Women in Leadership in the Nuclear Power Industry

Tamara R. Kenney
Regent University

This paper presents a research study on women in leadership positions within the nuclear power industry. There is very limited existing research into women in leadership within the male dominated world of nuclear power generation. The current state of women in leadership roles in general is reviewed as well as the roles of women in science and engineering based industries. An interview based study was conducted to investigate the career background and leadership actions of women in leadership roles within the nuclear power generation industry. Common themes of glass ceiling, stereotypes, effort, career influences, technical skills, women in nuclear, and openness/innovation were found in the participant's responses. This study contributes to the body of knowledge on women in leadership in male dominated industries like nuclear power and also provides insights into practices for developing additional women to take on leadership roles in this technically complex industry.

As of 2012, there were 104 nuclear plants in the United States providing approximately 20% of the electricity generated in the country (Dorfman, 2012 p. 270). This number has adjusted down slightly due to recent nuclear power plant closings at Vermont Yankee, Kewaunee, San Onofre, and Crystal River in 2013 (Lochbaum, 2014, p. 27). An additional change comes from the Tennessee Valley Authority starting fueling activities at Watts Bar for a new reactor, which was scheduled to begin operations in 2015 (Fertel, 2013, p. 86). Watts Bar successfully started and tested the new nuclear reactor in 2015; additionally construction is ongoing on two new nuclear power plants, VC Summer and Vogtle. The nuclear power industry remains an important part of the United States' power generation infrastructure despite changes in the total number of operating nuclear power plants. It is important that these nuclear power plants have a sustainable workforce to maintain and operate the plants over the coming decades to maintain safe and reliable generation of electricity in the United States. One important aspect of maintaining a sustainable workforce in nuclear power plants is understanding the role of women in this workforce.

There is a significant gap in the literature on women in leadership roles in the nuclear power industry. The majority of the literature on women and nuclear power is older than ten years, and is primarily related to gender differences in the acceptance of nuclear power (Nelkin, 1981, p. 14; Solomon, Tomaskovic-Devey, & Risman, 1989, p.

401). This gap in the leadership literature is reflective of the existing gap in the nuclear power industry; there are very few women in leadership positions within the nuclear power industry currently. It is interesting to find this lack of women in leadership in nuclear power as the nuclear industry was built off of the work of powerful women such as Marie Curie who is famous for her work with radioactivity (Wacławek & Wacławek, 2011, p. 1567) and Queen Frederika of Greece who was instrumental in the development of nuclear research in Europe after World War II (Rentetzi, 2009, p. 63).

The lack of women in leadership in the nuclear power industry is not reflective of the broader trend of more women in leadership roles in other industries that has taken place over the last few decades. There is a wealth of existing literature available on the changing roles of women and the change in attitudes towards women in leadership positions that has been conducted in the last few decades (Haack, 2014; Herrera, Duncan, Green, & Skaggs, 2012; Schuh, et al., 2014; Yukl, 2013). This research study provides a better understanding of the women in leadership roles within the nuclear power industry and how they have progressed into these leadership roles. This study contributes to the body of knowledge on women in leadership in the highly technical and male dominated field of nuclear power.

Literature Review

This literature review includes women in leadership roles, women in science and technology fields, and leadership in nuclear power plants. Each of these concepts provides an important part of the puzzle related to women in leadership at nuclear power plants. The literature review provided the basis for the interview questions used in the interviews with women in leadership within the nuclear power industry.

Women in Leadership

Women are reaching higher levels of achievement in leading major organizations in many areas of modern society (Haack, 2014, p. 37). Women are presidents or prime ministers of their countries in Brazil, Denmark, Lithuania, Jamaica, Costa Rica, Australia, Iceland, and Switzerland (Haack, 2014, p. 37). A woman was recently chosen to lead the International Monetary Fund which is one of the most important organizations in our global economy (Haack, 2014, p. 37). These examples provide evidence that women can attain the highest levels of leadership and can be successful in these positions. Despite these examples of women reaching high levels of leadership, there is still a gap between the number of men and women at the highest levels within organizations (Schuh, et al., 2014, p. 363).

Major organizations including the United Nations have focused on putting forward policies and recommendations aimed at improving women's lives around the world (Haack, 2014, p. 41). It is expected that women in leadership positions will increase over

ISSN 1941-4684 | editorelj@regent.edu

the coming decade (Herrera et al., 2012, p. 37). As conditions for women have improved around the world, so have their opportunities to step up and become leaders in their chosen professions (Haack, 2014, p. 41). The changing world of gender equality has allowed women to gain a foothold within their organizations that serves as a foundation for them to build their future careers and achieve higher levels of leadership (Haack, 2014, p. 41).

The issue of women in leadership is often associated with the existence of the "glass ceiling", which is characterized as the barrier to higher levels of leadership in an organization that women and minorities encounter in their careers (Haack, 2014, p. 43). The glass ceiling is an important concept in understanding women's advancement into leadership (Yukl, 2013, p. 372). In some industries and organizations, the glass ceiling is cracking or even breaking and we are seeing women and minorities advance to the top positions within their organizations (Haack, 2014, pp. 43-44). However, this shattering of the glass ceiling is not universal to all industries and organizations. This leads to the interview question, have you ever encountered a "glass ceiling" as a barrier to your advancement to higher levels during your career in the nuclear power industry (Haack, 2014, p. 2014)?

With the advancement of women into leadership positions in many industries the need to understand what, if any, effect gender has on leadership skills and behaviors becomes more prevalent (Herrera et al., 2012, p. 37). Women working in traditionally male dominated industries are expected to behave in a similar fashion as their male counterparts, this expectation becomes more pronounced as they reach leadership positions (Herrera et al., 2012, p. 38). Behaviors traditionally associated with masculine leaders include aggressiveness, ambition, competitiveness, dominance, self-confidence, and individualism (Herrera et al., 2012, p. 38). Behaviors traditionally associated with femininity include compassion, affection, helpful, friendly, sympathetic, and caring (Herrera et al., 2012, p. 38). Studies have been conducted that support these stereotypes in the perceptions of others when gauging leadership ability (Herrera et al., 2012, p. 38). While the whole population will not necessarily display this perceptual model of masculine versus feminine leadership, it is an important stereotype that can have an influence on the advancement of women into leadership positions. This leads to the interview question, have you encountered situations where you were discounted or hindered in your career due to stereotypes about your ability to lead as a woman (Herrera et al., 2012, p. 38)?

Recent studies have shown that women may be hindered in their quest for leadership by the presence of higher standards for women, external discrimination, less access to career development resources, and potentially precarious opportunities (Schuh, et al., 2014, p. 364). In addition to the presence of potential discriminating factors in selecting women for leadership roles, there is also a belief that men are more motivated to achieve positions of power than women are (Schuh, et al., 2014, p. 364). The perception

ISSN 1941-4684 | editorelj@regent.edu

of women and their power motivation may be a factor in women being selected for leadership opportunities. This leads to the interview question, do you feel you had to make more of an effort than your male colleagues to express your interest in leadership positions (Schuh, et al., 2014, p. 376)?

Women in Science

The majority of nuclear power plant jobs are based on science or engineering based education, therefore it is important to understand women's participation in science and engineering based careers in exploring the topic of women in nuclear power leadership. An area that is beginning to receive more focus in recent years is the need for women in science, technology, engineering, and math (STEM) careers (Savath & Brainard, 2013, p. 550). There are many programs currently in place in the United States designed to recruit women into the scientific arena or to promote the women who are already working within the sciences (Cozzens, 2008, p. 346). The goal of these programs is equality within the sciences, measured by equal levels of participation between men and women within scientific fields (Cozzens, 2008, p. 346). The focus of equality for women in science is on higher levels of female achievement in the areas of science and engineering (Cozzens, 2008, p. 347). It is particularly important that younger girls see women working in the sciences as it has been found that girls interpret the lack of females in scientific careers as a sign that women are not capable of working in scientific areas (Mallow, et al., 2010, p. 357).

One important aspect of programs for women in science is the design and implementation of programs in the United States aimed at helping young girls learn about possible careers in the sciences and math based fields (Cozzens, 2008, p. 347). These programs are designed to keep girls excited about math and science and encourage them to take the requisite courses in math and science that will afford them the option of pursuing scientific careers in their future (Cozzens, 2008, p. 347). An important aspect of this is the capability of females to perform at a high level in math and science, if they are not capable of completing the work necessary in these fields then they will naturally not be able to perform in these types of careers (Cozzens, 2008, p. 348). This is an often overlooked aspect of these types of programs, they assume that males and females are equal in respect to intelligence and capabilities and they also assume that women play a bigger role in the raising of children (Cozzens, 2008, p. 348). These assumptions are not validated or investigated when designing programs for women in science, they are simply taken for granted (Cozzens, 2008, p. 348). It is important for this study to understand whether the women leaders in nuclear power did possess the same capabilities and qualifications as their male counterparts. This gives rise to the question, do you have the same level of technical skills and qualifications as your male counterparts (Cozzens, 2008, p. 348)?

ISSN 1941-4684 | editorelj@regent.edu

It is important to understand that gender is not the only influencing factor in human development (Cozzens, 2008, p. 348). Women do not just differ from men, they also differ amongst women in their skills, abilities, desires, education, and goals (Cozzens, 2008, p. 348). People are born into different environments with different levels of wealth, they live in different environments, and they participate in different communities and social settings over the course of their lives (Cozzens, 2008, p. 348). These differences are important in understanding the development of each individual, it may be that one of these factors has a strong influence on women pursuing careers in scientific fields (Cozzens, 2008, p. 349). This leads to the interview question, can you describe any experiences from your upbringing that influenced your decision to pursue a technical career (Cozzens, 2008, p. 349)?

In 2012, only 13% of engineers in the United States were female according to the National Science Board (Ing, Aschbacher, & Tsai, 2014, p. 2). Interest in engineering as a career option for girls has been a focus of studies in the past and they have found that gender disparity exists as early as pre-high school (Ing et al., 2014, p. 2). They also found that girls who are aware of engineering as a career option are often those who have a family member or friend who is an engineer (Ing et al., 2014, p. 2). The influence of a family member or friend may be a factor in why women pursue careers in engineering and other technical fields. This leads to the interview question, did you have a family member or friend working in a technical field that influenced your interest in this type of career (Ing et al., 2014, p. 2)?

In a longitudinal study of student preferences for science and engineering careers, it was found that male students were more consistently interested in careers in engineering than female students (Ing et al., 2014, p. 5). However, it was also found that both males and females were interested in careers where they could improve health in others, help the environment, perform data analysis, and have their work reviewed by others (Ing et al., 2014, p. 8). The difference in engineering preference was more notable in the preference male students showed for designing, inventing, and developing things which was not as prevalent in female students (Ing et al., 2014, p. 8). The preference for engineering or engineering type work is an important factor in the desire to pursue a career in a field like nuclear power production. This leads to the interview question, did you always have an interest in pursuing a technical career (Ing et al., 2014, p. 8)?

Nuclear Power Plant Leadership

A majority of the population has learned most of what they know about nuclear power from the popular animated cartoon, The Simpsons (Woodcock, 2008, p. 153). However, pretty much everything related to nuclear power found on the popular TV show is inaccurate. This lack of accurate knowledge of nuclear power in the general population could be a factor in the attraction of top talent, both male and female. This leads to the interview question, were you aware of the potential for careers for women in the

ISSN 1941-4684 | editorelj@regent.edu

nuclear power industry before you began working in the industry (Woodcock, 2008, p. 153)?

To achieve the highest levels of nuclear power leadership, a background in nuclear power plant control room operations or an equivalent high level technical certification is required. The requirements for achieving this level of certification includes the need for a high level of cognitive ability in order to understand the complexity involved in operating a nuclear power plant (Schumacher, Kleinmann, & Melchers, 2011, p. 396). This level of cognitive ability and plant understanding is normally achieved through working as a reactor operator, then senior reactor operator, and then safety engineer over the course of many years (Schumacher et al., 2011, p. 396). This leads to the interview question, did you follow the traditional nuclear leadership career path working as a reactor operator and moving up through that hierarchy or did you follow a different career path (Schumacher et al., 2011, p. 396)?

Leadership in nuclear power plants plays a particularly important role as these plants are required to operate to the highest standards of safety (Martínez-Córcoles, Gracia, Tomás, Peiró, & Schöbel, 2013, p. 293). Safety is the primary responsibility of leaders within nuclear power plants and it requires a high level of technical knowledge to understand the plant and the proper decisions to make dependent on plant conditions (Martínez-Córcoles et al., 2013, p. 293). It is important for leaders in the nuclear industry to demonstrate a participative leadership style when making safety related decisions, which includes soliciting feedback from subordinates and communicating openly (Martínez-Córcoles et al., 2013, p. 294). In nuclear power plants, it is recommended that the most effective leadership style is one that encourages feedback, flexibility, encouragement of new initiatives, and the development of new ideas (Martínez-Córcoles et al., 2013, p. 294). These are important leadership behaviors because they encourage appropriate feedback from followers that will help ensure the safe and reliable operation of the plant. This leads to the interview question, do you encourage innovation and open communication from your followers (Martínez-Córcoles et al., 2013, p. 294)?

Methods

The above literature review provided important concepts and questions that were used in the interview question design for this study. The research design for this study consisted of an interview based approach focused on the careers of female leaders in the nuclear power industry. The method for sampling in this study is outlined below. The following section also includes the data collection method and interview questions used in conducting the interviews with women in nuclear power industry leadership positions.

ISSN 1941-4684 | editorelj@regent.edu

Sample Selection

The participants in this study are female leaders at nuclear power plants or in nuclear industry leadership positions. Because the population of women in this industry is very small, the level of leadership was expanded to include women in leadership roles at multiple levels within nuclear organizations. The criterion for women leaders in this study was women who are in management level or above positions within nuclear power organizations. Participants were recruited through the Women in Nuclear (WIN) organization which is sponsored by the Nuclear Energy Institute (NEI). Women from all operating nuclear utilities, as well as from all the major nuclear contracting companies, are members of this organization.

Due to the limited population of women in leadership roles within the nuclear power industry, it was difficult to state that saturation was achieved in the conduct of this study. Five female leaders in the nuclear power industry participated in this study. The age range of participants was 40 – 60 years old. Women participating in this study included multiple levels of management including nuclear power plant manager, nuclear industry organization executive, vice president of environmental health and safety, and director of operations. The amount of time spent in a career in the nuclear power industry ranged from 18 – 37 years for participants. Participants reported holding between 2 and 6 different leadership positions within the nuclear power industry.

The number of participants in this study aligns with Sanders' proposed method in the realm of organizational studies that seek to explicitly understand the meaning in human experiences with a sample population of 3-6 participants (Gill, 2014, p. 122). Giorgi proposes a method for use in psychology that is focused on understanding the essence of a phenomenon using a sample of at least 3 participants (Gill, 2014, p. 122). The number of participants is appropriate in this instance as this study seeks to understand the experiences of female leaders in the nuclear power industry (Gill, 2014, p. 122). As this was an exploratory study into women leaders in the nuclear power industry, additional future studies are recommended to achieve saturation and understanding of how women lead within this industry and what career paths they followed.

Data Collection

An in-depth interview was conducted with female leaders in the nuclear power industry to gain rich descriptions of their experiences and careers in this male dominated industry (Patton, 2015, p. 433). The interview was somewhat informal with an interactive process designed to draw out accounts of the experiences of these leaders over the course of their careers (Patton, 2015, p. 433). Each interview lasted approximately 45 minutes and all were conducted face to face. Conducting face to face

ISSN 1941-4684 | editorelj@regent.edu

interviews allowed for observing nuances of body language and facial expression in the conduct of the interview (Cozby & Bates, 2012, p. 141).

The interview guide was chosen to conduct this study because it allowed the researcher to devise structured questions to ask all participants but still allowed for flexibility in conducting the interview to follow up on themes emerging during the process (Patton, 2015, p. 438). Consistency of interview question use was ensured through the use of the interview guide which also helped reduce the potential for recording bias on the part of the researcher (Padgett, 2008, p. 184). An informed consent protocol was reviewed with all participants prior to conducting the interviews (Patton, 2015, p. 497). The informed consent protocol provided explicit instructions for the gathering of the information, the method for maintaining information, and the benefits and risks involved in participating in the conduct of this study (Patton, 2015, p. 497). All participants were interested in participating in the study and signed the informed consent forms.

To assist in maintaining the participant's confidentiality, a code name was used for gathering the records and interview transcripts to protect the responses of each participant and prevent them from being specifically attributed to a single participant (Cozby & Bates, 2012, p. 43). Audio-recording of all interviews were made after obtaining the consent of participants to aid in accurately capturing the responses and improving the accuracy of the transcription process (Creswell, 2014, p. 193). In addition to the audio-recording, the researcher took notes on key point and observations which were also coded with the code name of each individual participant for use during the data analysis phase of the study (Creswell, 2014, p. 194). All recordings, transcripts, and notes were be coded in a similar manner using the participant code names to facilitate analysis and maintain participant confidentiality (Padgett, 2008, p. 132). The transcription of each interview was given to the participants to serve as a validation check to ensure that the researchers captured the response and its intent accurately. No changes to any of the transcriptions were requested by any of the participants.

Interview Questions

The literature review of this paper provided the foundation for all questions included in the interview guide. At the beginning of each interview, general demographic information was collected from each participant including current position, number of leadership positions held within the nuclear industry, years of experience, and length of time in leadership to aid in coding results. Following suggested good interview practices, ice breaker questions were used in the beginning of the interview to assist in establishing rapport between the researcher and the participant (Creswell, 2014, p. 140).

- Have you ever encountered a "glass ceiling" as a barrier to your advancement to higher levels during your career in the nuclear power industry (Haack, 2014, p. 2014)?

ISSN 1941-4684 | editorelj@regent.edu

- Have you encountered situations where you were discounted or hindered in your career due to stereotypes about your abilities to lead as a woman (Herrera et al., 2012, p. 38)?
- Do you feel you had to make more of an effort than your male colleagues to express your interest in leadership positions (Schuh, et al., 2014, p. 376)?
- Did you have a family member or friend working in a technical field that influenced your interest in this type of career (Ing et al., 2014, p. 2)?
- Did you always have an interest in pursuing a technical career (Ing et al., 2014, p. 8)?
- Do you have the same level of technical skills and qualifications as your male counterparts (Cozzens, 2008, p. 348)?
- Can you describe any experiences from your upbringing that influenced your decision to pursue a technical career (Cozzens, 2008, p. 349)?
- Were you aware of the potential for careers for women in the nuclear power industry before you began working in the industry (Woodcock, 2008, p. 153)?
- Did you follow the traditional nuclear leadership career path working as a reactor operator and moving up through that hierarchy or did you follow a different career path (Schumacher et al., 2011, p. 396)?
- Do you encourage innovation and open communication from your followers (Martínez-Córcoles et al., 2013, p. 294)?

Analysis

Transcripts of each interview were created using word processing software. The transcript was then analyzed using a qualitative analysis software program, Quirkos, to code the data and analyze for themes. This study followed recommendations from Saldana (2013) in the analysis of the data gathered in interviews in this study. Interview data was analyzed using multiple first cycle coding methods from Saldana (2013) including: structural, descriptive, In Vivo, and values coding. Interview responses were first analyzed using structural coding to label and index the interview responses into a topic list aligned with the interview question structure (Saldana, 2013, p. 84). According to Saldana (2013) structural coding is appropriate for use in most qualitative studies and is particularly useful in those with semi-structured data collection methods such as the interviews conducted in this study (p. 84).

The next round of first cycle coding used descriptive coding to validate the topic list resulting from the structural coding, and further identified codes and themes present in the data. Saldana (2013) stated that descriptive coding is appropriate for many types of qualitative research study, and is particularly helpful to qualitative researchers learning how to use this method of qualitative analysis (p. 88). Due to the nature of the study, In Vivo coding was used to assist in further understanding the voice of the participant and identify areas of emphasis and importance in the responses (Saldana, 2013, pp. 91-95).

ISSN 1941-4684 | editorelj@regent.edu

Values coding was also used to identify the values the participants conveyed in their responses in this study. Values coding is appropriate in most qualitative studies but is especially useful when exploring the interpersonal or intrapersonal experiences that are an important factor in this study (Saldana, 2013, p. 111).

The use of multiple compatible first cycle coding methods is called eclectic coding and provides a way to develop deeper, complex meanings and themes from the codes found in the data (Saldana, 2013, p. 188). After completing the first cycle coding, second cycle coding methods of eclectic and pattern coding were conducted to recode the data and condense the results from the various first cycle coding methods into the prevalent themes represented by the data (Saldana, 2013, p. 206). Pattern coding was used to bring the various codes together to represent the higher level theoretical constructs present in the data (Saldana, 2013, p. 210). The results of the first and second cycle coding are presented in the following section of this paper.

The analysis conducted using the first and second cycle coding methods provided a set of themes represented in the interviews shedding light on women in leadership in the nuclear power industry. Table 1 presents a summary of the results of the data analysis and the main themes identified through the iterative data coding process. There were seven main themes found in the interview data including: glass ceiling, stereotypes, effort, career influences, technical skills, women in nuclear, and openness/innovation.

Table 1

Women in Nuclear Leadership Themes

Theme	Supporting Statements
Glass Ceiling	I worked with few women when I started
	There were no women leaders in the beginning
	I was often the only woman in the room
	I had to stand on a table to get them to listen to me
	There was no women's bathroom or change room at the plant when I started
Stereotypes	When I started, the only women were secretaries
	Sexual harassment was a part of everyday life in the beginning
	The guys were shocked I wanted to crawl around in the pipes and get dirty in the plant

ISSN 1941-4684 | editorelj@regent.edu

	I've seen women become more and more accepted in the field over my career
Effort	I had to provide more backup for my recommendations than my male colleagues
	I couldn't get people to respond to me in the beginning
	I had to prove myself over and over again to gain their respect
Career Influences	My father was an engineer
	My dad and brother helped build the local nuclear plant
	I was lucky to have a female mentor who was an engineer
	I was always good at math and science in school
	My science teacher in high school recommended I become an engineer
Technical Skills	I have a bachelor's and master's in nuclear engineering
	I received a technical nuclear certification from Westinghouse
	I asked to go to SRO (senior reactor operator) training
	I worked my way up through engineering and then worked in operations and maintenance
Women in Nuclear	My dad tried to discourage me from this field because there were no women
	There were very few women in the organization when I started
	I didn't know any women who worked in the industry
	I didn't know nuclear power was a career option for girls

ISSN 1941-4684 | editorelj@regent.edu

	I am optimistic that women will establish themselves as key to the success of this industry
	I mentor multiple young women who are the future of this industry
Openness/Innovation	It is hard to get the men to open up to me
	Every person I work with is comfortable sharing concerns and ideas with me
	It was hard at first but after I showed them that I knew my stuff, they were open and accepting
	New ideas are not always popular in this industry
	Many people are resistant to changing in nuclear
	There has been a significant shift in the last year to push for innovation and change

These themes were found during the first and second cycle coding processes. Overlap was found between the different themes throughout the descriptive, In Vivo, and values coding. Each of these themes will be examined further in the following sections to further explore and draw out the meaning found during the data analysis.

The issue of a glass ceiling was a common theme present in the responses from the participants. It was commonly stated that there weren't many or any other women in their workplaces when these women started. "I was often the only women in the room;" "there were no women leaders in the beginning." "I worked with few women when I started." In one particularly interesting story, one of the participants described a meeting in which the men would not listen to her recommendations, so "I had to stand on a table to get them to listen to me." This was an extreme example of a recurring theme in the data in which these women were not treated equally with their male counterparts during their early careers. In many of these comments, the issue of a glass ceiling was not specifically stated but these responses were provided in response to the question on whether or not a glass ceiling was encountered. The lack of women in the workforce and in the leadership in the nuclear power industry in the early days of these women's careers represented a significant barrier to their advancement. Participants repeatedly referenced the lack of female co-workers, and women role models in the industry as a hindrance to their development.

Following in the same line as the issue of glass ceilings, was the issue of stereotypes as a theme present in the data. The women that did work in the nuclear power industry in the early days were in menial jobs; one participant shared "the only women were secretaries." The nuclear power industry is one where working in the power plant involves physical activity and hands on operation and manipulation of large industrial

ISSN 1941-4684 | editorelj@regent.edu

equipment. "The guys were shocked I wanted to crawl around in the pipes and get dirty," one participant shared. The expectation was that the women wanted to sit in the offices, do administrative work, and not get dirty in the hands-on operation of the plant. Also present in this theme is the issue of sexual harassment; "sexual harassment was a part of everyday life in the beginning." The descriptions of the early days of the nuclear power industry, when most of the participants began their careers, was one of a "good old boys club" where women were treated as inferior, or as objects by their male counterparts.

When discussing the amount of effort that was required of them, many participants expressed that they had to do more to prove themselves than their male colleagues. The example of standing on the table to get them to pay attention is again relevant in this theme. However, there were many other comments shared referencing this differentiation. One participant noted "I couldn't get people to respond to me in the beginning" when describing her requests for information when working on a project. Multiple participants noted that they felt they had to provide more justification for their technical decisions than their male co-workers did; "I had to provide more backup for my recommendations than my male colleagues." An overall theme of feeling the need to prove their competency was present; "I had to prove myself over and over again to gain their respect." These perception-based responses indicate that the participants in this study felt that they put forth more effort than their male counterparts to gain respect.

Exploring the influences that led these women to choose a technical career in the nuclear power industry showed that family or teachers were the biggest influence. "My dad and brother helped build the local nuclear plant," and "my father was an engineer," demonstrated the familial influences moving these women toward this career. The other prevalent influence came from teachers or educators. One participant stated that "my science teacher in high school recommended I become an engineer," another interviewee noted that "I was always good at math and science in school." This theme reflects the need to continue programs to interest girls in science and technology that was highlighted in the literature review of this paper. Only one participant referred to a female influencing them into this career when she stated, "I was lucky to have a female mentor who was an engineer." The use of the word 'lucky' in this statement is representative of the lack of female mentors in this field.

Following the theme of understanding career influences is the discussion of technical skills. The nuclear power generation field is technically complex and requires a high level of education and training. All of the participants in this study expressed that they had the same technical qualifications as their male counterparts. Two participants noted they received a technical nuclear certification from Westinghouse as opposed to following the operations career track. Another participant said "I asked to go to SRO (senior reactor operator) training," and that she had to ask multiple times before she

ISSN 1941-4684 | editorelj@regent.edu

was allowed to go. Participants also noted the importance of their college education to their career. One noted "I have a bachelor's and master's in nuclear engineering" in response to the question on training and qualification. Most participants noted that they had worked their way up through either engineering or operations but one expressed that they had also moved around during their career, "I worked my way up through engineering and then worked in operations and maintenance." In all responses, the theme emerged of having the same level of technical education, skills, and qualifications as their male counterparts. It was also interesting to note that these women pursued and sometimes had to push to be allowed to pursue the certifications within the industry.

Women in nuclear was a theme that overlapped with the previous themes but it also stood out enough to be separated into its own theme. A constantly recurring message in the data was that there were not many, or in some cases any, other women working in this field. Comments that point to this theme included: "there were very few women in the organization when I started," "I didn't know any women who worked in the industry," and "I didn't know nuclear power was a career option for girls." This industry was not designed to include women, "There was no women's bathroom or change room at the plant when I started." The failure to include women in the industry may have been a product of the nuclear power industry developing out of a construction mentality. The workers who participated in constructing the nuclear power plants are often the ones that continued to work in the plants. Participants expressed a hopeful outlook for the future to include more women; "we have female plant managers now, I never thought I'd see that happen or become one of them." Other participants shared: "it is so nice to see more girls become interested in science and engineering," "I am optimistic that women will establish themselves as key to the success of this industry," and "I mentor multiple young women who are the future of this industry."

The final theme was the importance of openness and innovation in the industry. The responses to the questions related to this area reflected a mixture of attitudes towards change and innovation in the nuclear power industry. Some expressed that the industry was not open to innovation and change. "New ideas are not always popular in this industry," and "many people are resistant to changing in nuclear." While others stated, "there has been a significant shift in the last year to push for innovation and change." Aligned with the resistance to change were comments around lack of openness; "it is hard to get the men to open up to me." But there were also statements that reflected a positive atmosphere of openness; "every person I work with is comfortable sharing concerns and ideas with me." The responses painted a picture of an industry that recognizes the need to be open and innovative but still struggles with internal resistance to change. One participant summed it up thusly, "we know we need to innovate and adapt but we aren't quite sure how to go about it yet." The comments around openness

ISSN 1941-4684 | editorelj@regent.edu

and the need for innovation and change go hand in hand with a discussion of women in leadership in this field. The inclusion of women in leadership in the nuclear power industry is a significant change from the status quo since it is one that brings opportunities for the industry and the women within it.

The main themes found in the interview data analysis have been reviewed in detail in the preceding section, but it is also important to note that many of themes found in the data were overlapped or connected to other themes. Table 2 provides an overview of the relationships between the themes as well as the number of codes associated with each theme; note that some codes were associated with more than one theme. There were additional smaller themes found in the data that were not reviewed in depth in this study. They are noted in table 2 where they are related to the main themes but they appear more as subthemes to the identified main themes rather than as standalone themes related to the subject of women in nuclear power leadership.

Table 2

Relationships between Themes

Theme	# of Codes	Related Themes
Glass Ceiling	8	Stereotypes, career influences, effort, women in nuclear
Stereotypes	7	Glass ceiling, effort, women in nuclear, technical skills
Effort	7	Glass ceiling, stereotypes, openness/innovation, technical skills
Career Influences	5	Women in nuclear, family, education, technical skills
Technical Skills	5	Stereotypes, effort, women in nuclear
Women in Nuclear	5	Glass ceiling, stereotypes, effort, openness/innovation
Openness/Innovation	5	Career influences, communication, effort

Limitations

This study was limited in the small size of participants included in this initial study. This prevented the researcher from determining if saturation was truly achieved in the data collection and analyzing process. The sample size was limited due to the small

ISSN 1941-4684 | editorelj@regent.edu

numbers of women in leadership positions within the nuclear industry. It is recommended that future studies should be conducted with additional women in leadership in this industry to further investigate this topic. An additional limitation is the possibility for bias on the part of the researcher due to their years of experience working as a woman in the nuclear power industry. Future studies should be conducted by leadership experts who are not familiar with the nuclear power industry to help mitigate this potential for bias.

Conclusion

Women are breaking through the "glass ceiling" in many industries in countries around the world. One area where this is not happening as quickly is the male dominated nuclear power industry. The gender disparity in nuclear power is pronounced when compared to other industries, but is representative of the gender gap in engineering and science based industries where men are still more prevalent. Seven main themes were found in exploring the experiences of women in leadership in this industry using qualitative coding methods recommended by Saldana (2013). The main themes found were glass ceiling, stereotypes, effort, career influences, technical skills, women in nuclear, and openness/innovation.

Responses from the women leaders in this industry reflected a shift in the industry to become more open to women. The early days of their careers were discussed with many references to stereotypes, the glass ceiling, and a general exclusion of women from this industry. The discussion of current career dynamics with participants indicated a changing industry that recognizes the need to be more open and diverse but is struggling to find how to make that shift. As there is very little scholarly literature currently available on this topic, this study provides the first step on the path to understanding women in leadership in the nuclear power industry. Additional studies are recommended to further explore women in the nuclear power field and developmental options for the future of women in this industry.

About the Author

Tamara Kenney is a third-year PhD student at Regent University where she is studying organizational leadership and human resources development. She is a financial manager for a large electric utility, overseeing corporate nuclear finance.

Correspondence concerning this article should be addressed to Tamara Kenney at tamaken@mail.regent.edu.

Emerging Leadership Journeys, Vol. 9 Iss. 1, pp. 56-73.

ISSN 1941-4684 | editorelj@regent.edu

References

Cozby, P. C., & Bates, S. C. (2012). *Methods in behavioral research*. New York, NY: McGraw-Hill.

Cozzens, S. E. (2008). Gender issues in US science and technology policy: Equality of what? *Science & Engineering Ethics, 14*(3), 345-356. doi:10.1007/s11948-008-9061-x.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications, Inc.

Dorfman, D. A. (2012). The changing perspectives of U.S and Japanese nuclear energy policies in the aftermath of the Fukushima Daiichi disaster. *Pace Environmental Law Review, 30*(1), 255-290.

Fertel, M. S. (2013). State of the nuclear energy industry. *Electric Perspectives, 38*(3), 86-92.

Gill, M. J. (2014). The possibilities of phenomenology for organizational research. *Organizational Research Methods, 17*(2) doi:10.1177/1094428113518348, 118-137.

Haack, K. (2014). Breaking barriers? Women's representation and leadership at the United Nations. *Global Governance, 20*(1), 37-54.

Herrera, R., Duncan, P. A., Green, M. T., & Skaggs, S. L. (2012). The effect of gender on leadership and culture. *Global Business & Organizational Excellence, 31*(2), 37-48. doi:10.1002/joe.21413.

Ing, M. M., Aschbacher, P. P., & Tsai, S. S. (2014). Gender differences in the consistency of middle school students' interest in engineering and science careers. *Journal of Pre-College Engineering Education, 4*(2), 1-10. doi:10.7771/2157-9288.1090.

Lochbaum, D. (2014). Life after nuclear: Decommissioning power reactors. *Bulletin of the Atomic Scientists, 70*(4), 26-36. doi:10.1177/0096340214539111.

Mallow, J., Kastrup, H., Bryant, F. B., Hislop, N., Shefner, R., & Udo, M. (2010). Science anxiety, science attitudes, and gender: Interviews from a binational study. *Journal of Science Education & Technology, 19*(4), 356-369. doi:10.1007/s10956-010-9205-z.

Martínez-Córcoles, M., Gracia, F. J., Tomás, I., Peiró, J. M., & Schöbel, M. (2013). Empowering team leadership and safety performance in nuclear power plants: A multilevel approach. *Safety Science, 51*, 293-301. doi:10.1016/j.ssci.2012.08.001.

Nelkin, D. (1981). Nuclear power as a feminist issue. *Environment, 23*(1), 15-20, 38-39.

ISSN 1941-4684 | editorelj@regent.edu

Padgett, D. K. (2008). *Qualitative methods in social work research*. Thousand Oaks, CA: Sage Publications, Inc.

Patton, M. Q. (2015). *Qualitative research & evaluation methods*. Thousand Oaks, CA: Sage Publications, Inc.

Rentetzi, M. (2009). Gender, science and politics: Queen Frederika and nuclear research in post-war Greece. *Centaurus, 51*(1), 63-87. doi:10.1111/j.1600-0498.2008.00132.x.

Saldana, J. (2013). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications.

Savath, V., & Brainard, S. G. (2013). Managing nanotechnology risks in vulnerable populations: A case for gender diversity. *Review of Policy Research, 30*(5), 549-565. doi:10.1111/ropr.12031.

Schuh, S. S., Hernandez Bark, A., Van Quaquebeke, N., Hossiep, R., Frieg, P., & Dick, R. (2014). Gender differences in leadership role occupancy: The mediating role of power motivation. *Journal of Business Ethics, 120*(3), 363-379. doi:10.1007/s10551-013-1663-9.

Schumacher, S., Kleinmann, M., & Melchers, K. G. (2011). Job requirements for control room jobs in nuclear power plants. *Safety Science, 49*, 394-405. doi:10.1016/j.ssci.2010.10.002.

Solomon, L. S., Tomaskovic-Devey, D., & Risman, B. J. (1989). The gender gap and nuclear power: Attitudes in a politicized environment. *Sex Roles, 21*(5/6), 401-414.

Wacławek, W., & Wacławek, M. (2011). Marie Skłodowska-Curie and her contributions to chemistry, radiochemistry and radiotherapy. *Analytical & Bioanalytical Chemistry, 400*(6), 1567-1575. doi:10.1007/s00216-011-4922-6.

Woodcock, P. (2008). Gender, politicians and public health: Using the Simpsons to teach politics. *European Political Science, 7*(2), 153-164. doi:10.1057/eps.2008.5.

Yukl, G. (2013). *Leadership in organizations*. Upper Saddle River, NJ: Pearson.

ISSN 1941-4684 | editorelj@regent.edu