and that's great – that works for them. But then there are some [employees] that this doesn’t work for.”

Focus group participants also provided their insights on the barriers to career advancement in the nuclear industry. Like the responses from the one-on-one interview, several of the participants spoke of exclusion bias, with one stating, “It’s like nepotism. It’s just the bias. I guess maybe because it’s the nuclear [industry], but they think that women don’t exactly belong there, but that’s not true…. Another focus group participant commented:
Many times, in nuclear, when they hire people, they hire people that they know, and they feel comfortable with that person. They have some type of background [or connection] already with that person versus looking at the people that they have [internally] within their department that could very well be trained to learn to do the work.

Exclusion bias, lack of technical experience, and lack of flexible work schedules, as perceived by the participants, possibly serve as barriers to career advancement for women in the nuclear industry. The barriers present challenges for women in the nuclear industry; however, the study participants also expressed their perspectives on the enablers to career advancement. The third research objective explored and identified these enablers to career advancement through discussion with the study participants, which led to the identification of four themes as enablers to career advancement.

Perceived Enablers

*RO3. Explore enablers to career advancement as perceived by female leaders in the nuclear industry.*

Study participants provided their insights through discussion with the researcher, which led to the identification of the four themes, college degree, technical experience, mentors and champions, and self-promotions, as enablers to career advancement (see Figure 4). Interviews also highlighted subthemes for enablers to career advancement, which include a defined career path, leadership development, networking, a good support system, and volunteering. Table 9 provides the captured enablers and a representation of
Figure 4. Enablers to Career Advancement

how many of the total numbers of participants referenced the four enablers. As shown in Table 9, four of the six participants highlighted all four of these enablers to career advancement for women in the nuclear industry in their responses; five of the six participants provided their insight on education and mentors as enablers. All six participants discussed how self-promotion serves as an enabler in career advancement.

Table 9

| Identified Perceived Enablers |
|-----------------------------|-----|
| Perceived Enabler           | n   |
| College Degree              | 5   |
| Technical Capability        | 4   |
| Mentors and Champions       | 5   |
| Self-Promotion              | 6   |
**Theme 4. College Degree**

Study participants discussed the importance of education to career advancement. Several of the participants alluded to a college degree, in particular, and a master’s degree with limited work experience. Vanessa explained that “degrees teach you how to solve problems… and certainly will help to get you in the door. The MBA has been helpful especially with understanding different budget [processes]….” Adding to that, Cora stated, “A formal education is good, and a [bachelor’s] degree and an MBA definitely are helpful, but the informal [education] definitely is a part of that and should not be missed.” Julianna spoke of how having engineering coursework in her degree program provided her with a technical background that was good for her role. She shared, “My formal degree is not in engineering but at the same time, I had a lot of basic engineering classes as part of my degree [program]…. So, when I started in the nuclear industry, it's really good that I did have some technical background.”

Another participant, Sandra, addressed how the degree gets you to the dance or in the door and that people with unfinished degrees should go back to school to complete those degrees because the degree helps with career advancement. Sandra stated:

So, obviously, there are many things needed to be a leader, and I think having a degree of any sort is a ticket to the dance. Having a degree, a bachelor's degree or higher, especially if you don't have years and years of experience, is always the ticket to at least get you considered. So, [a degree] is number one. I always recommend that if people haven't finished their degrees that they go back and work on those because it is helpful. I believe [a degree provides] some basic skills that you fall back on as a leader.
Camille also shared how her engineering degree helped her with entry into the nuclear industry and how her master’s degree helped her when transitioning into a new role:

Yes, so my base entry into the nuclear industry, particularly the technical side of things, is that I have an engineering degree. That was the foundation that I needed to get into the reactor operator’s license program. I also have a master’s [degree]…which has helped me with transitioning from an individual contributor into a leadership role [and with] understanding the business side of things, as well as the technical side of things.

The discussion on enablers also led to the participants discussing technical experience as a plus for women to advance their careers. Participants expressed this as the foundation needed to understand the fundamental basis of nuclear power.

*Theme 5. Technical Capability*

Several of the participants emphasized that technical capability provided an advantage and contributed to their career progression. The participants spoke strongly of having and understanding the fundamental baseline knowledge of nuclear. Sandra boldly stated that “if you're a woman, and you have been an operator, or if you have been a technician like an electronics technician or a mechanic. You're like a double threat because, you know, that's just better all the way around.” Julianna expressed the importance of operations systems training:

I had basic engineering and plenty of advanced engineering classes in my degree [program]. I think if you're going to be in the nuclear industry, it's good to have some of the technical background and understanding of nuclear operations. I think any opportunities to work in operations systems training should be taken. Those
opportunities] are all very important to get the baseline fundamentals because there are many positions we can progress to in our careers.

In addition to training, Camille discussed the importance of having the capability, as well as a foundation. She stated, “Part of it is the technical training and capability. So, there is a foundation that you must possess technically.” Similarly, Vanessa discussed understanding the basics to learn how a nuclear plant runs. She shared some of the ways she gained her technical knowledge, “I stayed in ops through an outage…. I was able to learn how the plant really runs from an operations control standpoint. From an operator standpoint, I was able to learn about all the bad things that can happen and how to respond to actions and different things.”

In addition to having technical knowledge, participants highlighted mentors and champions as enablers to career advancement. Several of the participants stressed the importance of having a mentor and champion to support you through your career development.

**Theme 6. Mentors and Champions**

Study participants discussed the importance of mentors and champions, also referred to as sponsors, in their career progression in the nuclear industry. Mentors and champions helped to provide opportunities for growth and provide exposure. Vanessa acknowledged how mentors and champions influenced her career:

I always acknowledge that I have had people that crack doors [open] for me. I bring a set of talent and skills, and abilities to the table, and with the support of good mentors and good sponsors, I was able to go run through [those doors] to grow and advance. [Those doors] wouldn't have been cracked if I slacked off.
Mentorship and sponsorship influenced my career, but I also had to perform and bring my skills and abilities to the table, as well.

Camille also spoke of the strong mentors who provided support for her during her career. She stated, “It has to be a blend of all those things together. Absolutely, without my mentors and without my champions providing me some of those opportunities, I would not have received some of the exposure and the experience that I have.”

Julianna spoke about mentoring from a perspective of the benefits when provided to new talent to help them navigate their careers. She discussed, “In mentoring, we must ensure that we have our new talent set up with someone who can talk with them and help them navigate the male-dominated industry that we're in.” Zoe also mentioned that mentoring and champions align directly with development and career progression. She remarked, “I had one other thing [in my career] that is very often the most important thing to development and career advancement. I had a champion.” Sandra ardently expressed the importance of men providing mentorship to women, as well. She asserted that “at some point, there's also something we need men to do with mentorship and to step up and say, let me help guide you.” Focus group participants alluded to the need of having those leaders who would give them a chance – someone who would work with them to gain new experiences and opportunities to grow in their careers.

The final enabler participants discussed focused on self-promotion to learn more and confidently share your knowledge. The participants expressed their concern with women who do not speak up and do not take on new challenges to grow, as this behavior provides the opportunity for others to provide support to improve career advancement.
Theme 7. Self-Promotion

All six participants discussed the importance of self-promotion as an enabler to career advancement for women. Many of the participants spoke of volunteering and getting outside of their comfort zone. The participants also emphasized that self-promotion cannot partner with arrogance. Self-promotion focuses on gaining visibility through volunteering for roles that may be a challenge or that no one else wants. Julianna explained:

Women should volunteer and put [ourselves] into those roles that traditionally we wouldn't know we felt uncomfortable doing because sometimes those roles are hard. However, if you succeed in it, then it helps to get your name out there. It helps provide recognition for you and then helps you with other opportunities. I think a lot of times, we think that our actions will be recognized because of the good job we did, and I think that it's very difficult for us to say, hey, look at me and look at what I accomplished.

Cora spoke of women’s confidence and how important speaking up and bravery influence career advancement. She declared in a confident tone that women must “continue to be brave…keep being a good example…keep speaking up and…giving feedback.”

Likewise, Camille asserted that women should value themselves, confidently speak up, and understand that they possess skills and insights that organizations need:

I think one of the most important things is that women should not apologize because they are women. They need to recognize that they bring a different skill set, a different perspective, and different insights to the game and that those [differences] should be valued.
Volunteering and confidence continued to arise as focal points for self-promotion. Vanessa emphasized that volunteering for what no one else wants and having confidence positively influences career progression:

Volunteer for the [projects and activities] that no one else wants to do and then do it well…. Confidence is important, but you must be humble, as well. I find a lot of women that I mentor come across as not confident or too hesitant, and I work with them to help them overcome that.

In addition, Sandra provided the following insight:

[Women should] volunteer for everything. For example, volunteer for fire watch, volunteer to work in the outage control center, or just volunteer for every project that will get you some level of understanding of how a nuclear power plant works because in fairness, at any level in the organization, you must know enough to make decisions that are complementary to nuclear safety. The only way you can do that is to know enough to know what's right.

Zoe provides a different perspective on how self-promotion helps other women in the future. She sees self-promotion as a way to break down walls by showcasing your talent and helping the leader to think differently. She stated:

Part of my success is that I stand out. There are many times that I'm the only female in the room, and I just have a high level of comfort with that. I’m used to being the only female, and I recognize that not every woman has that experience. It may feel weird to some women to always be the only woman in the room, so what helped me was that it doesn't bother me. I'm very comfortable with that, and they may have to get used to that. Personal grit, perseverance, and personal
confidence – these attributes are very important for women. As you are showcasing your talent, you really are helping leaders to think differently about [the way nuclear has always done things] and that maybe employees don’t need to have 20 years in nuclear experience [to be a leader] …. When you’re able to help break down those walls, we can get opportunities.

Focus group participants also expressed the importance of self-promotion. Three of the six participants spoke of volunteering “for people to see you … and to get your foot in the door.” Another focus group participant discussed taking on new tasks and having to “show you are good and not being afraid to step up.” Focus group comments aligned with the information captured for the one-on-one interviews. Both groups see enablers as positive influences in career growth. College degree, technical experience, mentors and champions, and self-promotion serve as enablers to career advancement for women in the nuclear industry. The enablers provided opportunities for women to gain entry into the industry and progress their careers to leadership. The study participants also provided their perspectives on the business strategies that hinder career advancement. The fourth research objective explored and identified business strategies that hinder career advancement. Through discussion with the study participants, the researcher captured three themes as business strategies that hinder career advancement

Business Strategies that Hinder Female Advancement

RO4. Identify business strategies in place that hinder female advancement in the nuclear industry.

Study participants identified business strategies they experienced through their careers that hinder career advancement for women in the nuclear industry. The
participants discussed the outdated promotion strategy, lack of diverse hiring practices, and work-life balance as hindrances businesses currently implement that negatively influence the career advancement of women in the nuclear industry (see Figure 5). Additionally, subthemes emerged from the responses, which include previous hiring practices, resources not dedicated to diverse hiring, a formal path for promotion, and no career map.

Figure 5. Strategies that Hinder Career Advancement
Table 10 provides the captured business strategies as perceived from the lived experiences of current female leaders in the nuclear industry that hinder career advancement. As shown in Table 10, three of the six participants highlighted outdated promotion strategy as a business strategy that hinders career advancement. Three of six participants highlighted a lack of diverse hiring practices as a hindering business strategy for career advancement, and three of six discussed inflexible work schedules as a business strategy that hinders career advancement.

Table 10

*Identified Perceived Business Strategies Hindering Female Advancement*

<table>
<thead>
<tr>
<th>Perceived Business Strategy</th>
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<tbody>
<tr>
<td>Outdated Promotion Strategy</td>
<td>3</td>
</tr>
<tr>
<td>Lack of Diverse Hiring Practices</td>
<td>3</td>
</tr>
<tr>
<td>Work-Life Balance</td>
<td>3</td>
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</table>

*Theme 8. Outdated Promotion Strategy*

The participants spoke of the traditional paths to promotion strategy within the nuclear industry. The traditional, outdated promotion strategy requires long time commitments that present challenges for women. Cora shared:

Maybe informally, we should change or ensure that we [focus] more on the qualifications …. We should consider taking a fraction of hires and use some alternate justification [for a promotion] …. We can use that as a pilot if they're successful. We just have to change our mindset.

Additionally, Camille expressed similar thoughts and reflected on how this hinders the increase of women in leadership:
I think we have people who are committed to developing women and getting them into those roles. However, there's also still a paradigm about previous positions and what you must do to qualify for those roles. I think this needs to be evaluated by some of our leadership. There is this traditional nuclear career path that requires so many years in each position in order to get to a role. If we maintain that, the number of women in those roles will not improve.

Moreover, Sandra also expressed how the outdated promotion strategy may present challenges to women:

The historical method for achieving senior management and executive-level success has been through that long path I described of becoming an operator putting in your time in the control room, and spending time in the plant. It’s a long prospect, so I don't know that a lot of women want to put that much time in for something that they're not naturally drawn towards. Male leaders can't describe that on their own, which I think is the problem because they're the main ones at the top making the decisions.

Throughout the discussion on business strategies that hinder career advancement, study participants also discussed the lack of diverse hiring practices. Oftentimes in the nuclear industry, the focus centered on hiring people with Navy nuclear experience referred to as Navy Nukes.

*Theme 9. Lack of Diverse Hiring Practices*

Study participants shared their experiences and perspectives on how the lack of diverse hiring practices hinders career advancement. The lack of diverse hiring practices creates challenges to recruit diverse talent. Camille highlighted past practices, which led
to the hiring of more men than women in the past. She shared, “Previous hiring practices targeted Navy nukes. And until recently, women weren't in the Navy nuke program because they weren't allowed on those ships.” Zoe also expressed concern regarding how white males have reacted to discussion focused on improving diverse candidates:

There were a lot of challenges around if we're going to get more diverse candidates with comments from a couple of white males that obviously [implied that the] quality of this group is going to go down. And it's like if you're going to hire women and minorities, the group's not going to be as strong.

Vanessa expressed realistic optimism as she discussed diverse hiring practices hindering career advancement:

I do not think we are near where we need to be, which makes me ask why we aren’t there. Some of it is around different reasons, but a large part of it is because of the pipeline. We need to encourage young women and show them that this is a good career that is in demand. A couple of years ago, I looked at the [diversity] numbers, and they were flat. I look at the numbers now and wonder how is it that for the many years I've been here that we have not made an improvement [in our diversity numbers]. I’d like to say it's better, but the numbers don't really reflect any improvement.

Another business strategy that participants discussed that hinder career advancement focused on the work schedules, shift work, and the inflexibility of the nuclear industry. Inflexible work schedules, including shift work, presents unique challenges that could limit career advancement for women.
Theme 10. Work-Life Balance

Participants discussed the inflexible work schedules in the nuclear industry and how this can hinder the career advancement of women. In the nuclear industry, some positions require shift work, which can negatively impact work-life balance. Zoe described that organizations should try to incorporate “things that make the company a friendly place for women to work…. We have to recognize that the time for people who are balancing family might be a little bit different.” Julianna reflected on the demands of the jobs in nuclear and how the need for Nuclear to do things differently:

We're not where we need to be [regarding] being very flexible…. With the pandemic, we've learned that we can do a lot more remotely. We need to learn to do things differently. Younger people coming into the industry need that flexibility, and I'm concerned that our trajectory going forward is going to hurt if we don't learn from how we work during the pandemic. If we go back to business-as-usual, I may lose a lot of good people because they can go to another utility and have a more flexible schedule.

Sandra described and reflected on the strictness of the nuclear industry, especially with work schedules. She recalled times when she worked in ops, which required working six days a week for 12 hours each day. She stated:

The very inflexible nature of commercial nuclear power is demanding, and women, especially young women, just aren’t having that. The overall structure is very, very strict. What is it going to take to make our business more attractive to female workers, so we can have more diversity because it's a challenge, especially when you have a family? For example, during outages where you're required to
work on shift six days a week, 12 hours a day, I know a lot of good people that
we've lost just because of the inflexibility of those work schedules.

Focus group comments aligned with the information captured for the one-on-one
interviews. Similar comments focused on the lack of diverse hires and inflexible work
schedules emerged during the discussion. One focus group participant discussed that the
company did not hire many women into entry-level positions. Another participant
reflected on the understaffing of her department, which did not allow her to have a
flexible work schedule. Study participants also provided their perspectives on the
business strategies that improve career growth. The fifth research objective explored and
identified business strategies that enhance career advancement. Through discussion with
the study participants, the researcher captured three themes as business strategies that
enhance career advancement.

Business Strategies that Enhance Female Advancement

RO5. Identify business strategies in place that enhance female advancement in the
nuclear industry.

Study participants identified business strategies they experienced through their
careers that enhance career advancement for women in the nuclear industry. The
participants also shared strategies they would like to see implemented to enhance career
advancement for women. The participants discussed formal mentoring, career paths for
promotion, and diversity recruitment as strategies that enhance career advancement (see
Figure 6). Also, several subthemes emerged from the interviews, including succession
planning, diversity goals, community engagement, intern program, recruitment and
STEM outreach, and leadership development. Table 11 provides the captured business
strategies that enhance or improve career advancement as perceived from the lived experiences of current female leaders in the nuclear industry. As shown in Table 11, three of the six participants highlighted a formal mentoring program as a business strategy that improves career advancement.

![Figure 6. Strategies that Enhance Career Advancement](image)

Also, three of the six participants expressed the need for a career path for promotion. Diversity recruitment emerged in four of the six participant interviews as a business strategy to enhance career advancement.
Table 11

*Identified Perceived Business Strategies Increasing Female Advancement*

<table>
<thead>
<tr>
<th>Perceived Business Strategy</th>
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<tbody>
<tr>
<td>Formal Mentoring Program</td>
<td>3</td>
</tr>
<tr>
<td>Career Path for Promotion</td>
<td>3</td>
</tr>
<tr>
<td>Diversity Recruitment</td>
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*Theme 11. Formal Mentoring Program*

The participants reflected on the strategies that helped them progress in their careers and on strategies that could provide a better way to enhance females’ career advancement in the nuclear industry. Julianna discussed mentoring new talent as they enter the workforce:

> With mentoring, [we] make sure we have our new talent set up with someone that can talk with them and help them navigate the male-dominated industry that we're in…. However, they really need some type of formal program. We call them buddies, but it needs to be more of a formal mentor or someone who can help them navigate [their careers]. I think that the mentoring is probably a good [strategy] and not just to help navigate your career, but [to also have someone] you can vent to…or give ideas.

Vanessa spoke of the importance of a support network and development process. She stated, “You must bring them in…, and you have to recruit…. You must have a good support network forum, and then you must develop them.” Camille reflected on the importance of mentors and champions in her career:
A good deal of it is working hard, being dedicated, and delivering a quality product. But I must also give credit [because] I’ve had some very strong mentors along the way. I’ve also had some champions who have helped me to get positions and who also put me in positions. Then, [those champions] made sure that I succeeded in those positions.

Participants also identified a strategy that the business should develop for women in the nuclear industry. The three participants discussed the need for a formal career path for women as they start early in their careers to help them decide on opportunities that will lead them toward their career goals.

**Theme 12. Career Path for Promotion**

Study participants reflected on the benefit entry-level employees would have if they could identify the positions needed to move through the career progression earlier in their careers. Camille suggested:

I would like to see more identification of candidates and at an entry-level. Then, I would like to see a formal path that develops them into the positions we would like them to excel in their career progression. For instance, if an engineer is hired and in year two or year three, we identify that this person is going to be a future engineering director or is going to be a future site Vice President, then we should know what experiences we need this person to have and start scheduling those opportunities early rather than waiting to do so in the future. This presents an awkward moment when this person needs to become a department leader but first, the person must go to license class because that’s needed to become a department leader. Instead of waiting for those opportunities, start scheduling them early.
Vanessa added that “the more you can think about it on the front end, you can decide what you really want to do. You can decide how you are going to get there and get someone to help you. You can ask someone to sit down and help you develop a career path. The more you know what is needed to progress, the more in control you can be of your career.”

Julianna thought through her response as she reflected on the question and then provided this reply:

For [women], sometimes they don’t know what is next, but a career path for women could help them understand decisions [they need to make early in their careers] because sometimes it is a sacrifice. They might be willing to do shift work if they know that getting it done early on in their career, then they can get operations under their belt. Having a defined career path to share with new talent would be good.

Four of the six study participants identified diverse hiring practices as a much-needed business strategy to enhance the career advancement of women in the nuclear industry. The participants focused on the importance of intentional recruiting strategies specifically targeting female hires.

*Theme 13. Diversity Recruitment*

The study participants explained that the nuclear industry no longer looks to the Navy nuclear program for recruiting. Camille shared that “the recruiting process has changed… we're targeting more of the engineering background, rather than just Navy Nukes. Vanessa spoke to the need to be intentional in recruiting efforts to bring in more female talent. She articulated the importance of recruiting:
More of a focus on the recruiting of female’s diversity in any way is needed. You must recruit… If you want to grow top female talent, you must start with recruiting [the talent]. You must go find them – you must go get them and bring them in. You must make them feel included and provide them with a support network.

Sandra connected community engagement to recruiting strategies as a way to improve diversity by stating, “I know that we have strategic initiatives around engagement with our communities, which…by in and of itself is intended to improve the diversity of our workforce. Like Sandra, Zoe shared an example of a current program that directly ties into diverse hiring strategies. Zoe reflected that the company’s intern program “…has really focused on bringing in diverse candidates who are looking to work at the company in the future.” Focus group participants shared some of the same insights as the one-on-one participants. The career path for promotion theme recurred multiple times during the interview. Some of the focus group participants also expanded the thought of career path for promotion to include job shadowing to allow women to spend time in the role to gain technical experience.

After the completion of all interviews, the researcher performed a comprehensive review of participant responses. The researcher read and reread the transcript and used NVIVO to identify the codes for each research objective. The codes linked to research objectives to determine the emergent themes. The researcher utilized the emergent themes in exploring the study’s research objectives.
Connecting Research Themes to Research Objectives

The researcher completed six one-on-one interviews and a focus group interview, which resulted in 13 themes and 20 subthemes of factors that influence females’ career advancement in the nuclear industry. The identified themes correlate to each research objective. Participant demographic information (i.e., degree, degree focus area, years of experience in nuclear energy, and years of experience in their current role) support RO1. Research objective 2 explores the barriers to female leaders’ career advancement in the nuclear industry. RO2 contains three themes identified by participants as exclusion bias, lack of technical experience, and lack of flexible work schedules. Lack of diversity, stereotypes, lack of confidence, lack of opportunities, and no career map emerged as the five subthemes that connect with RO2. Research objective 3 explores the enablers to female leaders’ advancement in the nuclear industry. College degree, technical capability, mentors and champions, and self-promotion emerged as the four themes for RO3. The researcher identified defined career path, leadership development, networking, good support system, and volunteering as the five subthemes linked with RO3.

Research objective 4 identifies the business strategies that hinder career advancement as perceived by female leaders in the nuclear industry. The three business strategies that hinder career advancement identified by participants for RO4 include work-life balance, lack of diverse hiring practices, and outdated promotion strategy. Previous hiring practices, resources not dedicated to diverse hiring, a formal path for promotion, and no career map emerged as four subthemes for RO4. Research objective 5 identifies the business strategies that enhance career advancement as perceived by female leaders in the nuclear industry. The three business strategies that enhance career
advancement identified by participants for RO5 include a formal mentoring program, career path for promotion, and diversity recruitment. The researcher identified succession planning, diversity goals, community engagement, intern program, recruitment, and STEM outreach, and leadership development as six subthemes for RO5. Table 12 illustrates the link between the research objectives and the themes for the study.

Table 12

*Research Objectives and Theme Correlation*

<table>
<thead>
<tr>
<th>Research Objective (RO)</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO1</td>
<td>Demographics (degree level, degree focus area, years of experience in the nuclear industry, and years of experience in current position)</td>
</tr>
<tr>
<td>RO2</td>
<td>Exclusion Bias</td>
</tr>
<tr>
<td></td>
<td>Lack of Technical Experience</td>
</tr>
<tr>
<td>RO3</td>
<td>College Degree</td>
</tr>
<tr>
<td></td>
<td>Technical Capability</td>
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<tr>
<td></td>
<td>Mentors and Champions</td>
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<tr>
<td></td>
<td>Self-Promotion</td>
</tr>
<tr>
<td>RO4</td>
<td>Work-Life Balance</td>
</tr>
<tr>
<td></td>
<td>Lack of Diverse Hiring Practices</td>
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<tr>
<td></td>
<td>Outdated Promotion Strategy</td>
</tr>
<tr>
<td>RO5</td>
<td>Formal Mentoring Program</td>
</tr>
<tr>
<td></td>
<td>Career Path for Promotion</td>
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<tr>
<td></td>
<td>Diversity Recruitment</td>
</tr>
</tbody>
</table>

Summary

Chapter IV describes the data analysis process utilized to develop the codes, themes, and results of the study. Additionally, the chapter provides participants’
demographics and quotes from the interviews and focus group comments, which addressed the research objectives for this study. Participants shared their experiences as female leaders in the nuclear industry. These participant experiences provided the data to develop emergent themes. Participants shared that career advancement in the nuclear industry requires some level of technical knowledge. Additionally, many of the participants acknowledged that a mentor or sponsor offered support that helped them to progress in their careers. The answers and comments from the one-on-one and focus group interviews produced 13 themes and 20 subthemes. Chapter V offers findings from the research and follows each finding with a conclusions and recommendations, as well as including limitations, discussion, and recommendations for future research.
CHAPTER V – CONCLUSIONS

This study focused on the lived experiences of female leaders in the nuclear industry. Chapter I through Chapter IV presented background information, the study’s purpose, literature to support the study’s importance, the methodology, and the results from the data collection. Chapter V includes a summary of the study, findings, conclusions, and recommendations. Additionally, the researcher also includes limitations of the study, discussion, recommendations for future research, and chapter summary.

Summary of the Study

As more women enter STEM fields, an increase in gender diversity in leadership roles in the nuclear industry should improve. Within the nuclear industry, a small percentage of women hold leadership roles (Jais & Hassan, 2018; Kenney, 2015; Kovaleski, 2014). A disparity in gender diversity persists in the nuclear workforce worldwide, which constrains not only diversity but also competitiveness in the industry (Gaspar & Dubertrand, 2019). The purpose of this qualitative study was to explore the factors influencing female leaders’ career advancement in the nuclear industry. This study required perspectives of female leaders who currently hold a title in the nuclear industry of senior manager or higher.

Each participant joined an interview via Webex to explore factors influencing female leaders’ career advancement in the nuclear industry. Six female senior managers or higher and six female nuclear employees who were not in a senior manager or higher position volunteered to participate in the study and share their experiences and perspectives on career advancement. The researcher used the participant’s gender, job title, and industry as selection criteria. The researcher used IPA to analyze the data
collected. Excerpts from the transcribed interviews produced Themes and Subthemes (see Figure 7) that link to each research objective. Data analysis returned findings, conclusions, and recommendations.

Figure 7. Themes and Subthemes of Female Leaders’ Career Advancement in the Nuclear Industry

Findings, Conclusions, and Recommendations

The study’s findings capture female leaders’ perceptions of factors that influence career advancement in the nuclear industry. The findings align with the existing literature. Study findings result from participant accounts of lived experiences. Participant responses reveal factors that serve as barriers or enablers to career
advancement. Participants also provided responses that reveal business strategies that either hinder or enhance career advancement for women in the nuclear industry. Three findings developed from the documentation, synthesis, and interpretation of study participant experiences.

**Finding 1: Having a mentor or champion is critical to the career advancement of men and women in the nuclear industry.**

Participants spoke about having a mentor or champion who motivated and assisted them throughout their career journey. Participants credited champions with helping to open doors for opportunities to gain valuable experiences or for placing them in roles that provided an opportunity for growth. Additionally, participants expressed the importance of men serving as mentors for women during their career progression. Participants also acknowledged the need to develop mentorship for new talent as they onboard to help them navigate in a male-dominated industry.

**Conclusion:** The literature supports the value of mentorship to assist future female leaders in the nuclear industry in navigating their career paths. Mentors and champions provide valuable coaching and opportunities for advancement for female leaders in the nuclear industry. Mentoring relationships between experienced leaders and lesser experienced individuals cultivates and develops the leadership capability of less experienced individuals (Dunbar & Kinnersley, 2011; Ragins, 2012). Individuals gain significant advantages from mentoring relationships (Rhodes, 2018; Miller, 2021) and champions.

Participants from the study expressed the importance of mentors and champions in their career journey, which allowed them to progress into the senior leadership roles
they currently hold. Participants in senior leadership positions expressed concerns with men serving as mentors to women, as well. With so few senior female leaders in the nuclear industry, the need for female senior leaders presents a shortage of mentors for new talent entering the nuclear industry.

Recommendation: Develop a formal mentoring program that allows women in the nuclear industry, who want to grow in their careers, to connect with current senior leaders – men and women – who can assist in navigating their careers. A formal mentoring program also emerged during the data analysis as a theme for strategies that enhance career advancement for women in the nuclear industry, where participants spoke of the importance of mentors to help steer new talent as they begin their career journeys. The creation of a formal mentoring program can also provide aspiring female leaders with insights on how to excel in a male-dominated industry. The relationship between a mentee and mentor can progress into an opportunity for the mentor to serve as a champion for the mentee, which can lead to opportunities for new experiences and promotion. The mentoring relationship can also positively influence diversity initiatives and produce positive results related to the organization’s diversity outcomes and the mentor’s intrinsic accomplishment (Ragins, 1997).

Finding 2: Past recruiting and hiring practices create a male-dominated workforce that lacks diversity, which can hinder the recruitment, hiring, and advancement of women.

Recruiting and hiring serve as key strategies for the growth and advancement of diverse talent. Study participants from the one-on-one interviews and the focus group interview assert that those responsible for hiring contribute to the lack of gender diversity
in the nuclear industry. Participants identified previous hiring practices, which emerged as a subtheme, as a strategy that hinders career advancement, and a lack of diversity, which emerged as a subtheme connected to barriers to career advancement. Participants expressed the importance of identifying how the workforce became male-dominated by reflecting on past recruiting and hiring practices that largely focused on the recruitment from the Navy nuclear program. Additionally, participants spoke of the need for intentional recruiting for internal and external hires that focus on gender diversity.

Conclusion: Research supports the significance of a diversified workforce that includes gender balance. An organization that recruits and hires with a focus on gender diversity will improve innovation, decision-making, and leadership abilities (Bagshaw, 2004; Dessler, 2001; Diaz-Garcia et al., 2013, Govindji, 2014; Torchia et al. 2011; Wittenberg-Cox, 2019). The National Research Council (2012) also advises that gender bias in a STEM workforce may cause innovation to decline, limiting the productivity and profitability of an organization. Moreover, the literature suggests that a gender-diverse organization can increase a company's financial performance and build a competitive advantage against others in their industries (Govindji, 2014). Career mapping and succession planning emerged as subthemes in the data analysis for this study. Research asserts the importance of career mapping and succession planning for career growth in the workplace (Gomez, 2014).

Study participants highlighted the challenges of navigating in an industry where the majority of the senior leaders are non-diverse and men. In addition to the external hiring practices that did not focus on gender diversity, participants shared experiences of challenges promoting internally to advance their careers. Participants describe the
decisions they had to make in their careers regarding work-life balance or starting a family over pursuing their career goals because of inflexible work schedules. Participants also suggest inflexible work schedules may hinder diverse hiring and serve as a deterrent to women interested in working in the nuclear industry. Participants acknowledge the gender bias in the industry but focused on courage, perseverance, and tenacity to reach their goals.

**Recommendation:** A nuclear industry focus on intentionality in their practice, advertisement, and recruitment of women for positions in the nuclear industry. Recruiting should target universities with engineering programs, gender-focused STEM associations, state and national conferences for engineering associations, as well as business programs to support the hiring of technical and non-technical leadership nuclear roles. Applications received should then process through a structured and organized process to consistently identify qualified, prospective candidates. Interview committees must consist of diverse committee members in both ethnicity and gender, and all interview committees should receive information and training explaining their roles and expectations as interview committee members.

Leaders in the nuclear industry could incorporate career mapping and succession planning to advance the careers of employees. The early identification of new talent at the entry-level can provide valuable coaching and insight to guide women through their nuclear career journey. A discussion and understanding in the early part of their career path can direct women toward the necessary experiences they may need to advance to the next level in an organization. Previous literature supports the concept of integrating structured career mapping plans and succession planning to prepare current employees
for higher-level positions (Gomez, 2014). Implementing these strategies can improve the career growth of women internally in the organization and help remove barriers obstructing the pipeline for leadership positions.

*Finding 3:* Women must self-promote by engaging and showcasing individual talents to advance their careers in the nuclear industry.

All study participants conveyed the importance of self-promotion as an integral strategy in growing their careers and advancing into senior leadership roles. Additionally, participants convey the importance of how engaging and volunteering for roles and projects allowed them to showcase their talent, as well as learn and understand more about how nuclear power plants work. Participants explained how integral volunteering for projects, especially the projects no one else wanted to do, became a part of their success because they were able to stand out and gain exposure to leaders. Participants highlight self-promotion as a benefit and driver to building relationships, which oftentimes turned into access for additional opportunities. Participants also discussed the importance of women having confidence, engaging with leaders, and understanding they bring a different perspective and insight to the organization that can provide value.

*Conclusion:* Female leaders advancing their careers within the nuclear industry actively engage in the organization and look for opportunities to volunteer to gain experience to advance their careers. An employee’s emotional, behavioral, and cognitive state drives the employee’s engagement toward preferred organizational outcomes (Shuck & Wollard, 2010). According to Mengue et al. (2013) and Vance (2006), employees who proactively drive organizational success, possess initiative, and drive change represent engaged employees within an organization. Study participants
overwhelmingly attribute their career advancement to self-promotion by volunteering for opportunities, such as projects and additional assignments, to demonstrate their initiative and build a reputation within the organization.

Recommendation: Exposure to developmental opportunities, internally and externally, for female employees in the nuclear industry can play an integral part in growing the talent pipeline for future leadership positions. During the early years of employment, female employees should receive support from their leaders to provide feedback and engage within the organization. Leaders could meet with new female employees to encourage and recommend participation in opportunities that may arise during their career journey. Leaders can drive the level of engagement of employees through support and motivation (Gruman & Saks, 2011; Harter et al., 2002; Vance, 2006).

Being intentional and understanding how to navigate their career path represents integral factors that women in the nuclear industry must understand to advance their careers. Female employees who want to progress to senior leadership roles should communicate their ambitions to their leader. They could also seek projects or other opportunities in other parts of the organization to gain a deeper understanding of business functions, especially functions that provide an opportunity to build additional technical knowledge. Increasing female employee involvement in opportunities and additional role assignments may increase engagement and develop a gender-balanced talent pipeline within the organization.
Discussion

Thomas and Moye (2015) discuss the importance of human capital development and the ability of individuals to increase their skills through continuous learning, development, and training, which can improve the productive capacity of employees. This study explored the lived experiences of female leaders’ career advancement in the nuclear industry, and study participants spoke candidly about their experiences related to continued learning and development in their career journey. Study participants expressed the importance of influencing change to address the barriers to career advancement for emerging female leaders in the nuclear industry. Each of the one-on-one participants in this study shared their insights, challenges, and successes working and progressing into leadership in the nuclear industry. Additionally, the participants acknowledged an increased focus on gender diversity from their organizations; however, they maintain that this focus must continue to improve gender diversity within the nuclear industry. Focus group participants also provided their insights on the enablers and barriers to career advancement in the nuclear industry. The responses highlight the continued focus on improving gender diversity in the workforce and the importance of internal employees gaining knowledge and having opportunities to obtain additional experiences and skills.

Exploring female leaders lived experiences provides insight into barriers, enablers, and business strategies influencing career advancement and may provide integral information to women seeking to enter the nuclear industry or to those currently in the nuclear industry who struggle to navigate their careers. Participants acknowledge the responsibility of supporting other women in the industry to assist in career journeys; however, due to the responsibilities of their roles and because only a few female leaders
occupy senior positions, their bandwidth does not always allow them to support all requestors. Existing literature shows that a gender-balanced workforce improves innovation, productivity, and profitability (National Research Council, 2012) and that a diverse workforce increases management decision-making and abilities (Bagshaw, 2004; Dessler, 2001; Diaz-Garcia et al., 2013, Govindji, 2014; Wittenberg-Cox, 2019); therefore, increasing gender diversity remains vital to the growth and viability of the nuclear industry.

Limitations of the Study

Limitations indicate factors or areas of study the researcher cannot control that can affect outcomes of the study (Lunenburg & Irby, 2008; Roberts, 2010; Shadish et al., 2002). Creswell (2007) states that limitations exist as possible issues that can affect the validity of the study. Three limitations exist for this study: (a) unconscious bias of the female leaders, (b) the population size, and (c) generalizability.

Unconscious Bias of the Female Leaders

An unconscious bias can be advantageous or adverse and lives in every person, as it forms over the course of one’s life (Responsible Conduct of Research, 2020). The responses provided by female leaders in this study reflect their lived experiences, which inform their expectations. Certain scenarios can activate unconscious attitudes and beliefs and can deter the engagement of the participant and hinder transparency in responses. The researcher followed the interview protocol and guiding questions to appropriately engage participants through the interview process. Additionally, the researcher advised each participant of the Employee Assistance Program before each interview to reduce hesitation of sharing negative experiences.
Population Size

The limited number of female leaders in the nuclear industry limited this research. The limited number is due to the unique and technical skillset required for progression into higher level leadership roles within the nuclear industry. Further, a limited amount of women hold leadership roles in the nuclear industry. Moreover, with few female leaders in the industry, limitations existed regarding obtaining the participants to complete interviews. The researcher received a list of eight female leaders in senior level roles in the sampling group for the study. Of the eight female leaders, six responded to serve as participants in the study. The limited number of participants constrained the researcher’s ability to collect data for the study.

Generalizability

According to Creswell (2013), generalizability exists when the broadening of the study’s results and findings extend from the sample population to the greater population. If the research findings do not pertain to other populations, the research data lacks generalizability if the findings do not apply to other populations (Ferguson, 2004; Kukull & Ganguli, 2012). This study utilized a purposive sampling technique, which provides the assists the researcher in selecting the participants most likely to resemble the target populations (Merriam, 2002; Merriam & Tisdell, 2016; Salkind, 2012).

This research explored the factors for female leaders’ career advancement in the nuclear industry. The researcher received eight participant names meeting the study’s criteria, with six participants responding to share their lived experiences. However, saturation occurred after facilitating four interviews. The researcher conducted all six interviews to ensure no new data emerged. This study’s findings and results may not
represent the views of all female leaders in the nuclear industry due to the limitation of the small number of research participants, which limits the ability to generalize results. Expanding the study to include nuclear facilities across the United States could have offered perspectives that provided more insight on career paths and opportunities.

**Recommendations for Future Research**

Opportunities exist to extend and grow this research. The researcher explored the lived experiences of female leaders in senior leadership roles in the nuclear industry. Additionally, the study participants also work in nuclear locations within the Southern Region of the United States. Participants’ responses related to enablers, barriers, and business strategies suggest that a focus on gender diversity exists, but a continued, intentional focus must continue to drive improvement in gender representation in the nuclear industry. Exploring the experiences of female employees in entry-level leadership may provide different perspectives on career advancement. Also, the research lens can extend to include female leaders in senior leadership roles within the nuclear industry in other regions of the U.S.

Additional research could compare perceptions of female leaders in senior leadership roles with the perceptions of the entry-level leaders' perceptions. Conducting a comparison of senior-level leaders and entry-level leaders could determine if there are gaps in understanding the barriers or challenges for leaders seeking to progress to senior-level roles. Researching this population may also provide insights to determine if the perceptions of business strategies that enhance career advancement for female leaders align with entry-level leaders and senior-level leaders. Additionally, conducting a comparative study may provide findings that lead to the development and implementation
of improved business strategies geared to increase gender diversity in the nuclear industry. A study aimed at understanding the perspective of male leaders in the nuclear industry regarding barriers, enablers, and business strategies influencing the career advancement of female leaders could provide beneficial insights. Qualitative interviews with male leaders could provide an alternative perspective and additional information, which may help female leaders to understand male leader viewpoints as contributing factors to career advancement for women in the nuclear industry.

Finally, the research lens can also extend to other career fields and industries experiencing gender bias or forms of implicit bias. Qualitative and mixed-methods studies could provide beneficial insights to explore the perspective of the workforce, especially leadership, regarding barriers, enablers, and business strategies influencing career advancement.

Summary

Chapter V includes a summary of the study, research findings, conclusions, and recommendations. The purpose of this study was to explore the lived experiences of female leaders in the nuclear industry to determine the factors that influence career advancement. Five research objectives helped guide the study. The researcher conducted virtual one-on-one semi-structured interviews and used interpretative phenomenological analysis to review and transcribe data to identify common codes. Data analysis revealed three perceived barriers, four perceived enablers, three perceived business strategies that hinder career advancement, and three perceived business strategies that enhance career advancement. The researcher triangulated the lived experiences and responses of the six one-on-one study participants with the lived experiences and responses from a focus
group, which consisted of six non-senior level female employees in the nuclear industry located in the Southern Region of the United States.

The study participants shared similar experiences that served as challenges during their career journey, and likewise, had similar experiences to share that focused on the support and opportunities they received progressing through their careers. The researcher categorized these responses into themes. Participants highlighted bias, lack of technical experience, and lack of flexible work schedules as barriers to career advancement. Participants noted a college degree, technical experience, mentors and champions, and self-promotion as enablers to career advancement. The researcher found that although barriers exist, the female leaders leveraged the identified enablers to advance their careers. Conversely, participants pointed to inflexible work schedules, lack of diverse hiring practices, and an outdated promotion strategy as business strategies that hindered career advancement. To address these strategies, the study participants recommend a formal mentoring program, a career path for promotion, and diverse hiring practices as strategies for organizations to implement to enhance career advancement for women in the nuclear industry.

Increasing gender diversity in an organization can improve a company’s financial performance, increase the diversity of thought, and enable better problem solving (Badal, 2014). Leaders in the nuclear industry could intentionally develop and implement programs to recruit and retain female talent to increase the representation of women. The development and implementation of formal mentoring programs and career path programs may also contribute to improving the diversity of talent pipelines to include more women on succession plans for higher level roles. Therefore, these strategies may
assist nuclear industry leaders and women in the nuclear industry by improving efforts to promote initiatives to advance female careers, which also improves the industry’s focus on developing human capital to drive innovation, productivity, and profitability.
From: Anesa Davis
Sent: Sunday, April 18, 2021 3:28 PM
To: ncesweb@nsf.gov
Subject: Notification of NCSES Data Cited in Dissertation

Dear NCSES Webmaster:

As requested on your Permissions webpage, I am writing to provide notification of the use of Figure 3 from The State of U.S. Science and Engineering 2020 under Science & Engineering Indicators in my dissertation. The title of Figure 3 is First university degrees in S&E, by selected region, country, or economy: 2000-16, and the URL is https://ncses.nsf.gov/pubs/nsb20201/u-s-and-global-education.

I plan to explore the factors that influence female leaders’ career advancement in male-dominated science, technology, engineering, and math industries, specifically the nuclear industry. I plan to include Figure 3 in my literature review discussion of STEM education in the United States compared to other countries.

If you require additional information, please advise by replying to this email.

Thank you,

Anesa Davis
anesa.davis@usm.edu
APPENDIX B – Initial Email to WIN Regional President for Support

From: May, Tamara <tschmal@entergy.com>
Sent: Monday, April 26, 2021 8:36 AM
To: Anesa Davis <Anesa.Davis@usm.edu>
Subject: RE: Requesting Research Support

Dear Ms. Davis,

We, Entergy USWIN, would be honored to support your research project. Our Fleet Group meetings monthly and can provide you the opportunity to present your request to our chapters (7). I will work with each site president to secure the candidates you need to interview via Site Chapter Monthly meeting as well as an email to each respective group.

I am excited to partner with you on this project.

Respectfully,

Tamara L. May, President Entergy WIN

---

From: Anesa Davis <Anesa.Davis@usm.edu>
Sent: Friday, April 23, 2021 11:59 AM
To: May, Tamara <tschmal@entergy.com>
Subject: Requesting Research Support

Greetings Tamara,

I hope you are doing well. As we have discussed, I am a Ph.D. student at The University of Southern Mississippi. As a part of this program, I am planning to conduct research exploring the experiences of female leaders in the nuclear industry. The research involves interviewing females who are currently employed in the nuclear industry. To start, I need your assistance by providing a letter of support for the research (please support by replying to this email) and agree to:

- Send an email to WIN members, who are senior manager or above, to request their participation in a virtual, one-on-one interview
- Send an email to WIN members, who are not senior manager or above, to request their participation in a virtual, focus group interview

Please let me know if you have any questions. Thank you in advance for your support and assistance.

Kindest regards,
APPENDIX C – One-on-One Interview Questions

1. Describe your present job position.
   a. What processes do you oversee?

2. Tell me about your professional career in the nuclear industry.
   a. How did those roles/experiences prepare you for your current role?

3. Tell me about any formal or informal education or training that prepared you for your leadership role.
   a. What training courses or learning opportunities would you recommend for aspiring female leaders in the nuclear industry?

4. What behaviors or leadership attributes do you feel are necessary for women to advance in the nuclear industry?

5. What are your perceptions of gender diversity in your department?
   a. How is this true, or not, for the organization?
   b. How is this true, or not, at your company?
   c. How is this true, or not, in the nuclear industry?

6. What enabled you to rise to your leadership position in the nuclear industry?

7. What barriers do you think currently contribute to the underrepresentation of female leaders in your company or the nuclear industry?
   a. If there are no current barriers, what barriers were present before that no longer exist?

8. Tell me about strategic initiatives to attract and retain female talent in your company.
a. In addition to these strategies, are there any additional strategies you would like to implement or see implemented?

b. Are there any strategies that you would like to see changed or improved? If so, why?

9. Is there anything you would like to add regarding your experience as a female leader in the nuclear industry?

Exit Statement

Thank you for participating in this research study and for meeting with me today. As we previously discussed, I will email you a copy of your transcribed interview notes within a week and ask that you review for accuracy. If I do not hear from you within three days, I will assume all information is accurate. Do you have questions before we end the interview session? Again, thank you!
APPENDIX D – Focus Group Interview Questions

1. Describe what behaviors or leadership attributes you feel are necessary for women to advance in the nuclear industry.

2. What are your perceptions of gender diversity in your department? Why?
   a. What leads you to these beliefs?
   b. How is this true, or not, for the entire organization?

3. What barriers do you think currently contribute to the underrepresentation of female leaders in your company or the nuclear industry?
   a. If there are no current barriers, what barriers were present before that no longer exist?

4. What are your thoughts on women’s access to leadership positions in the nuclear industry?

5. Tell me about strategic initiatives to attract and retain female talent in your company.
   a. In addition to these strategies, are there any additional strategies you would like to implement or see implemented?
   b. Are there any strategies that you would like to see changed or improved?
      If so, why?

6. Is there anything else you would like to add regarding your experience as a female employee in the nuclear industry?
APPENDIX E – One-on-One Interview Script

Introduction:

Thank you for taking time from your busy schedule to participate in this study. I am a Ph.D. candidate at The University of Southern Mississippi, and I am currently in the data collection phase of my dissertation. My study focuses on factors that influence female leaders’ career advancement in the nuclear industry. It will take approximately 45-60 minutes to complete this interview. Please feel free to take a break at any time during the interview. I will record the interview for transcription purposes. To maintain confidentiality, you will receive an alias that will serve as your identifier, and I will not record personal information, such as your name or email. Your name will not be associated with this study in any way. Please feel free to speak honestly and openly. Do I have your permission to record the interview?

Interviewer: ______________________________  Date: ____________________________

Interviewee/Alias: _____________________________________________________________

Start Time: ______________________________  End Time: ___________________
APPENDIX F – Focus Group Interview Script

Introduction:

Thank you all for taking time from your busy schedules to participate in this study. I am a Ph.D. candidate at The University of Southern Mississippi, and I am currently in the data collection phase of my dissertation. My study focuses on factors that influence female leaders’ career advancement in the nuclear industry. This focus group will last approximately 45-60 minutes. Please feel free to take a break at any time during the interview. With the group’s agreement, I would like to record the interview for transcription purposes. To maintain confidentiality, you will receive an alias that will serve as your identifier, and I will not record personal information, such as your name or email. Your name will not be associated with the study in any way. You will be identified in the research by the term “focus group.” Please feel free to speak honestly and openly. Do I have your permission to record the interview?

Interviewer: ______________________________ Date: ______________________________
Start Time: ______________________________ End Time: ______________________________
This study focuses on exploring the lived experiences and perspectives of female leaders in the nuclear industry and the career advancement of women in the industry. The interview protocol follows:

• The interview will begin with the researcher informing the participant of the approximate length of the interview, how the research may influence change, and the participant’s right to end the interview at any time.

• The researcher will gain written consent from the participant and answer any questions regarding the study and confidentiality.

• The researcher will ask the participants basic demographic questions, followed by questions related to their experiences with career advancement in the nuclear industry. Each semi-structured question seeks to gather information regarding their lived experiences.

• The researcher will ask the participants to provide their perceptions of enablers and barriers to career advancement in the nuclear industry.

• The interview will address the demographics of female leaders in the nuclear industry, barriers as perceived by female leaders in the nuclear industry, and enablers as perceived by women in the nuclear industry.

• Questions will aim to discover themes about female leaders’ career advancement in the nuclear industry.
1. Start the interview.
   a. Ask the participant for permission to record the interview.
   b. Begin recording.
   c. Ask semi-structured, open-ended interview questions.
   d. Use prompts and thought-provoking questions as needed to help the
      interviewee maintain focus.
   e. Stop the interview at the 60-minute mark or ask to continue if not finished.

2. After the interview:
   a. Provide the participant a copy of the Long Form Consent.
   b. Explain that the transcribed data will be emailed to them to review for
      accuracy and validation.
   c. Explain member checking and its importance in validating research.
   d. Email the transcripts to participants to revise or approve.
   e. Request a 3-day return on the validated documents. If documents are not
      returned, the researcher will assume the transcript is correct.

3. At the conclusion of the meeting:
   a. Thank the participants for supporting the research.
   b. Explain that the participants will receive research results once the
      university approves.
APPENDIX H – Focus Group Interview Protocol

This study focuses on exploring the lived experiences and perspectives of female leaders in the nuclear energy industry related to their career advancement in the industry.

The interview protocol follows:

- The interview will begin with the researcher informing the participants of the approximate length of the interview, how the research may influence change, and the participant’s right to end the interview at any time.
- The researcher will gain written consent from the participants and answer any questions regarding the study and confidentiality.
- The researcher will ask the participants basic demographic questions, followed by questions related to their experiences with career advancement in the nuclear industry. Each semi-structured question seeks to gather information regarding their lived experiences.
- The researcher will ask the participants to provide their perceptions of enablers and barriers to career advancement in the nuclear industry.
- The interview will address the demographics of female leaders in the nuclear industry, barriers as perceived by female leaders in the nuclear industry, and enablers as perceived by women in the nuclear industry.
- Questions will aim to discover themes about female leaders’ career advancement in the nuclear industry.
1. Start the interview.
   a. Ask the participants for permission to record the interview.
   b. Begin recording.
   c. Ask semi-structured, open-ended interview questions.
   d. Use prompts and thought-provoking questions as needed to help the interviewee maintain focus.
   e. Stop the interview at the 60-minute mark or ask to continue if not finished.

2. After the interview:
   a. Provide the participants with a copy of the Long Form Consent.
   b. Explain that the transcribed data will be emailed to them to review for accuracy and validation.
   c. Explain member checking and its importance in validating research.
   d. Email the transcripts to participants to revise or approve.
   e. Request a 3-day return on the validated documents. If documents are not returned, the researcher will assume the transcript is correct.

3. At the conclusion of the meeting:
   a. Thank the participants for supporting the research.
   b. Explain that the participants will receive research results once the university approves.
   c. Address any concerns and answer questions.
APPENDIX I – Member Check Email

Dear (Participant’s Name),

Thank you for participating in the research study titled: *Factors Influencing Female Leaders' Career Advancement in the Nuclear Industry*. As we discussed, attached is a copy of the interview transcription for your review. Please take some time to read the entire transcript and mark any places that you think are inaccurate or you would like to change. If I do not hear back from you within three days (date), I will assume that no changes are required, and you are satisfied with the transcript.

Thank you for your assistance. Do not hesitate to contact me if you have any questions or concerns.

Sincerely,

Anesa Davis
Doctoral Candidate
The University of Southern Mississippi
anesa.davis@usm.edu
817.929.2636

The Institutional Review Board of The University of Southern Mississippi reviewed and approved this project, which ensures research projects involving human subjects follow federal regulations. Direct any questions or concerns about rights as a research participant to the Chair of the IRB at (601) 266-5997 or irb@usm.edu. Participation in this project is completely voluntary, and participants may withdraw from this study at any time.
APPENDIX J – Thank You Letter to Participants

Dear (Participant’s Name),

Thank you for participating in the research study of factors that influence female leaders’ career advancement in the nuclear industry. I truly appreciate your time and support provided to this study. I wish you much success as you move forward in your career.

Sincerely,

Anesa Davis
Doctoral Candidate
The University of Southern Mississippi
anesa.davis@usm.edu
817.929.2636

The Institutional Review Board of The University of Southern Mississippi reviewed and approved this project, which ensures research projects involving human subjects follow federal regulations. Direct any questions or concerns about rights as a research participant to the Chair of the IRB at (601) 266-5997 or irb@usm.edu. Participation in this project is completely voluntary, and participants may withdraw from this study at any time.
NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION
The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.

PROTOCOL NUMBER: IRB-21-238
PROJECT TITLE: Factors Influencing Female Leaders' Career Advancement in the Nuclear Industry
SCHOOL/PROGRAM: School of IAPD, Human Capital Development
RESEARCHER(S): Anesa Davis, Heather Annulis

IRB COMMITTEE ACTION: Approved
CATEGORY: Expedited

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: June 3, 2021

Donald Sacco, Ph.D.
Institutional Review Board Chairperson
Subject: Request for Participation in a Research Study – One-on-One Interview

Hello (Insert Name),

As a senior leader, I would like to invite you to participate in a one-on-one interview for a research study. Anesa Davis is a doctoral student exploring the experiences of female leaders in the nuclear industry to determine factors that influence career advancement. If you choose to participate, I respectfully request that you:

• Participate in an interview (approximately one hour) via Webex.
• Provide information about your experiences as a female leader in the nuclear industry.
• Review the interview transcript for accuracy of intent.

Your participation will offer insights into strategies women and leaders can use to increase female representation in senior manager and above positions in the nuclear industry. You will receive a copy of the study results.

Thanks in advance for your consideration in participating in this study titled: Factors Influencing Female Leaders’ Career Advancement in the Nuclear Industry.

If you would like to participate, please let Anesa know by emailing anesa.davis@usm.edu or call 817.929.2636 no later than (date).

Thank you,

Tamara May
President Entergy WIN
U.S. Women in Nuclear

The Institutional Review Board of The University of Southern Mississippi reviewed and approved this project, which ensures research projects involving human subjects follow federal regulations. Direct any questions or concerns about rights as a research participant to the Chair of the IRB at (601) 266-5997 or irb@usm.edu. Participation in this project is completely voluntary, and participants may withdraw from this study at any time.
APPENDIX M – Initial Email to Focus Group Participants

Subject: Request for Participation in a Research Study – Focus Group Interview

Hello (Insert Name),

As a WIN member, I would like to invite you to participate in a focus group interview for a research study. Anesa Davis is a doctoral student exploring the experiences of female leaders in the nuclear industry to determine factors that influence career advancement. The focus group interview seeks information from women who currently do not hold senior leadership positions, and the first 12 WIN members to volunteer to participate will be chosen. If you choose to participate, I respectfully request that you:

- Participate in an interview (approximately one hour) via Webex.
- Provide information about your experiences working in the nuclear industry.

Your participation will offer insights into strategies women and leaders can use to increase female representation in senior manager and above positions in the nuclear industry. You will receive a copy of the study results.

Thanks in advance for your consideration in participating in this study titled: *Factors Influencing Female Leaders’ Career Advancement in the Nuclear Industry*.

**If you would like to participate, please let Anesa know by emailing anesa.davis@usm.edu or call 817.929.2636 no later than (date).**

Thank you,

Tamara May
President Entergy WIN
U.S. Women in Nuclear

The Institutional Review Board of The University of Southern Mississippi reviewed and approved this project, which ensures research projects involving human subjects follow federal regulations. Direct any questions or concerns about rights as a research participant to the Chair of the IRB at (601) 266-5997 or irb@usm.edu. Participation in this project is completely voluntary, and participants may withdraw from this study at any time.
Hello (Participant’s Name),

I am excited about our upcoming interview. Thank you for agreeing to share your experience as a female leader in the nuclear industry. As a reminder, the interview details follow:

- Interview scheduled on (date) at (time) via Webex.
- Interview will take approximately one hour.

Please review and sign the informed consent form that I have included in this email. Please confirm your plan to attend by replying and attaching the signed informed consent form to this email. Also, please answer the below questions in your reply:

- What is your current job title?
- How many years of service do you have in the nuclear industry?
- How many years of service do you have in your current position?
- What degree or degrees do you hold?
- What is the focus area of your degree or degrees?

I appreciate your willingness to assist with this study.

Sincerely,

Anesa Davis
Doctoral Candidate
The University of Southern Mississippi
anesa.davis@usm.edu
817.929.2636

The Institutional Review Board of The University of Southern Mississippi reviewed and approved this project, which ensures research projects involving human subjects follow federal regulations. Direct any questions or concerns about rights as a research participant to the Chair of the IRB at (601) 266-5997 or irb@usm.edu. Participation in this project is completely voluntary, and participants may withdraw from this study at any time.
Hello (Participant’s Name),

I am excited about our upcoming focus group interview. Thank you for agreeing to share your experience as a female employee in the nuclear industry. As a reminder, the interview details follow:

- Interview scheduled on (date) at (time) via Zoom.
- Interview will take approximately one hour.

Please review and sign the informed consent form that I have included in this email. Please confirm your plan to attend by replying and attaching the signed informed consent form to this email.

Sincerely,

Anesa Davis  
Doctoral Candidate  
The University of Southern Mississippi  
anesa.davis@usm.edu  
817.929.2636

The Institutional Review Board of The University of Southern Mississippi reviewed and approved this project, which ensures research projects involving human subjects follow federal regulations. Direct any questions or concerns about rights as a research participant to the Chair of the IRB at (601) 266-5997 or irb@usm.edu. Participation in this project is completely voluntary, and participants may withdraw from this study at any time.
APPENDIX P – Informed Consent

STANDARD (SIGNED) INFORMED CONSENT

STANDARD (SIGNED) INFORMED CONSENT PROCEDURES

This completed document must be signed by each consenting research participant.
- The Project Information and Research Description sections of this form should be completed by the Principal Investigator before submitting this form for IRB approval.
- Signed copies of the consent form should be provided to all participants.

Today’s date:

PROJECT INFORMATION

Project Title: Factors Influencing Female Leaders’ Career Advancement in the Nuclear Industry
Principal Investigator: Anera Davis
Phone: 817-929-2636 Email: anesa.davis@usm.edu
College: Arts and Sciences School and Program: Human Capital Development

RESEARCH DESCRIPTION

1. Purpose:

The purpose of this study is to explore the lived experiences of female leaders in the nuclear industry to determine factors that influence career advancement.

2. Description of Study:

This study explores your lived experiences as a female leader in the nuclear industry. One-on-one virtual interviews will last approximately one hour. All interviews will be audio recorded and made available for your review to verify accuracy.

3. Benefits:

This study does not offer rewards for participation. The information you provide may increase the knowledge about female perceptions and experiences in the nuclear industry, and the information may also offer strategies for females and leaders to increase gender diversity in leadership roles.

4. Risks:

Minimal, if any, risk exists. However, the researcher recognizes a potential risk where the interview questions could invoke anxieties to relive past experiences that may have been unfavorable or disappointing. You may end the interview at any time without any penalty. Also, if you experience any discomfort reliving any negative past experiences, the researcher recommends that you reach out to your Employee Assistance Program (EAP) for help.

5. Confidentiality:

Your identity and responses will be confidential. You will receive an alias as your identifier during the study. Only you and I will know your identity.
6. Alternative Procedures:

No alternative procedures are available. If you decide to withdraw or end participation after we begin, you may do so without penalty, consequence, or without providing a reason.

7. Participant's Assurance:

This project and this consent form have been reviewed by USM's Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5125, Hattiesburg, MS 39406-0001, 601-266-5997.

Any questions about this research project should be directed to the Principal Investigator using the contact information provided above.

CONSENT TO PARTICIPATE IN RESEARCH

Participant's Name: __________________________

I hereby consent to participate in this research project. All research procedures and their purpose were explained to me, and I had the opportunity to ask questions about both the procedures and their purpose. I received information about all expected benefits, risks, inconveniences, or discomforts, and I had the opportunity to ask questions about them. I understand my participation in the project is completely voluntary and that I may withdraw from the project at any time without penalty, prejudice, or loss of benefits. I understand the extent to which my personal information will be kept confidential. As the research proceeds, I understand that any new information that emerges and that might be relevant to my willingness to continue my participation will be provided to me.

__________________________________________  __________________________________________
Research Participant                                      Person Explaining the Study

_________________________                __________________________
Date                                                        Date
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## APPENDIX R – Emergent Themes

### Barriers to Career Advancement - RO2

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<td>bias</td>
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<td>shift work</td>
<td>Inflexible work schedule</td>
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<td>bias</td>
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### Business Strategies that Hinder Career Advancement - RO4

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<td>Zoe</td>
<td>given a little bit more Work flexibility</td>
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</table>
Zoe: look at other opportunities, other parts of the organization what they bring to the table

Sandra: mostly men at the top, mostly man, making the decisions

Sandra: Inability to be flexible

Sandra: drive the diversity improvements

Julianna: inflexible work schedules

Vanessa: resources not dedicated

Business Strategies that Enhance Career Advancement - RO5

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Enablers to Career Advancement - RO3

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<td>college degree</td>
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<td>Cora</td>
<td>bachelor's degree or higher</td>
<td>college degree</td>
</tr>
<tr>
<td>Cora</td>
<td>volunteered to do something</td>
<td>volunteer for projects to increase knowledge</td>
</tr>
<tr>
<td>Cora</td>
<td>Volunteer for everything</td>
<td>volunteer for projects to increase knowledge</td>
</tr>
<tr>
<td>Cora</td>
<td>be willing to step up and volunteer</td>
<td>volunteer for projects to increase knowledge</td>
</tr>
</tbody>
</table>
Don't be afraid to get selected just because you're the only woman that volunteered volunteer for projects to increase knowledge

I worked my butt off hard work and perseverance

you have got to promote yourself you have self-promotion

got to get out there and let people know what you want to do what you can do self-promotion

self-promoting self-promotion

senior reactor operator license Technical capability

operational background Technical capability

ingeering degree or chemical engineering college degree

leadership courses leadership development training

women need to avoid getting into typical women gender specific roles self-promotion

technical training and capability Technical capability

strong mentors mentors and champions

champions mentors and champions

career path career path for promotion

leadership courses leadership development training

Level of comfort with be in the only female in the room self-promotion

Personal grit, perseverance, and personal confidence hard work and perseverance

expert knowledge and speaking up self-promotion

Bravery self-promotion

mentoring mentors and champions

confident in my abilities self-promotion

provided an opportunity self-promotion

operations training Technical capability

technical training and capability Technical capability

leadership courses leadership development training

flexibility support

support from mentor mentors and champions

mechanical engineering college degree

senior reactor operator license Technical capability

career path career path for promotion

networking mentors and champions

good support system support

sponsors mentors and champions

mentoring mentors and champions

confident in my abilities self-promotion
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