

THE CURRENT STATUS AND EFFECTS OF PROACTIVE COMMUNICATION ON  
ACCIDENT RISKS AND EMERGENCY PREPAREDNESS IN THE CONTEXT OF  
NUCLEAR POWER STATIONS

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## ABSTRACT

### THE CURRENT STATUS AND EFFECTS OF PROACTIVE COMMUNICATION ON ACCIDENT RISKS AND EMERGENCY PREPAREDNESS IN THE CONTEXT OF NUCLEAR POWER STATIONS

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This dissertation focuses on emergency preparedness communication, which is defined as communication efforts and activities to inform the public of accident risks and emergency response plans before a large-scale accident occurs. Emergency preparedness communication is essential in reducing accident damage. However, organizations have tended to ignore emergency preparedness communication because of the assumption that such communication would harm public confidence in their risk-generating activities. The Fukushima Daiichi Nuclear accident in 2011 is one example of organizations ignoring emergency preparedness communication.

The purpose of this dissertation is two-fold: (1) to examine the current status of emergency preparedness communication at nuclear power plants in the United States and (2) to investigate the effects of emergency preparedness communication on people's perceptions and attitudes toward nuclear plants. To achieve these goals, this project conducted two separate studies.

First, the current study conducted a content analysis using the websites of all nuclear power plants in the U.S. and discussed how emergency preparedness communication was conducted and what messages were communicated in online media. The results showed that most websites provided information on emergency preparedness, but that emergency preparedness was emphasized less than other types of information. Nuclear power plants in the U.S. tended to emphasize information on the benefits of nuclear power, rather than on emergency preparedness.

Second, this study employed an experiment to examine how communicating accident risks and emergency preparedness would affect people's perceptions and attitudes toward nuclear plants. The experiment created fictional nuclear power plant websites that delivered different messages as stimuli. The study compared the control condition, which gave respondents only general information on the nuclear plant, to the emergency preparedness communication condition, in which respondents were provided information on emergency response planning. The experiment yielded mixed findings. Information on emergency preparedness increased negative feelings and decreased positive feelings. However, the information concurrently enhanced the perception that the plant was honest. The information also increased the perception that the plant was caring when respondents thought that they were familiar with nuclear power. The author formulated a model that included those perceptions and emotions to predict people's willingness to accept a nuclear plant at local and general levels.

This dissertation contributes to the field of risk and crisis communication by advancing discussion on the benefits and drawbacks of informing the public of accident risks and emergency preparedness. The study reveals understanding of nuclear power plants' provision of information as well as the public perception of emergency preparedness information. Emergency preparedness communication does not increase or decrease the level of support for nuclear power plants. However, emergency preparedness communication changes the public's reasoning for acceptance of the plants, shifting their acceptance from an emotional-based to trust-based reaction. As a practical implication, this study recommends that nuclear power plants in the U.S. communicate accident risks and response plans more openly and proactively to achieve public trust in the nuclear industry.

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## **Chapter 1 Introduction: What We Witnessed at the Fukushima Nuclear Power Plant Accident: The Importance and Difficulties of Emergency Preparedness Communication**

This dissertation focuses on emergency preparedness communication, which the author defines as pre-crisis communication that outlines accident risks and emergency response measures to be taken during an emergency, especially in the context of nuclear power plants. As will be explained later in this dissertation, scholars (e.g. Coombs, 2000; 2007, Fearn-Banks, 2007; Heath & Palenchar, 2009; Mitroff & Anagnos, 2001; Seeger, 2006) have agreed with the need for and the importance of such pre-crisis communication. Studies (e.g. Sandman 2003a, 2006; Sjöberg, 1998) have also addressed that the implementation of emergency preparedness communication often faces administrative difficulties and challenges. Apart from those studies, the majority of crisis management literature has traditionally focused on strategies at the post-crisis, rather than pre-crisis stage (Pauchant & Mitroff, 1992). The same also applies to studies in crisis communication (Avery, Lariscy, Kim, & Hocke, 2010). Crisis communication scholars have predominantly studied the effects of organization-public relationships (OPR) on reputational damage and recovery in the post-crisis phase (Olaniran, Williams, & Coombs, 2012). So far, few studies have examined the influence of exposure to pre-crisis planning and emergency preparedness on public perceptions and attitudes toward the communicator. Furthermore, no known research has investigated how risk-generating facilities or organizations conduct pre-crisis communication on accident risks and emergency preparedness.

This dissertation is one of the first scholarly attempts to provide a comprehensive overview of the current situation of emergency preparedness communication in U.S. nuclear power plants. This work also aims to offer direction to overcome the difficulties of implanting

emergency preparedness communication by discussing the effects of emergency preparedness communication on public perceptions and attitudes toward accepting nuclear power plants. Before proceeding to a main discussion, this introduction chapter will provide a rough outline of emergency preparedness communication. Using one of the most serious nuclear disasters in history as an example, the Fukushima Daiichi nuclear power plant accident in 2011, this introductory section will illustrate what happened when sufficient pre-crisis communication on accident risks and emergency preparedness was absent. This research will also attempt to explain why the Japanese nuclear power plant lacked emergency preparedness communication. In doing so, this section will demonstrate the importance and the difficulties of emergency preparedness communication at risk-generating facilities such as nuclear plants. The overview and structure of this dissertation is elaborated at the end of this chapter.

### **The Accident**

On March 11, 2011, at 2:46 pm (Japan Standard Time), a 9.0 magnitude earthquake hit a wide range of the Tohoku region of Japan. The earthquake, which was later referred to as the 2011 Tohoku Earthquake, or the Great East Japan Earthquake, occurred with the epicenter located approximately 130 kilometers (81 miles) east-southeast of the Oshika Peninsula of Miyagi prefecture and the relatively shallow hypocenter at an underwater depth of approximately 24 kilometers (15 miles) (Kishocho [Japan Meteorological Agency], n.d.; Suzuki & Kaneko, 2013). According to a report by the Shobocho [Fire and Disaster Management Agency] (2017), the quake continued for approximately six minutes, causing massive damage to the area including more than 19.5 thousand deaths, six thousand injured, and two thousand missing. As of July 2017, it was the strongest earthquake that had hit the Japanese archipelago (Kishocho [Japan

Meteorological Agency], n.d.) and the fourth most powerful in recorded earthquake history since 1900 (U.S. Geological Survey [USGS], n.d.).

The earthquake formed large tsunamis, which struck the northeast Tohoku and Kanto regions along the coast of the Pacific Ocean. About an hour after the first quake, the largest tsunami with over 9.3-meter (30.1-foot) height was observed in Soma city of Fukushima prefecture, about 300 kilometers (186 miles) northeast of Tokyo. The tsunamis started striking the northeast Tohoku and Kanto regions, the areas along the coast of the Pacific Ocean and washed over 561 square kilometers (139 thousand acres) across 62 communities in six prefectures (Kokudochiriin [Geospatial Information Authority of Japan], 2011).

At 3:36 p.m., 50 minutes after the first quake, one of the tsunamis reached the Fukushima Daiichi Nuclear Power Plant and destroyed the cooling facilities at the number 1, 2, and 3 reactors of the Fukushima Daiichi plant (Tokyo Electric Power Company [TEPCO], 2013), which is located about 225 kilometers (140 miles) northeast of Tokyo. The fuel rods inside the reactors were overheated and started to meltdown. The overheated rods also triggered hydrogen explosions at reactor buildings, which released radioactive materials confined in the reactor buildings into the atmosphere. Consequently, high levels of radioactive particles were detected outside the plant site (Atomic Energy Society of Japan [AESJ], 2015; Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; International Atomic Energy Agency [IAEA], 2015; National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission [NAIIC], 2012; Organisation for Economic Co-operation and Development [OECD], 2013).

Facing an unprecedented national emergency, the Japanese government took a lead in reacting to the accident, yet seemingly on an ad-hoc basis. At 8:50 p.m. on March 11, the

government first issued an evacuation instruction to the residents within 2 kilometers (1.2 miles) from the Fukushima Daiichi nuclear plant. However, within half an hour, at 9:23 p.m. the government revised the instruction to evacuation of residents within 3 kilometers (1.9 miles) of the nuclear plant. The government expanded the evacuation twice on the proceeding day, March 12, after recognizing the wider spread of radioactive materials. The government issued their first instruction at 5:44 a.m. to residents within 10 kilometers (6.2 miles) of the nuclear plant, and then at 6:25 p.m., to those within 20 kilometers (12.4 miles) of the nuclear plant (Investigation Committee on the Accident at the Fukushima Nuclear Power Stations, 2012; Naikakufu [Cabinet Office, government of Japan], 2011). The government also issued a sheltering instruction on March 15 to the residents outside the 20-kilometer (12.4-mile) but within the 30-kilometer (18.6-mile) radius from the Fukushima nuclear plant. The instruction was also revised in one and a half months. On April 25, the sheltering instruction was elevated to a voluntary evacuation instruction. It is estimated that the evacuation instruction affected more than 100 thousand local residents in the area (Investigation Committee on the Accident at the Fukushima Nuclear Power Stations, 2012; Naikakufu [Cabinet Office, government of Japan], 2011). As will be explained later in this chapter, no clear rules or guidelines existed for evacuation and sheltering in the case of nuclear emergencies in Japan.

The assessment of the accident was not implemented in a timely manner, even though IAEA requires prompt evaluation and communication in the case of a nuclear emergency (IAEA, 2014). The Japanese government initially underestimated the seriousness of the accident and gradually raised the assessment of the seriousness in the first month. This imprecise and delayed assessment of the accident garnered public criticism (e.g. AESJ, 2015).

One week after the start of the accident, on March 18, the Japanese government evaluated the accident. Among these six reactors at the Fukushima Daiichi nuclear power plant, accidents at three reactors were rated as level 5 on the International Nuclear and Radiological Event Scales (INES) (IAEA, 2014), meaning that the accident had “wider consequences” with a limited release of radioactive material. One was evaluated at level 3 (“serious incident”), and the rest were not evaluated. However, after admitting a wider spread of radioactive particles from the plant site, the government decided to rate the accident as a level 7 on April 12 (Shushokantei [Prime Minister of Japan and His Cabinet], 2011). This evaluation in the accident rating level indicated that the accident was a “major accident” (IAEA, 2014) in the history of nuclear power. As of July 2017, there are only two nuclear accidents rated as level 7: the Chernobyl disaster in 1986 and the Fukushima Daiichi nuclear disaster (IAEA, 2014).

### **Communication Chaos**

Both journalistic work and academic investigation have reported that there was chaos in communication during the accident. The chaos occurred not only between the responsible entities and the public, but also within the organizations, such as the electric power company and government agencies (Omoto, 2015). NAIIC (2012) also pointed out that the communication confusion was prevalent in the chain of command, among the Prime Minister, government officials, and responsible staff in the electric power company.

This confusion in communication exacerbated damage from the accident. Without prior communication on accident risks and emergency response plans, local residents and local authorities needed to start seeking information on evacuation and sheltering. Consequently, people received inconsistent information from various sources and they had to decide which instructions to rely on (NAIIC, 2012). Due to a lack of accurate information, evacuees

unknowingly headed to the points where the radioactive plumes spread, which resulted in their unnecessary exposure to radiation (Kingston, 2014; NAIIC, 2012; Omoto, 2015; Tateno & Yokoyama, 2013). Even after the accident, cows in the Tohoku region were secondarily contaminated by radioactive materials from the Fukushima nuclear plant because farmers kept feeding contaminated rice straw. The government only alerted cattle farmers, but failed to communicate with rice straw suppliers (NAIIC, 2012; Omoto, 2015).

It was true that the Fukushima nuclear accident was triggered by a tsunami following a massive earthquake. However, some scholars (e.g., Suzuki & Kaneko, 2013; Kingston, 2014) have argued that the accident was preventable if prevention measures were properly installed and if the possibility of an accident was adequately evaluated. The NAIIC report (2012) also concluded that the Fukushima accident was a “man-made disaster”.

### **Pitfalls of the “Safety Myth”**

Why did this communication chaos occur? Many accident reports (e.g. AESJ, 2015; IAEA, 2015; Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; NAIIC, 2012) found the reason in the Japanese government’s and nuclear industry’s strong belief that the Japanese nuclear technology was absolutely safe. In his foreword to the IAEA’s final report of the Fukushima accident (2015), the Director General of IAEA, Yukiya Amano criticized this “safety myth” shared within the Japanese nuclear industry as follows:

A major factor that contributed to the accident was the widespread assumption in Japan that its nuclear power plants were so safe that an accident of this magnitude was simply unthinkable. This assumption was accepted by nuclear power plant operators and was not challenged by regulators or by the government. As a result, Japan was not sufficiently prepared for a severe nuclear accident in March 2011. (n.p.)

Reich (2014) argued that the Japanese government's and nuclear industry's strong emphasis on absolute safeness in their public communication on nuclear power had hindered the nuclear plant operator from developing emergency response plans and initiating public discussion on accident risks. On this point, AESJ's investigation report (2015) articulated that the government and the electric power companies failed to evaluate the possibilities of nuclear accidents "due to fear of upsetting the long-established safety myth" (AESJ, 2015; p. 250). An anthropological study on the Fukushima accident (Kingston, 2014) demonstrated that there had been no evacuation drills with the local authorities or communities before the Fukushima accident because the plant owner had been reluctant to inform the local residents of any accident risks. Kingston (2014) also showed that the government had never given any instructions about the operator's lack of emergency response planning and training because the absence of emergency preparedness communication conveniently worked to promote nuclear energy in the country by downplaying the possibilities of nuclear accidents. As a result, residents near the Fukushima plant were barely informed of what they should do in the case of nuclear accidents, nor how the nuclear plant or local authorities would inform them of an emergency (Manabe, 2015, p.49; Suzuki & Kaneko; 2013). Instead of communicating emergency response planning and preparedness with the public, Japanese electric power companies spent money and resources on massive advertising and public relations campaigns to propagate the benefits and absolute safeness of nuclear power generation (Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; NAIIC, 2012).

### **Nuclear Power in Japan**

It is important to understand the circumstances surrounding the use of nuclear energy in Japan to grasp the full picture of the "safety myth" forged by the nuclear power industry in

tandem with the Japanese government. Why did the government advocate the absolute safety of the country's nuclear technology and try to strongly promote the use of nuclear energy in the country? The reason dated back to the 1950s when Japan faced the need for secure energy sources to rebuild the economy after World War II. As a country with few natural resources, securing reliable and abundant energy supply at a low cost has been and continues to be a critical national issue with a significant influence on the country's politics and diplomacy (Morse, 1981).

In 1953, the Japanese government received \$42 million in loans (about \$ 308 million by today's values) from the Export-Import Bank of the United States to develop the country's electric infrastructure mainly by building new hydro-electric generating stations. The new infrastructure played a significant role in supplying sufficient energy for Japan's economic growth after the war. However, at the time, the Japanese electric power industry was seeking to diversify power sources and showing strong interest in nuclear power as an alternative energy source that guaranteed a stable and affordable supply of electricity (Eyre, 1965). Therefore, President Eisenhower's speech on the "*Atoms for Peace*" program at the UN General Assembly meeting in 1953 was a perfect opportunity for Japan. Only two months after the announcement, in March 1954, the Japanese national legislature (referred to as the Diet) passed a budget proposal to start a preliminary research program to explore the possibility to introduce nuclear power with technical and financial support by the U.S. government (Chunichi Shimbun, 2013; Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; Research Organization for Information Science and Technology [RIST], 1998). Japan, by seizing on the momentum in the U.S. policy shift, initiated its civilian nuclear program.

However, it was not an easy task for the government and the energy power industry to persuade citizens to accept nuclear power in Japan, where anti-nuclear and anti-American

sentiments had been deep-rooted for years since the war (Suttmeier, 1981). Only 9 years had passed from when the country was devastated by two nuclear bombs in Hiroshima and Nagasaki, resulting in over 100,000 deaths. Furthermore, on March 1, 1954, a Japanese fishing boat, the *Daigo Fukuryu Maru* (Lucky Dragon Number 5) was exposed to and contaminated by radiation fallout near Bikini Atoll in the Pacific Ocean, where the United States was conducting a series of nuclear tests called Operation Castle Bravo. One of the fishermen died six months later from acute radiation syndrome and became a nationwide icon of anti-nuclear movements that lasted from the late-1950s to the mid-1970s (Chunichi Shimbun, 2013; Kinefuchi, 2015). In August 1955, one of the largest protests against nuclear power mobilized more than 30 million people, or roughly one-third of the Japanese population, to appeal for a ban of nuclear bombs (Aldrich, 2012). This historic and long-lasting anti-nuclear power movement, in combination with the fear of revitalizing such public sentiments, contributed to the government and the nuclear industry's heavy reliance on massive advertising and public relations campaigns to promote the benefits and absolute safety of nuclear power generation (Independent Investigation Commission on the Fukushima Nuclear Accident, 2014).

Nevertheless, Japan continued to steer its policy further toward promoting civilian use of nuclear power. In October 1955, the Japanese government announced that they would start full-scale research on nuclear reactors at the newly-founded Japan Atomic Energy Research Institute ([JAERI]: Nihon Genshigyoku Kenkyujo). In August 1957, the country's first nuclear reactor, which had been imported from the United States, successfully reached criticality. In 1962, JAERI developed Japan's first domestically-made research reactor. In July 1966, eleven years after the announcement of the government's formal engagement in nuclear research, Japan started the operation of Tokai power station, its first commercial nuclear power plant using a

British-made reactor (RIST, 1998). The oil crisis in 1973 pushed the country's nuclear development further. For example, after the rapid industrial expansion, Japan depended on fossil oil imports, mainly from Middle-Eastern countries, for 66% of the total electricity generation in 1974 (Caldwell, 1981; Shigenenerugicho [Agency for Natural Resources and Energy], 2017). The re-evaluated national energy policy placed a high priority on reducing Japan's reliance on oil imports and diversifying the energy source. Largely, Japan sought to advance nuclear plant construction in the country (Shigenenerugicho [Agency for Natural Resources and Energy], 2017; World Nuclear Association, 2017a).

Since the first nuclear power plant went into service in 1966, the Japanese government and the country's nuclear power industry have maintained a strong partnership in terms of not only the development, but also the operation of nuclear power stations in the country. The government established a joint public-private venture, the Japan Atomic Power Company, for the operation of the Tokai power station. At the developing stage of the nuclear power generation, Japanese nuclear power plants were planned and authorized by the national government but operated by private electric companies. For example, the national government finalized the design of the Unit 1 reactor at the Fukushima Daiichi Nuclear Power Station built in 1971. The government introduced the reactor, which was designed by General Electric, as a "turnkey" reactor. Later, investigation reports on the Fukushima nuclear accident (e.g. AESJ, 2015; Independent Investigation Commission on the Fukushima Nuclear Accident, 2014) argued that the reactor design did not fit the Japanese environment. Specifically, investigation reports critiqued the government because the reactor was equipped with emergency diesel-powered generators in the basement to withstand a tornado, but tornadoes are not a common natural

disaster in Japan. In 2011, when a tsunami hit the Fukushima nuclear station, the seawater submerged the generators and the plant lost its backup electricity supply.

This “government-planned, privately-owned” scheme also led to confusion between the responsibilities of the national government and the plant operator, and who was ultimately responsible for providing compensation for the damages from the accident. The country’s Act on Compensation for Nuclear Damage, which was legislated in 1961, required nuclear plant operators to carry insurance and limited the amount of damage liability of the operator. The Act also stipulated that the national government would unlimitedly compensate damages exceeding the amount. However, the Act does not explicitly mention whether the national government has an obligation to provide aid to the nuclear company, and it does not state that the government must compensate accident victims. The act only vaguely states that the government will provide “necessary measures” to rescue and help victims and prevent the escalation of a disaster. Regarding this legal vagueness, an accident report by the Independent Investigation Commission (2014) on the accident pointed out that this Act reflected the “myth of safety” (p.42) that prevailed in national nuclear policy. The Japanese government estimated that the existing insurance system would suffice to compensate for damages of a nuclear accident and, therefore, naively assumed that there was no need for determining details of the compensation schemes for nuclear accidents because such serious accidents would never happen at nuclear power plants (Takemori, 2011).

Japan advanced the commercial use of nuclear energy as a national policy by building a partnership between the national government and the nuclear power industry. However, this strong tie became a breeding ground for a cozy relationship between the governmental agency, which was supposed to oversee and regulate the nuclear industry, and the nuclear power

companies, which hoped to promote the commercial use of nuclear energy (AESJ, 2015; Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; NAIIC, 2012). Until the formation of the Nuclear Regulatory Authority (NRA) within the Ministry of Environment in September 2012, the Ministry of Economy, Trade, and Industry (METI) was responsible for both promoting and regulating the civil use of nuclear industry. The Nuclear Industrial Safety Agency (NISA), a part of METI, directly oversaw the nuclear power industry as a responsible governmental arm. The Nuclear Safety Commission (NSC) within the Cabinet Office operated as a safety advisory board to review actions by nuclear regulatory entities including NISA. However, the safety-review procedure remained unclear because the NSC's responsibility overlapped with that of NISA. The cross-check function also failed to properly work because NISA was responsible for providing NSC with inspection guidelines (AESJ, 2015; Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; NAIIC, 2012). Moreover, it was common that high-ranking officials in those governmental agencies obtained executive posts in private electric power companies after their retirement. Consequently, individuals from the nuclear industry, financial sector, the media and academia, formed a closed and exclusive group called the "*Genshiryoku mura* (Nuclear Village)". The Nuclear Village afforded special benefits to the members within the circuit (Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; Kingston, 2012a; 2012b; NAIIC, 2012). Because of the Nuclear Village, the country's regulations on nuclear safety, including emergency preparedness, were discounted and the government and nuclear industry highlighted the benefits and safety of nuclear power in public communications (Kingston, 2012a; 2012b).

### **Repeated History: Looking Back at the Three Mile Island Accident**

Although situations surrounding nuclear energy are different, the pervasive belief that nuclear technology was absolutely safe and government's belittling attitude toward emergency response planning, were not unique to Japan. In fact, a similar tendency was observed in the United States before the Three Mile Island (TMI) nuclear power plant accident.

The unit 2 reactor at the Three Mile Island Nuclear Generating Station, located near Middletown, Pennsylvania, partially melted down on March 28, 1979. The accident began with a minor failure in a non-nuclear portion (the secondary system) in the plant. Either electrical or mechanical failure in the secondary system stopped a circulation of cooling water from the main feedwater pumps to the steam generators. The halt in the water supply triggered an increase in the heat and pressure in the nuclear section (the primary system). Immediately, the turbine-generator and the nuclear reactor shut down to prevent the facilities from being overheated and causing a nuclear chain reaction. Yet, decay heat continued to generate within the reactor and the reactor pressure continued rising.

To control the high pressure in the primary system, the pilot-operated relief valve at the top of the pressurizer automatically opened. The valve was designed to close when the pressure returned to regular levels because opening the valve allowed cooling water to escape from the primary system. In this case, the automatic switching mechanism did not work. Due to a mechanical problem, the relief valve was stuck and failed to close. Consequently, coolant water continued pouring out from the primary system through the stuck-open valve.

Even worse, the operators at the station could not detect the flow of the coolant water because no system was installed to measure the water level in the reactor. Furthermore, a light on the control panel indicated that the valve was "not open". As a result, the plant operators reduced

the amount of coolant water pumped up into the primary system to prevent the system from filling up because they assumed that the valve was shut and the reactor core was properly covered with coolant water. This action led to the boiling away of the rest of the coolant water in the reactor core and caused a loss-of-coolant accident (LOCA). Without the adequate coolant water circulation, the nuclear fuel in the reactor overheated and began to melt. At these initial stages of the accident about half of the core melted down (U.S. President's Commission on the Accident at Three Mile Island, 1979; U.S. Nuclear Regulatory Commission [NRC] Special Inquiry Group, 1979; NRC, 2013a; Walker, 2004).

Although the plant staff did not have a way to identify the direct cause of the accident, alarms were going off and warning lights were flashing in the control room to indicate the irregular situation of the nuclear reactor. For example, unusually high temperatures on the discharge line of the pilot-operated relief valve were detected and the temperatures and pressures of the containment building were showing as abnormally high. These were clear indications of a loss-of-coolant accident. However, the plant operators ignored the signs because they could not believe that the nuclear power plant was causing a serious accident (U.S. President's Commission on the Accident at Three Mile Island, 1979; NRC Special Inquiry Group, 1979).

Facing the aftermath of the first serious nuclear accident in history, President Carter issued an order to organize a committee to investigate technical causes of the accident. The committee, headed by Dartmouth College President John Kemeny, submitted a report ("the *Kemeny Report*") and recommended that the federal government redefine the roles of managing agencies and redesign emergency preparedness programs for nuclear power plants (NRC, 2014). The *Kemeny Report* also identified the prominent cause of the accident as a human factor. The plant's emergency system detected the abnormality of the nuclear reactor, but workers at the

plant turned off the system because they believed that the U.S. nuclear technology would never fail. In fact, shutting down the emergency system was a normal operation commonly shared among the plant workers in similar situations (e.g. high pressurizer level) (van Erp, 2002). The plant staff never assumed that the system was actually alerting a serious failure. The *Kemeny Report* documented that fundamental changes were necessary in the attitudes of people, as well as organizations and procedures, by claiming that “no amount of technical “fixes” will cure this underlying problem” (U.S. President’s Commission on the Accident at Three Mile Island, 1979, p.24). Reviewing the *Report* thoroughly, van Erp (2002) explained that the TMI accident was triggered by people’s misunderstanding of “safety culture” (p. 157), which created a pervasive belief that nuclear technology was absolutely safe. As will be explained in the next chapter, the recommendations in the *Kemeny Report* became fundamentals of regulatory requirements on emergency preparedness at nuclear power facilities today (NRC, 2014).

The Chernobyl Nuclear Power Plant accident that occurred in 1986 was another major disaster in nuclear history. the consequence of a flawed reactor design in the Soviet era resulting from insufficient training of the operating staff (Nuclear Energy Institute, 2015; World Nuclear Association, 2016). After reviewing the accident, the U.S. government inspected all reactor systems and staff training programs in the country. In 1989, they concluded that differences in reactor design and operation requirements made it highly unlikely that similar accidents would happen in the country and no regulation change was required. (NRC, 2013b)

### **This Study**

Witnessing the aftermath of the 2011 Fukushima Daiichi nuclear disaster, people recalled and reaffirmed the importance of pre-crisis communication, providing the public with information on emergency response planning and preparedness (Latré, Perko, & Thijssen, 2017).

As witnessed, the absence of emergency preparedness information led to a communication chaos among the public and public officials during and after the crisis (NAIIC, 2012). Highlighting the need for proactive communication on emergency preparedness, this dissertation will discuss the current status of pre-crisis communication on accident risks and emergency response plans and the effects of such communication on public perceptions, attitudes, and acceptance of nuclear power plants in the United States.

The next chapter focuses on theoretical discussions as to why emergency preparedness communication is needed and why emergency preparedness communication is difficult to implement in a real-life situation. This extended literature review will demonstrate that emergency preparedness communication is required from the following three viewpoints: (1) governmental regulations and legal requirements, (2) ethical grounds, and (3) strategic communication perspectives. All of these viewpoints will justify the necessity of emergency preparedness communication. However, this chapter will point out that (1) people's psychological biases, (2) organization's general reluctance to communicate about risks and emergencies, and (3) low societal interests hinder the implementation of emergency preparedness communication.

The second chapter also provides a background and a brief history about the use of and the regulatory frameworks of nuclear energy in the United States. Although the number of reactors has declined, the United States remains highly reliant on nuclear energy, generating the largest amount of nuclear-based electricity in the world. This suggests that nuclear energy is still an important issue in the United States.

Chapter 3 explores the current situation of emergency preparedness communication at nuclear power plants in the United States. This chapter will analyze the websites of U.S. nuclear

power plants and discuss how emergency preparedness information is communicated in online media. By focusing on websites, which the regulatory agency does not recognize as a part of public information channels and because websites are not under governmental supervision as of July 2017, this chapter will demonstrate what messages nuclear power plants “proactively” attempt to disseminate.

Chapter 4 will employ experiments to examine what happens if nuclear power plants proactively initiate emergency preparedness communication. The experiments will pay special attention to the perceptions of trust and emotions toward the operator of a nuclear power plant. This chapter will show how people’s perceptions of trust and emotions toward a nuclear plant change when they receive emergency preparedness information. Then, this chapter will demonstrate how these perceptions of trust and emotions influence people’s willingness to accept a nuclear plant at local and general levels. Specifically, this chapter focuses on whether people are willing to accept a nuclear power plant within their community and whether they are willing to do so somewhere else in the country. By distinguishing between local and general acceptance, this chapter discusses driving factors and different effects of emergency preparedness communication on supportive attitudes toward a nuclear plant at each level.

The last chapter integrates the findings and discussion from Chapter 3 (content analysis) and Chapter 4 (experiments) to generate holistic discussion on emergency preparedness communication. The chapter concludes with a summary of this dissertation’s academic contributions, as well as provides the practical implications of emergency preparedness communication.

This dissertation is one of the first scholarly attempts to investigate the current status of emergency preparedness communication and the effects of proactively disclosing accident risks

and emergency response plans on people's perceptions and attitudes toward the communicator in risk-generating organizations. This dissertation should be considered a cornerstone of research, that not only argues for the necessities of emergency preparedness communication, but also the advantages or disadvantages of proactively disclosing accident risks and emergency response plans to achieve public acceptance of risk-generating facilities. This dissertation suggests that conducting honest and transparent public communication on accident risks and emergency response plans is important not only on ethical grounds, but also as a strategic method to achieve favorable public attitudes toward risk-generating facilities within their community.

## **Chapter 2 Background, Extended Literature Review, and Methodology**

As seen in the Fukushima case, the absence of emergency preparedness communication in the pre-crisis phase deteriorates the harm of the accident during and even after a crisis. There seem to be various obstacles to implementing effective pre-crisis communication on emergency response planning and preparedness. This extended literature review discusses the need for and challenges of such emergency preparedness communication. This chapter first provides a snapshot of the civic use of nuclear energy in the United States. Then, this chapter points out three layers of justifications as to why emergency preparedness communication needs to be conducted. This chapter concludes by arguing why emergency preparedness communication is difficult to implement.

### **Background**

#### **Overview of the Use of Nuclear Power in the United States**

The United States has maintained a strong interest in developing and employing nuclear power technology for military and commercial use since the Manhattan project during World War II. Since the country's first commercial nuclear power plant, the Shippingport Atomic Power station went into service in 1957, the country has promoted its use of nuclear power for electricity generation. In 1980, the country relied on nuclear energy for only 11% of the net generation. In 1995, nuclear energy generated 673 billion kWh, which accounted for 20% of the total electricity generated in the United States (U.S. Energy Information Administration [EIA], 2017). Since then, the country has depended on nuclear energy for approximately 20% of electricity generation. In 2016, nuclear energy generated 805 billion kWh, which again, accounted for approximately 20 % of the total generated electricity in the United States (EIA, 2017). Regarding other sources, 34% of electricity came from natural gas-fired power plants,

30 % from coal, 5.5% from hydro, and another 5.5% from wind power stations, making nuclear energy the third-largest energy source for the electricity generation in the country (EIA, 2017). Currently, the U.S. is the largest nuclear power supplier in the world, generating about 30% of the world's nuclear electricity (World Nuclear Association, 2017b).

As of June 2017, there were 99 licensed commercial nuclear power reactors at 60 sites across 30 states (NRC, 2017a). Of those, 35 sites have two or more reactors. Until the launch of the Unit 2 reactor at Watts Bar Nuclear Generating Station in Tennessee in 2016, no new nuclear reactors were constructed in the country in over 20 years. Applications for building 7 new reactors at 4 existing sites were submitted to the Nuclear Regulatory Commission (NRC) and were in the process of review as of April 2017 (NRC, 2017a). However, between October 2012 and June 2016, 14 reactors at 11 sites have closed or announced plans for closure (Larson, 2016). As the numbers of nuclear reactors decreased, the average capacity factor of nuclear energy has risen since 1975. It rose from 55% in 1975 to 67 % in 1990, and surpassed 90% in 2002. Since 2002, the capacity factor has remained high (about 90%). In 2016, the factor reached 92.5% (EIA, 2017).

### **The Roles of the U.S. Department of Energy (DOE)**

Commercial nuclear power plants in the United States are owned and operated by private or public utility companies. All of the power plants are subject to the supervision and regulation of the NRC, the Federal Emergency Management Agency (FEMA), the U.S. Department of Energy (DOE), and other governmental agencies.

In the United States, the Office of Nuclear Energy within the DOE runs the majority of federal research programs on nuclear energy. One of the aims of the office is to promote research at national laboratories to develop next-generation nuclear reactors and advanced fuel-cycle

technologies. The office also supports schemes for government-private partnerships for constructing and operating nuclear reactors (Office of Nuclear Energy, n.d.). The DOE's role includes supporting and advancing other energy-related technologies such as fossil and hydro fuels, as well as alternative and renewable energy sources including wind and solar (DOE, n.d.).

The DOE was established in the midst of the energy crisis in 1977 due to a strong demand for overseeing energy issues holistically rather than individually (Sylves, 1984a). The DOE assumed roles and projects formally implemented by the Atomic Energy Commission (AEC), which had assumed the legacies of the World War II Manhattan Project in 1946, the Energy Research and Development Administration (ERDA) in 1976, and other agencies. By integrating projects dispersed across agencies into a single Cabinet-level department, DOE aimed to achieve simpler and more efficient management of nuclear policy (Sylves, 1984a).

### **Nuclear Regulatory Commission (NRC)**

The U.S. Nuclear Regulatory Commission (NRC) was formed in 1975 and assumed the regulatory power of AEC. Before the formation of NRC, AEC was expected to play roles in both promoting and regulating the civilian use of nuclear energy, although AEC's mission had placed more focus on the promoting aspects, licensing, building and operating nuclear power plants (Sylves, 1984a, 1984b).

NRC is primarily responsible for issuing and reviewing operation licenses to commercial nuclear power facilities. The commission has the authority to take action, including shutting down nuclear reactors that it judges as incapable of assuring public safety. NRC also takes the lead in reviewing and assessing the onsite (within nuclear power stations) emergency response planning and overall emergency preparedness. The U.S. Federal government requires "reasonable assurance that adequate protective measures can and will be taken in the event of a

radiological emergency" (Emergency Plans, 2013) to all commercial nuclear power plants in the country. At NRC, emergency preparedness is defined as an action taken to prepare for emergencies before they occur "to simplify decision making during emergencies" (NRC, 2016, n.p.). In doing so, the governmental agencies will be able to "rapidly identify, evaluate, and react to a wide spectrum of emergency conditions" (NRC, 2016, n.p.).

For planning purposes, NRC sets two distinct emergency planning zones (EPZs) around nuclear power plants (NRC, 2014). The first EPZ expands 10 miles in radius around a nuclear power plant, called "the plume exposure pathway EPZ." In the case of a serious nuclear accident, people within this EPZ may be exposed to the dangers of inhaling and direct exposure to radioactive materials from a nuclear reactor. The second EPZ, the ingestion exposure pathway EPZ, is an area within a 50-mile radius from a nuclear power plant. This EPZ is designed to reduce the risks of the public's ingestion of food and water contaminated by radioactive particles from a crippled nuclear reactor. Food and water in this EPZ will be monitored and tested in the event of a nuclear accident.

NRC also classifies nuclear incidents and accidents based on their severity and impacts on the public (NRC, 2014). Whenever incidents or accidents occur at nuclear power plants, NRC issues a notification or a warning by employing their Emergency Classification scale. When any abnormal symptoms that may degrade the safety level of the plant are detected, but without any releases of radioactive materials, NRC issues Notification of Unusual Event (NOUE). In the case that the unusual events entail any radiological material releases, the classification is elevated to Alert or a more severe classification, Site Area Emergency (SAE) or General Emergency (GE). The declaration of SAE suggests that emergency response centers are staffed to monitor the event and are prepared for off-site evaluation in case the situation is exacerbated. When the event

involves core melting or loss of reactor control, GE is declared. The GE declaration initiates predetermined emergency response procedures for the general public outside the nuclear power plant, including instructions of large-scale off-site evaluation, sheltering, and the prophylactic use of Potassium Iodide (KI). By introducing the Emergency Classification scheme, NRC requires nuclear plant operators to continuously assess unusual events and provide updates on the event to the off-site emergency managers in the state, local authorities, and to the public.

### **Federal Emergency Management Agency (FEMA)**

Before the Three Mile Island (TMI) nuclear power plant accident in 1979, NRC encouraged, but did not require, states and local governments to prepare emergency response plans in the case of a nuclear disaster. According to Sylves (1984a, b), off-site (outside-nuclear power station) planning was intentionally left undiscussed because both nuclear proponents and opponents agreed that it was unnecessary, and even harmful to prepare offsite contingency plans. Pro-nuclear communities argued that it was unlikely for U.S. nuclear power stations to occur large-scale nuclear accidents involving evacuation of the neighborhood communities. Therefore, these communities assumed that such emergency planning and preparedness commutation would evoke unnecessary anxiety among the public. On the other hand, nuclear opponents believed that off-site planning was not realistic because when a nuclear accident occurs people would not follow the government or nuclear power plant operators' instructions or directions (Sylves, 1984a). Some anti-nuclear communities also claimed that emergency response planning was only a placebo because it merely forged a false sense of confidence in nuclear plants without promising absolute safety (Mitchell, 1981).

Sylves (1984b) demonstrated that the U.S. Congress also purposefully adopted an indifferent stance toward involvement of state and local authorities in off-site emergency

planning. Specifically, Sylves (1984b) argued that Congress feared that anti-nuclear state and local governments would use the opportunity to delay or even block proposed nuclear projects by refusing to prepare emergency plans required for licensing the facilities. Reflecting such opposition from the public and Congress, off-site nuclear emergency planning and communication remained a voluntary decision for state and local actors.

The TMI accident drastically changed the situations surrounding off-site nuclear emergency preparedness and communication. Accident investigation reports, including the *Rogovin Report* (NRC, 1979) and the *Kemeny Report* (U.S. President's Commission on the Accident at Three Mile Island, 1979), showed that although some of state and local governments had voluntarily developed nuclear emergency plans, most of them were considered unfeasible during actual accidents because they lacked information and enough input from nuclear power plants. In many cases, local authorities did not know that their jurisdictions would be affected by a nearby nuclear accident.

The TMI accident and its investigation reports brought public and political attention to off-site emergency response planning and preparedness for nuclear power plants. People started to ask what kinds of emergency response plans and preparedness were in place at their state and local governments, as well as at nearby nuclear power facilities. Off-site emergency planning became a topical issue across all levels of government (Sylves, 1984b). President Carter issued an executive order to assign the lead role of off-site nuclear emergency planning and response to the Federal Emergency Management Agency (FEMA) in December 1979, based on the recommendations made by the aforementioned Kemeny Committee. Since then, responsibilities for reviewing nuclear power plants' emergency response planning and preparedness have been

divided between FEMA and the NRC: the FEMA takes a lead in evaluating off-site emergency preparedness and response planning while NRC oversees on-site plans.

FEMA and NRC regulations are intended to minimize the adverse effects of nuclear accidents and prevent unnecessary radiation exposure to the public. In the case of a nuclear emergency, the operator of the nuclear power station is expected to evaluate the condition of the reactor according to NRC's Emergency Classification and provide necessary information and response recommendations for the state and local authorities. The state or local governments have primary responsibility in implementing necessary actions to protect the public, including announcing the accidents, instructing sheltering or evaluation, and providing information on the KI intake to protect the thyroid gland from radioactive iodine.

### **Extended Literature Review**

#### **Why Does Emergency Preparedness Communication Need to Be Conducted?**

There are at least three primary reasons why nuclear power plants need to inform the public of emergency response planning and preparedness. First, nuclear plants have to do so to achieve permission to operate a plant because of laws and regulations. Second, nuclear plants have an ethical obligation to inform local residents about accident risks and emergency response plans, as a socially responsible entity. Third, nuclear plants can disclose risks and response plans as part of their strategic communication efforts. This dissertation proposes these three reasons as levels of justification. This section will explain each level in detail and discuss why this study will focus on the third level.

**1. Governmental regulations and legal requirements.** Why do nuclear power plants need to communicate about accident risks and emergency response planning with the public? The first reason why nuclear power plants must communicate about accident risks and

emergency response planning with the public is governmental regulations and legal requirements. Generally, governmental agencies heavily regulate and control nuclear power plants (World Nuclear Association, n.d.). For example, in the United States the NRC grants licensing to and regularly reviews all commercial nuclear power stations. The NRC takes the lead in reviewing the onsite emergency preparedness and overall emergency response planning. Working in tandem with NRC, FEMA holds responsibility for evaluating off-site emergency preparedness and response planning of nuclear power plants. FEMA's requirements include disseminating emergency preparedness information to the local residents (NRC, 2014).

U.S. nuclear power plants are also required to demonstrate that their emergency response plans are actionable and tested on a regular basis. As part of the Reactor Oversight Process, the NRC evaluates nuclear power plants' emergency response planning and training with the local residents. Licensees must test their emergency plan with off-site authorities at least once every two years. The NRC inspects these exercises and FEMA assessed the exercises. The results of the NRC and FEMA evaluations are posted on the NRC website and made open to the public.

In addition to NRC's and FEMA's regulations and guidelines, nuclear power plants in the United States must comply with the requirements outlined under the Emergency Planning and Community Right-to-Know Act (EPCRA), the Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 (Pub. L. 99-499) (NRC, 2014). The act aims to help make the public aware of potential chemical hazards from nearby risk-generating facilities and guarantees access to information on hazardous materials at the facilities and their uses and releases into the off-site environment. EPCRA also mandates the formation of local emergency planning committees (LEPCs) in the areas near risk-generating facilities. LEPCs are responsible

for emergency response planning and are expected to function as a community forum for emergency preparedness (U.S. Environmental Protection Agency [EPA], 2015).

**2. Ethical concerns.** The second reason for the need for emergency preparedness communication arises from ethical concerns. This justification related to ethics can be further divided into the following two arguments: (1) emergency preparedness communication bolsters community resilience to a disaster, and (2) information on emergency planning provides the public with the power to monitor risk-generating facilities.

***Bolster community resilience to disasters.*** Accidents entail economic and health damage. However, if people have sufficient knowledge of and preparation for the accident, the harm may be minimized. Therefore, emergency preparedness communication needs to be conducted to save people's lives and alleviate damage from an accident. This line of justification for emergency preparedness communication is based on ethical concerns. As seen in the Fukushima case, the lack of information of emergency response planning and preparedness triggered communication confusion among the public and the officials. It also deteriorated damage from an accident during and even after the crisis (Tateno & Yokoyama, 2013).

Scholars have long discussed that pre-crisis planning and communication is prerequisite for effective emergency management. Information on emergency response planning and preparedness makes it possible for ordinary citizens to take actions to reduce accident risks and mitigate damage from a possible emergency situation (Coppola & Maloney, 2009; Haddow & Haddow, 2014). Seeger (2006) observed the benefits of pre-crisis planning and communication in its functions of identifying risks, corresponding risk reduction, and pre-setting crisis responses. Seeger (2006) also addressed that pre-crisis communication is key to the best practice of crisis communication. Mitroff (1986), a pioneer of risk and crisis research, argued for the need

for organizational pre-crisis planning and emergency preparedness communication to achieve efficient decision-making processes during emergencies, identify necessary recourses to save the public, and allow for proactive responses to various crises.

Some studies have discussed the effect of pre-crisis communication on community resilience. A RAND report sponsored by the U.S. Department of Health and Human Services (Chandra et al., 2011) pointed out that effective pre-crisis communication is essential to community resilience because it equips the public with necessary information on risks and possible actions to help mitigate the harm. Norris and colleagues (2008) also noted that pre-crisis communication enhances the public knowledge and their adaptive capability; hence pre-crisis communication bolsters the public's ability to cope with disasters. Effective risk communication is essential to resilience because it provides ordinary citizens with accurate information on dangers and behavioral options for mitigation (Andrulis, Siddiqui, & Gantner, 2007). Therefore, risk-generating facilities such as nuclear power plants need to engage in emergency preparedness communication.

***Empower the public.*** Scholars have also argued that open and transparent communication on accident risks and emergency planning provides the power to monitor risk-generating facilities to the public: Consequently, such information provision would contribute to preventing serious accidents and hazards (Hadden, 1989). In fact, in regard to EPCRA, EPA (1997), which holds the lead role in enforcing the act, stated that one of the objectives of the act is “empowering the public with information helps assure [industry] compliance with existing laws and encourages companies to take additional measures to reduce industrial chemical releases” (n.p.). Lewis (2005) also claimed that the community-right-to-know is not only a legal

requirement, but also a moral duty, because open access to quality information can prevent emergencies and help democratic decision-making on selecting sites for hazardous facilities.

From ethical perspectives, emergency preparedness communication is required. Nuclear power plants should proactively inform the public about accident risks and emergency response plans to save people from possible nuclear disasters. Nonetheless, by sharing information about accident risks and response plans with the public, nuclear power plants should expect public scrutiny. The question then remains: what are the benefits for risk-generating facilities to inform the public about accident risks and emergency response plans? The third justification for emergency preparedness communication may provide an answer.

**3. Strategic communication perspectives.** Risk-generating facilities, such as nuclear power plants, should proactively initiate emergency preparedness communication at the pre-crisis stage to (1) diminish unnecessary fear, (2) gain the public's trust, and (3) achieve favorable attitudes toward the operation. This is the third justification for emergency preparedness communication.

***Diminish fear.*** As past studies have shown (e.g. Palenchar & Heath, 2002; Renn & Levine, 1991), disclosing risks tends to decrease people's negative feelings because such information reduces uncertainty. Uncertainty reduction happens only when the communicator can assure that the disclosed risks can be properly managed (Alfidi, 1979; Fischhoff, 1983; Weinstein, 1979). In the context of public acceptance of chemical facilities, Palenchar, Heath and Dunn (2005) found that people's fear of possible accidents such as terrorist attacks significantly reduced when facility operators informed the public that the facility used toxic chemicals and that they had emergency response plans in place.

However, scholars have remained uncertain whether the feeling of fear should be diminished. Heath and Palenchar (2000) criticized that past risk communication studies have focused too heavily on relieving the public's negative feelings, such as fear and anxiety. Fear and anxiety are "negative" emotions; however, they also make the public vigilant and alert to their environment (Sandman, 2003b, 2006; Otway & Wynne, 1989). The absence of negative emotions might lead to a false feeling of security that risks do not exist (Heath & Palenchar, 2000), as seen with the Fukushima "safety myth."

***Enhance trust.*** Along with reduced negative emotions, scholars have also discussed that enhanced trust is a consequence of disclosing the presence of risks and emergency response plans. Numerous research and policy documents have demonstrated that sharing risk assessment and management processes with the public for their scrutiny and involvement is the best way to retain the public's trust and confidence (e.g. ESRC Global Environmental Change, 2000; Glicken, 2000; Irwin, 1995; Jones, 2002; Owens, 2000; Palenchar & Heath, 2002; Renn & Levine, 1991). Covello (1992) proposed that the public's trust in the chemical industry would increase if chemical plants "built up track records of dealing openly, fairly, and safely with their employees, customers, and neighboring communities" (p. 362) by proactively disclosing risk and emergency preparedness information. People tend to trust the industry more when it proactively provides solutions to risks than when it downplays them (Heath & Abel, 1996a).

Norris and colleagues (2008) argued that trust acquired through effective pre-crisis communication overcomes distrust at the time of an emergency. As a result, according to Norris and colleagues (2008), people who receive information on accident risks and emergency response plans prior to an accident are more likely to follow instructions and directions during an accident, than those who do not receive information on emergency preparedness. Trust toward

organizations influences people's behavior not only at the pre-crisis stage, but also throughout crisis phases.

As will be fully explained in Chapter 4 in this dissertation, trust has become a key concept in risk and crisis communication, yet no consensus has been established regarding its definition. Moreover, scholars have appeared to agree that trust is a concept with multidimensionality (Earle, Siegrist, & Gutscher, 2007). However, no agreement exists on how many and what elements comprise the trust concepts. Prior studies have not discussed what elements of trust are affected by proactive disclosure of risk and emergency preparedness information.

***Forge public acceptability of risks.*** Past studies have shown that such trust would contribute to favorable attitudes toward the communicator. Chess (2001) discussed that risk communication was one of the means to decrease uncertainty and increase legitimacy of risky activities and facilities. A lack of strategic pre-crisis communication may cause public feelings of distrust, which could lead to their oppositional attitudes.

Research has also demonstrated that self-disclosing risks leads to enhanced public trust and supportive attitudes toward the organization, especially when the organization explains that competent professionals can manage the risks (De Vocht, Claeys, Cauberghe, Uyttendaele, & Sas, 2016; Fischhoff, 1983; Heath & Palenchar, 2000; Renn, & Levine, 1991). Even in a case of uncontrollable risks such as terrorism, when residents were informed of a chemical industry's emergency response planning and efforts, residents demonstrated a higher level of trust toward the industry and government officials. Residents also showed more supportive attitudes toward the operation of the chemical facilities in their community (Palenchar, Heath, & Orberton, 2005). Studies on proactive disclosure of risk and emergency information have generally yielded similar

results. Proactive disclosure of risks tends to increase the public's favorable attitudes toward the organization (e.g. Farchi & Gidron, 2010; Wigley & Pfau, 2010).

Through a longitudinal study on public acceptance of hazardous chemical facilities, Heath and Abel (1996) and Palenchar and Heath (2002) found that the lay public desires to not only be informed of but also be a part of the risk communication process and emergency response planning. When the industry was not responsive to such needs, people were likely to oppose risk-generating chemical facilities. In contrast, residents who had more knowledge of the industry's safety efforts tended to participate in such emergency response planning; felt more trust toward the chemical facilities; and governmental officials, and showed more supportive attitudes toward the chemical industry. Chapter 4 of this dissertation further discusses this link between emergency preparedness communication, trust, and acceptability, in the context of nuclear power plants.

### **The Difficulties of Implementing Emergency Preparedness Communication**

The previous section examined the needs for emergency preparedness communication from three viewpoints. It seems obvious that emergency preparedness communication is important and necessary for the public and risk-generating facilities such as nuclear power plants. However, studies (Gouldson, Lidskog, & Wester-Herber, 2007; Sandman 2003a, 2003b, 2006; Sjöberg 1998) have demonstrated that organizations, especially privately-held companies, tend to face challenges when proactively disclosing accident risks and emergency response planning to the public, as seen in the case of the operator of the Fukushima nuclear power plant. This section discusses why conducting emergency preparedness communication is difficult for organizations, from psychological and societal perspectives.

**Normalcy and optimistic biases.** First, one of the factors that make emergency preparedness communication challenging can be found in psychological biases that human beings hold by nature. In general, people are prone to underestimate or ignore the possibility of unusual events that would interrupt their daily lives and routines. This mental tendency is called a “normalcy bias” (Drabek, 1986). Typical examples of this normalcy bias are people’s belief that disasters “can’t happen to us” or “life will be unchanged, even after a disaster” (Valentine & Smith, 2002, p. 186). People in a crisis tend to misinterpret that their situation is safe and secure especially at the initial stage, because they cannot recognize the existence of danger or a threatening condition (Aguirre, 2005; Kuligowski, & Gwynne, 2010; Quarantelli, 1991). Valentine and Smith (2002) have argued that the normalcy bias is one of the reasons that the authorities fail to develop emergency response plans and take preparation measures with the public.

Even when people perceive risks of a dangerous event, they are unlikely to think that it would occur to them. People tend to believe that they will enjoy a greater likelihood of positive events and have a lesser possibility of negative events happening to them than to others. Weinstein (1989) named this unrealistic optimism as “optimistic bias” and many studies have analyzed this bias in the context of risk perceptions (e.g. Gurmankin, Baron, & Armstrong, 2004; Salmon, Park, & Wrigley, 2003).

Research also has found that not only is the lay public susceptible to this optimistic bias, but also experts, such as scientists. Scientists tend to be overly confident and optimistic about their studies and technologies (Hansson & Bryngelsson, 2009). As a result, they overlook the possibility that their research could cause problems to society and downplay the social issues and risks associated with their work. (Hultman & Koomey, 2007; Tichy, 2004; Utgikar & Scott,

2006). Salmon and colleagues (2003) also demonstrated that corporations are likely to be influenced by similar optimistic bias. In the context of bioterrorism, they argued that optimistic bias contributed to creating a false sense of security in organizations, and consequently this led to a lack of awareness of and preparedness for bioterrorism risks.

**Fear of fear.** The second factor that makes emergency preparedness communication challenging is organizations' general assumption that risk-related information may cause negative reactions from the public. Even when organizations overcome normalcy and optimistic biases and recognize serious risks in their activities and facilities, they tend to be unwilling to share the information with the public because organizations tend to underestimate the public's capability to handle risk information. In contrast to the normalcy bias, Omer and Alon (1994) posited the idea of an organizational "abnormalcy bias", which explained organizations' tendency not to disclose risk information on the grounds that the lay public could not properly manage fear of a possible disaster. Organizations affected by this abnormalcy bias expect that mismanaged public fear could lead to undesirable behavioral responses such as panic, looting, or opposing the operation of a risk-generating facility.

Planning for and communicating about emergency response planning implies, by definition, that organizations admit any possibilities of such emergency situations, or accident risks at their facilities. Studies have shown that organizations tend to be hesitant to disclose risk-related information because of fear of evoking negative feelings among the public (Sandman, 2003a, 2006; Sjöberg, 1998). Siegrist, Gutscher, and Keller (2007) noted that risk and crisis communicators often face a dilemma that hiding information from the public could lead to a loss of credibility and trust, but providing comprehensive risk information could also trigger unnecessary fear and anxiety among the public.

At the 2011 Fukushima nuclear disaster, numerous accident investigations (e.g. AESJ, 2015; Independent Investigation Commission on the Fukushima Nuclear Accident, 2014; IAEA, 2015; NAIIC, 2012) reported a lack of prior information on emergency response plans and preparedness. They claimed that the lack of prior information on emergency response plans was a result of both the Japanese government's and electric power companies' heavy reliance on a "safety myth". This safety myth sorely emphasized the benefits and absolute safeness of nuclear power without addressing any accident risks or emergency response plans. The government and the nuclear plant operators did not wish to arouse negative public feelings because they assumed such feelings could cause anti-nuclear attitudes and become an obstacle to promote nuclear energy in the country (Independent Investigation Commission on the Fukushima Nuclear Accident, 2014).

**Low political, media, and public, interests.** Low societal interests in emergency response planning also make pre-crisis communication difficult. As observed in the political situation in the United States before the TMI accident, emergency preparedness hardly attracted political attention. Planning and discussing off-site emergency planning was a topic that policymakers purposefully avoided. In the Fukushima case, politicians and government officials responsible for regulating the nuclear industry exerted little influences to force the plant operators to prepare for nuclear emergencies. Emergency preparedness was not a topic of interest and proposing the need for off-site nuclear emergency planning was not considered an issue that would garner support from constituents (NAIIC, 2012).

The news media seldom regard emergency planning and preparedness as newsworthy. Barnes and colleagues (2008) noted that news articles related to a disaster tend to focus on government efforts toward response and recovery rather than mitigation or preparation. A

preliminary study on news coverage of nuclear emergency preparedness also revealed that local news media near nuclear stations barely reported on emergency planning and preparedness (Chavez & Oshita, 2014), despite NRC and FEMA's joint licensing criteria that requires nuclear plant operators to arrange a media briefing event at least once a year to share information on nuclear risks and emergency response plans (NRC & FEMA, 1988, p.51).

The public do not show a strong interest in both emergency response planning and preparedness. Studies (e.g. Paton, 2008; Zwolinski, Stanbury, & Manente, 2012) on the effects of emergency preparedness communication on people's adaptation of risk-mitigating behaviors have illustrated that people tend not to pay attention to such pre-crisis messages and seldom adopt protective measures toward possible hazards (Paton, 2003; 2008). In the case of preparedness against accidents in local nuclear power plants, Zwolinski and colleagues (2012) have observed that although two thirds of residents within 10 miles of a nuclear power plant (the plume exposure pathway EPZ) realized that they lived near a nuclear power plant, about one half of the respondents did "nothing" to prepare for possible nuclear accidents. Furthermore, only one third of the total sample correctly answered how to respond to hearing a three-minute civil defense siren (Zwolinski, et al., 2012). Adalja and colleagues (2014) also found a prevailing misunderstanding on the KI (Potassium Iodide) intake among the local residents, despite nuclear plant operator and local authorities providing pre-crisis communication efforts.

This dissertation does not pursue this point further, yet the author acknowledges that the lack of societal interest in emergency response planning and preparedness is one of the most important problems to be addressed and solved in emergency preparedness communication. Paton (2008) reviewed past ineffective risk communication activities and argued that placing efforts on constructing risk messages was not sufficient to motivate the public to adopt risk-

mitigation behaviors. Instead, Paton (2008) discussed that risk communicators should take consideration of the relationship between the organization and the public. According to Paton (2008), trust toward the organizations responsible for regulating and managing risks is a crucial predictor of the public's intentions to follow emergency response plans and take preparedness measures against a possible disaster. Trust is regarded as key to maintain social cohesion and save the public from hazards of possible accidents.

This chapter illustrated situations and overviews regarding nuclear power generation in the United States. Then, it demonstrated why organizations need to engage in emergency preparedness communication in the contexts of legal and regulatory requirements, ethical concerns, and strategic communication strategic perspectives. Although it is obvious that emergency preparedness communication is necessary for the public as well as organizations, conducting such communication tends to face numerous challenges, such as psychological biases, organizational tendency to fear the public, and low societal interest in emergency preparedness. The next chapter examines the status of emergency preparedness communication by nuclear power plants in the United States, by analyzing what information U.S. nuclear power plants proactively communicate with the public. The question remains: do U.S. nuclear power plants provide the public with information on emergency response plans and preparedness?

### **Methodology**

To explore the current status and the effects of emergency preparedness communication in the U.S. nuclear power context, this dissertation employs a mixed method, combining content analysis (Chapter 3) and experiments (Chapter 4). While details will be elaborated in each chapter, this section briefly describes the methodology employed in this dissertation.

First, the next chapter (Chapter 3) is devoted to a content analysis as a methodology to scrutinize the current situation of emergency preparedness communication at nuclear power plants in the United States. This dissertation specifically focused focusing on websites as communication channels, where unlike paper-based materials, plant operators can take a proactive lead in deciding the content. Overall, this dissertation analyzed how voluntarily nuclear plant operators disseminate information on emergency preparedness and what messages they proactively try to communicate with the public. In this study, two coders were hired and asked to code all web pages hosted by U.S. nuclear plant operators using a coding sheet. The coding items included whether the coders were able to find an emergency preparedness brochure or booklet and whether they were also able to identify the following key information: past accident, accident prevention measures, benefits of nuclear power, and emergency preparedness, on the plants' websites.

The following chapter (Chapter 4) adopts experiments using an online questionnaire as a method to examine the effects of emergency preparedness communication on people's attitudes toward a nuclear power plant. This study employed a between-subject design and tested three fictional messages: general information (condition 1), emergency preparedness communication (condition 2), and benefit-emphasis communication (condition 3). The focus of analysis was placed on the comparison between condition 1 and 2, and condition 3 was prepared to confirm the analysis. This study retrieved 552 usable responses in total using an online sample pool. This study primarily examined the messages' effects on people's attitudes regarding accepting a nuclear power plant somewhere in the country and within their community, presuming that their perceptions of trust and emotions toward the nuclear plant would mediate the effects. This dissertation employed a moderated mediation model as an analysis framework.

### **Chapter 3 Content Analysis: The Current Status of Online Information Provision and Emergency Preparedness Communication by Nuclear Power Plants in the United States**

This chapter is devoted to discussing the current status of nuclear power plants' use of proactive emergency preparedness communication in the United States. As seen in the previous chapter, emergency preparedness communication is considered crucial in preventing nuclear accidents, alleviating damage from nuclear disasters, and enhancing public trust. However, numerous studies have highlighted the difficulties in conducting emergency preparedness communication.

This chapter analyzes what messages U.S. nuclear power plants proactively deliver. Specifically, this chapter discusses how U.S. nuclear power plants conduct emergency preparedness communication. As far as the author is aware, no academic studies or practical surveys exist that focus on nuclear plants' communication on accident risks and emergency response plans.

#### **Background**

As briefly illustrated, NRC has authority to make final decisions on licensing commercial nuclear power reactors in the United States. While FEMA holds primary responsibility to assess off-site emergency preparedness of nuclear power plants, NRC reviews both on-site and off-site emergency response planning and preparedness for licensing purposes. Federal regulations (Emergency Plans, 2013) provide sixteen evaluation points on emergency planning that NRC and FEMA use in licensing inspection. One of the evaluation points specifically addresses the aspect of emergency preparedness communication as follows:

Information is made available to the public on a periodic basis on how they will be notified and what their initial actions should be in an emergency (e.g., listening to a local broadcast station and remaining indoors), the principal points of contact with the news media for dissemination of information during an emergency (including the physical location or locations) are established in advance, and procedures for coordinated dissemination of information to the public are established. (CFR § 50.47(b) (7))

A joint document with NRC and FEMA, NUREG-0654 FEMA-REP-1 Rev 1. titled “Criteria for preparation and evaluation of radiological emergency response plan and preparedness in support of nuclear power plants” defined this requirement with five detailed assessment criteria (NRC & FEMA, 1988). Specifically, the Section G. “Public Education and Information” in the Chapter II Planning standards and Evaluation Criteria explains the possible methods of emergency preparedness communication as “Means for accomplishing this dissemination may include, but are not necessarily limited to: Information in the telephone book; periodic information in utility bills; posting in public areas; and publications distributed on an annual basis.” (p.49)

Since the criteria were established in 1988, no changes or additions have been made in terms of the recommended channels for information dissemination, as of June 2017. On this point, Adalja and colleagues (2014) found that emergency managers struggled to update their communication methods to fit digital media, such as websites and social media, because NRC and FEMA’s evaluation criteria merely requires annual dissemination of information using traditional media. Digital forms of communication are not included as suggested channels; therefore, communication efforts using new media are not considered as activities that fulfill the NRC and FEMA’s criteria. With their limited budget, emergency preparedness officers consider

unrewarding to disseminate emergency preparedness information using digital media although they recognize that web-based communication tools would allow them to reach a wider population (Adalja, et al., 2014).

This study pays special attention to nuclear power plants' communication efforts on their websites for the following reasons. First, as described, NRC and FEMA's criteria for evaluating nuclear plant operators' off-site emergency planning and preparedness only considers communication materials in paper format. All commercial nuclear power plants in the United States must prepare and distribute communication materials on emergency preparedness in the form of a pamphlet or a calendar to local residents living in a 10-mile distance from nuclear stations. However, as of June 2017, there were no requirements or recommendations on communicating emergency preparedness using websites to reach a wider public. By examining how nuclear plant operators take a proactive step to initiate emergency preparedness communication, specifically by placing the emergency information on their website, this analysis is able to address how much nuclear plant operators are willing to share information on emergency preparedness with the public.

Second, websites are considered as the important "first foray into the new way of reaching an audience" for the nuclear industry and regulatory bodies (OECD, 2014, p.17) because they function as the "foundation for all computer-mediated communication" (ibid). NRC has also stressed the importance of online media and has explicitly encouraged nuclear power operators to use online media to communicate with the public. Online communication tools, including websites, have gathered strong attention from the nuclear industry and regulators (FEMA, 2013; NRC, 2017b).

However, a preliminary study (Chavez & Oshita, 2014) has showed that nuclear power plants in Michigan barely communicated about nuclear risks and emergency preparedness with the public on their websites. This study expands this study in Michigan US nuclear power stations' use of websites for emergency preparedness communication.

### **Research Questions**

This study explores the current status of emergency preparedness communication in the context of nuclear power plants in the United States, by examining the following three research questions. The first question aims to provide an overview of nuclear power plants' use of websites and examine whether the power plants use the media as “a foundation of all computer-mediated communication” (OECD, 2014, p. 17).

***RQ1.** How do U.S. nuclear power plants use websites as a communication channel?*

The second question intends to capture U.S. nuclear power plants' use of websites as means to deliver their messages.

***RQ2.** What messages do U.S. nuclear power plants deliver to the public on the websites?*

Then, the last question focuses on how proactively nuclear plant operators conduct emergency preparedness communication on their websites.

***RQ3.** How is information on emergency response planning and preparedness delivered on the websites by U.S. nuclear power plants?*

### **Methods**

Following a previous preliminary study (Chavez & Oshita, 2014), this study conducts a content analysis on the websites of nuclear power plants. This content analysis expands its scope from three commercial nuclear stations within the state of Michigan to 60 plants across the country. The unit of analysis is a website of a commercial nuclear power plant in the United

State. The coders analyzed all web pages that were linked from the top page and hosted under the same domain name. If a website contained a link to another page hosted by a different organization such as NRC, this study excluded the linked page from the analysis because information on such pages are not considered to be managed and provided by the nuclear plant operator. This study examined all 60 nuclear power stations in the United States. The list of the plant names is enclosed in Appendix A.

### **Coding Procedure**

This content analysis was conducted between February and March 2016, using two undergraduate students hired by the author's doctoral advisor as coders. The author and his advisor gave oral instructions on each coding item until the coders showed full understanding of all of the items. The coders used a coding sheet (Appendix B) to analyze each nuclear plant's website. The coders worked independently, but were allowed to ask questions about the concepts of coding items. Both coders analyzed all websites. The coders were monetarily compensated upon completion of the analysis.

This study analyzed websites of U.S. nuclear power plants using the following coding categories. First, the study reviewed nuclear power plants' online communication on their websites to answer RQ1. In particular, this analysis examined whether emergency preparedness booklets or guidebooks, which nuclear power plant operators were required to prepare for the local residents, were made obtainable from the websites. Information on emergency preparedness from the text on the webpages was separately coded in this analysis. Then, this content analysis investigated whether the website provided links to their social media accounts.

Second, this study analyzed what information nuclear power plants delivered on their websites to answer RQ2 and RQ3. This content analysis focused on whether and how the

following four aspects of information were communicated using the online communication channel: (1) past accidents, (2) accident prevention measures, (3) emergency response planning and preparedness; and (4) benefits of nuclear power, based on findings from a preliminary study (Chavez & Oshita, 2014).

The cornerstone of this analysis was the difference between (2) accident prevention measures and (3) emergency response planning and preparedness. In this study, the category of (2) accident prevention includes measures taken to confine a technical abnormality and other incidents within the plant and prevention of an accident (e.g. installing a system to detect technological failures, building a bank against a tsunami, and implementing training and drills for plant fire). On the other hand, (3) emergency response planning and preparedness refers to schemes and actions to be implemented in the case of an accident (e.g. emergency sirens, emergency radio stations, sheltering, and evacuating). In short, (2) accident prevention is related to measures taken before an accident, and (3) emergency preparedness refers to actions after an accident. This distinction corresponds to IAEA's five levels of protection concept in Defense-in-Depth in Nuclear Safety (INSAG-10) (IAEA, 1996). The concept defines the measures and procedures necessary to protect the citizens against nuclear failures during the five stages. For example, (2) Accident prevention in this analysis matches the first to forth levels at the Defense-in-Depth concept, defined as detecting, controlling, and confining an abnormality or an incident of the plant within the nuclear site. The fifth level of Defense-in-Depth refers to informing the public of a nuclear emergency and minimizing nuclear hazards at off-site communities. The last level, which refers to procedures *after* an accident happens, corresponds to (3) emergency preparedness in this analysis.

Each coding category has sub-coding items, which were developed in previous research (Chavez & Oshita, 2014). The (1) past accidents category includes (a) accidents within the plant, (b) the TMI nuclear accident, (c) the Chernobyl nuclear accident, (d) the Fukushima nuclear accident, and (e) other accident. (2) Accident prevention contains actions to prevent the following events: (a) technical failure, (b) human error, (c) intentional accident such as terrorism, and (d) natural disaster. In a similar vein, (5) emergency preparedness is classified by the type of measures: (a) siren, (b) evaluation plans, (c) emergency media, (d) KI (Potassium Iodide) distribution and intake, and (e) recovery plans. The (6) benefits of nuclear power, benefits for (a) the local community, (b) the environment, and (c) the economy were analyzed separately.

## **Results**

### **Inter-coder Reliability**

Table 1. shows inter-coder reliability for each coding item ( $N = 60$ ) after the coders finished coding the material in the first round. The results suggest that the agreements achieved in coding are not random. This allowed the researchers to use the coding data for further analyses. After examining this reliability test, disagreements found between coders were solved by the coordination of the author. The author also coded the materials as a third coder and determined which coding was reasonable.

**Table 1.** Inter-coder Reliability on Each Coding Item (N=60)

Coding item	Scott's Pi
Emergency preparedness booklets	1.00
Social media	.77
Past accidents	
Within the plant	1.00
TMI	1.00
Chernobyl	1.00
Fukushima	.97
Other	1.00
(combined)	.97
Accident prevention	
Technical failure	.93
Human error	.92
Intentional accident	1.00
Natural disaster	.97
(combined)	.97
Emergency Preparedness	
Siren	.96
Evacuation plans	.93
Emergency media	1.00
KI	1.00
Recovery plans	1.00
(combined)	.93
Benefits	
Local	.97
Environmental	.96
Economic	.97
(combined)	.94

## **Website as an Information Hub**

**RQ1** asked how U.S. nuclear power plants use websites as a communication channel.

The analysis showed that the coders found the PDF version of an emergency preparedness booklet on more than 75% (n = 46) of the websites. The coders also identified that about 90% (n = 53) of nuclear power plants provided links to their social media accounts, such as Facebook, Twitter, and LinkedIn on their websites. These findings suggest that U.S. nuclear plant operators attempt to use their website as a hub of information for the public by aggregating information in one place.

## **Messages on the Websites**

**RQ2** and **RQ3** were intended to explore what messages are delivered on the websites of U.S. nuclear power plants (**RQ2**); in particular, how information on emergency planning and preparedness is communicated on their websites (**RQ3**).

Table 2 describes information found on the websites of U.S. nuclear power plants. This content analysis most commonly observed information on the benefits of nuclear power generation. About 85% of nuclear plants mentioned local, environmental, or economic benefits of nuclear power on the websites. In particular, the plants emphasized the environmental benefits most frequently (76.7%), followed by economic (61.7%) and local benefits (55.0%).

The second-most observed information on the websites was accident prevention (58.3%). About 43% of the nuclear power plants placed information on their measures and activities against natural disasters on their websites. Plant operators' efforts in preventing technical failures were communicated on about 42% of the websites.

Less than a half (43.3%) of the websites mentioned past nuclear accidents. The most recent major nuclear accident, the Fukushima Daiichi nuclear power plant accident was

addressed by about 40 % of nuclear plants. Accidents such as TMI, Chernobyl or other minor incidents were barely described on their websites.

Among the categories that this content analysis employed, emergency preparedness was the least informed topic on the website. While the coders found the PDF version of emergency preparedness brochures on most of the nuclear power plant websites, only 40% of plants addressed emergency response planning and preparedness in the text on the websites. Among the emergency preparedness information, evacuation was the most observed topic (38.3%) followed by information on warning sirens (31.7%) and the emergency media (25.0%) that local authorities and plant operators would use to make an announcement to local residents in the case of an emergency. Information on distribution and intake of KI (Potassium Iodide) tablets was not common in website communications (18.3%). No nuclear power plants mentioned any recovery plans after an emergency on their websites.

**Table 2.** Observed Information on the Websites (N=60)

Item	n	%
Past accidents		
Within the plant	1	( 1.7% )
TMI	2	( 3.3% )
Chernobyl	1	( 1.7% )
Fukushima	24	( 40.0% )
Other	0	( 0.0% )
(Any of above)	26	( 43.3% )
Accident prevention		
Technical failure	25	( 41.7% )
Human error	20	( 33.3% )
Intentional accident	22	( 36.7% )
Natural disaster	26	( 43.3% )
(Any of above)	35	( 58.3% )
Emergency preparedness		
Siren	19	( 31.7% )
Evacuation plans	23	( 38.3% )
Emergency media	15	( 25.0% )
KI	11	( 18.3% )
Recovery plans	0	( 0.0% )
(Any of above)	24	( 40.0% )
Benefits		
Local	33	( 55.0% )
Environmental	46	( 76.7% )
Economic	37	( 61.7% )
(Any of above)	51	( 85.0% )

### Information Navigation

To further explore the RQs described earlier, particularly RQ1 and RQ3, this study examined where information on emergency response planning and preparedness was placed on the U.S. nuclear power plants' websites. In other words, this additional analysis investigated the accessibility of emergency preparedness information. This analysis measured how many pages, in the shortest manner, viewers need to browse before reaching emergency preparedness information. For example, if the emergency preparedness information is placed on the top page,

this analysis counted it as “1”. When there is a link to an emergency preparedness booklet in the PDF format on the top page, this study counted it as “2”, because the viewers need to move to the booklet page to retrieve the information. This analysis specifically compared the accessibility of emergency preparedness information with the most commonly communicated topic on the websites, benefit information.

Among the 60 websites this study analyzed, nuclear emergency preparedness information was observed on 47 websites, either in the PDF brochure and/or within the text page. On the other hand, 51 websites placed information on the benefits of nuclear energy. This study computed a one-way analysis of variance (ANOVA) comparing the numbers of pages that a viewer was required to browse before reaching emergency preparedness information or benefit information. A significant difference was observed between the types of information ( $F(1, 96) = 70.67, p < .001, \eta^2 = .42$ ). The analysis implied that to reach emergency preparedness information viewers needed to browse more pages ( $M = 2.15, SD = .75$ ) than when attempting to reach benefit information ( $M = 1.17, SD = .37$ ). The result of the ANOVA also illustrated that top (the first) pages of nuclear power plants’ websites usually contain information on the benefits of nuclear power, while information on emergency preparedness was placed on the second or following pages, in most cases.

### **Summary of Findings and Results**

The content analysis depicted the current status of nuclear power plants’ communication efforts, especially in providing the public with emergency preparedness information, on their websites. First, it appears that the majority of nuclear plant operators actively use their websites as their “information hub” by providing links to their social media accounts and emergency preparedness booklets in PDF format. Second, many nuclear plant operators place emergency

preparedness booklets online, yet they tend not to proactively address emergency response planning and preparedness as part of an explanation on their facilities. Third, nuclear power plants in the United States are more likely to focus on providing information on the benefits of nuclear power generation than on emergency response planning and preparedness in website communication. The benefit of nuclear power is not only the most commonly communicated topic, but also more emphasized than emergency preparedness because it is easier to navigate to the benefit information on their websites.

The operators of nuclear power plants may not attempt to “hide” emergency preparedness information; however, this content analysis showed that U.S. nuclear plants are not proactively sharing emergency preparedness information with the public. Nuclear plant operators use their website as a channel to inform the public of the benefits of nuclear power rather than communicate emergency preparedness of the facility.

## **Chapter 4 Experiments: The Effects of Emergency Preparedness Communication**

As discussed in Chapter 2, risk-generating facilities such as nuclear power plants are required and expected to initiate emergency preparedness communication for several reasons. However, as observed in the content analysis in Chapter 3, nuclear plant operators in the United States tend not to proactively conduct emergency preparedness communication on their websites: Instead, they seemingly prefer to promote the benefits of nuclear power.

This chapter will further explore the strategic communication perspective of emergency preparedness communication discussed in Chapter 2 and examine the effects of such pre-crisis communication by nuclear power plants. What would happen to the audiences' perceptions and attitudes toward nuclear power plants when they are exposed to information on emergency planning and preparedness from risk-generating facilities such as nuclear power plants? Would proactive disclosure of emergency information enhance public trust and create positive attitudes toward the communicator, as numerous studies have shown (e.g. De Vocht, Claeys, Cauberghe, Uyttendaele, & Sas, 2016; Farchi & Gidron, 2010; Fischhoff, 1983; Heath, & Palenchar, 2000; Palenchar, Heath, & Orberton, 2005; Renn, & Levine, 1991; Wigley & Pfau, 2010)? Or, as organizations often assume (Sandman, 2003a, 2003b, 2006; Siegrist, Gutscher, & Keller, 2007; Sjöberg, 1998), would communicating accident risks and emergency response plans lead to the loss of public trust and support? By using online experiments, this chapter will discuss how proactive disclosure of emergency response planning and preparedness influences public trust, emotions and attitudes toward acceptance of a new nuclear power plant.

## **Theoretical Framework and Development of Research Questions and Hypotheses**

The following section will explain the theoretical framework and develop research questions and hypotheses for experiments. Based on past literature (Guo & Ren, 2017), this study presumes that emergency preparedness information first influences the audiences' trust and emotions, then, psychological factors would shape their attitudes. In particular, experiments in this study examine the influence of providing emergency preparedness information on audiences' attitudes in regard to accepting a nuclear power plant, through their perceived trust and emotions.

### **Outcome Variables: Local and General Acceptability**

As Heath and colleagues (1998) addressed, one of the key outcome variables in risk communication research is whether the communicator can achieve stakeholders' support for the source of a risk. In past studies on risk and technology acceptance, the term "support" has been used as synonym for "acceptance." However, the word "acceptance" has been loosely defined and used interchangeably with other words such as acceptability, adoption, use, and supportive attitudes (Huijts, Molin, Chorus, & Van Wee, 2011).

This study differentiates between the term "acceptability" and "acceptance" or "support" by employing Huijts, Molin, and Steg (2012)'s terminology. Huijts and colleagues defined "acceptance" as behavior in contrast to acceptability, which was defined as an "attitude toward[s] possible behaviors in response to the technology" (p. 528). Huijts and colleagues' distinction derived from the theory of planned behavior (TPB; Ajzen, 1991), which posited that behavior is guided by attitude toward behavior along with two other factors: subjective norms and perceived behavioral control, through behavioral intentions. It should be emphasized that *acceptability* of nuclear power may lead to the *acceptance* of the technology, yet there are also other factors that

influence the *acceptance* as behavior. In this sense, *acceptability* and *acceptance* are separate concepts. This study classifies the words such as support, use, and adopt as terms referring to behavior; namely, synonyms of *acceptance*. On the other hand, terms such as *supportive attitudes* and *willingness to accept* are defined as a type of *acceptability*. This study primarily examines public attitudes, or *acceptability*, toward a nuclear power plant.

This study also distinguishes between types of acceptance (and acceptability) using the taxonomy defined and analyzed in the recent studies on technology adoption (e.g. Huijts, Molin, & Steg, 2012; Huijts, Molin, Chorus, & Van Wee, 2011; Wolsink, 2010; Wüstenhagen, Wolsink, & Bürer, 2007). One of the acceptance types, *socio-political acceptance*, involves people's technology acceptance at regional, national and international levels. This acceptance may not directly affect their environments or lives. People can show supportive attitudes toward a certain technology at a socio-political level without considering its consequences on their lives. However, when an issue shifts from global to local, from general support to a siting decision, people recognize difficulties and problems specific to their own situation (Bell, Gray, & Haggett, 2005): This level of local acceptance is termed *community acceptance*.

Scholars have argued that the NIMBY (Not-In-My-Backyard) syndrome takes place in the gap between *socio-political* and *community acceptance* (Wolsink, 2006; Bell et al., 2005). Portney (1991) described NIMBYism as a reflection of people's self-contradictory attitudes. People tend to show general support for a new technology and regard it as desirable to build a facility as long as it will be located somewhere not in their backyard and it does not affect their own lives. In the context of attitudes toward nuclear facilities, Tanaka (2004) examined the difference between people's general support for nuclear facilities (*socio-political acceptance*) and their support for siting the facilities in their community (*community acceptance*) in an

experimental setting. Tanaka observed a significant gap between the two types of acceptance and discussed that there were different psychological mechanisms behind the two acceptance types. General acceptance was a result of both perceived risks and perceived benefits. However, local (siting) acceptance was only correlated with perceived benefits.

This study focuses on people's attitudes toward accepting a nuclear power plant; namely, acceptability of a nuclear power station. Moreover, experiments in this chapter analyze the influence of emergency preparedness communication on two types of acceptability: socio-political acceptability and community acceptability, or general acceptability and local acceptability. General acceptability discusses how provision of emergency preparedness information influences people's support for nuclear power in general. Local acceptability examines how emergency preparedness communication affects people's evaluation of having a nuclear power plant in their neighborhood. This study considers both types of acceptability as equally important. General acceptability is a common topic of inquiry in major opinion polls (e.g. Gallup, 2016) and has the potential to influence policy decisions at a national level. Local acceptability is critical when implementing national policy and making facility-siting decisions because it is deeply related to local residents' decisions on whether they will allow the construction of a nuclear facility in their neighborhood.

Due to the lack of accumulated research on the direct effect of emergency preparedness communication on acceptability of a risk-generating facility at general or local levels, this study proposes the following research question on the overall effect of emergency preparedness information on the acceptability of nuclear power plants.

***RQ4:** How does emergency preparedness communication influence local and general acceptability of a nuclear power plant?*

## Mediators and Moderators

This study introduces two mediation terms, trust and emotions, as variables that mediate the effects of emergency preparedness communication on local and general acceptability of a nuclear power plant. In principle, a mediator variable specifies how and why a particular effect of an independent variable occurs on dependent variables (Baron & Kenny, 1986; Hayes, 2013).

This study also introduces subjective knowledge as a moderator, which interferes in the relations between variables. Moderator variables modify the strength or the direction of an effect of a dependent variable on independent variables (Baron & Kenny, 1986 Hayes, 2013).

**Mediator: trust.** Risk management and risk communication research has treated trust as a key concept (Engdahl & Lidskog, 2014). As observed, previous studies have shown that proactive communication on risks and emergency preparedness enhances public trust. Past scholars have recognized trust as a strong predictor of public acceptability of risk-generating technologies: Trust influences acceptability of a technology directly (e.g. Siegrist, Cousin, Kastenholz, & Wiek, 2007; Terwel, Harinck, Ellemers, & Daamen, 2009) or indirectly through perceived risks and perceived benefits (e.g. Siegrist, Cvetkovich, & Roth, 2000).

Nuclear power is no exception. Studies have indicated that the perception of trust influences public acceptability of nuclear power (Greenberg, 2009, 2013; Tsujikata, Tsuchida, & Shiotani, 2016; Visschers, Keller, & Siegrist, 2011; Visschers & Wallquist, 2013; Slovic, 1999; Whitfield, Rosa, Dan, & Dietz, 2009). Previous studies examined the influence of people's trust on acceptability of nuclear energy using various actors as objects of trust: plant operators (Siegrist & Cvetkovich, 2000); nuclear scientists (Siegrist, Cvetkovich, & Roth, 2000); government agencies responsible for regulating the technology (Guo & Ren, 2017). Those

findings were almost always consistent. Trust toward any of those actors led to the public's acceptability of nuclear power.

Scholars have agreed that trust is an important concept in risk and technology acceptance studies; however, there is no consensus on the definition of trust itself (Siegrist, Conner, & Keller, 2012). Among various definitions of trust, probably one of the most prominent is that proposed by Rousseau, Sitkin, Burt, and Camerer (1998): "Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (p.395). Mayer, Davis, and Schoorman (1995) proposed another popular definition of trust or "the willingness of a party to be vulnerable to the action of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (p. 712).

In addition to the many definitions, discussion on the dimensionality of trust has also complicated the concept. Many scholars have argued that trust is a multidimensional concept (see Earle, Siegrist, Gutscher, 2007). Yet, many different views of dimensions and components of trust exist in previous research. For example, Mayer and colleagues (1995) argued that trust consists of three core elements: ability; benevolence; and integrity. Renn and Levine (1991) suggested five dimensions of trust: competence, objectivity, fairness, predictability and faith. Some scholars identified four elements of trust: commitment, competence, care and predictability (e.g. Kasperson, Golding, & Tuler, 1992; Peters, Covello, & McCallum, 1997) and others discussed trust as a concept consisting of dimensions including integrity, dependability and competence (e.g. Hon, & Grunig, 1999; Rahn, & Transue, 1998; Roduta-Roberts, Maibach, Leiserowitz, & Zhao, 2011).

Taking Johnson's (1999) criticism that past studies made the trust concept too complicated, researchers have started developing a concise but sufficiently explanatory trust model. Earle, Siegrist, and Gutscher (2007), for example, reviewed studies on trust and risk perceptions and dissected two primary dimensions of trust: value-based trust (social trust) and competence-based trust (confidence). Employing this trust dichotomy, Siegrist, Earle and Gutscher (2003) proposed the Trust, Confidence, and Cooperation (TCC) model of cooperation, which explained two distinctive pathways (social trust and confidence) leading to public support (cooperation). This framework has been regarded as a promising approach to better understand risk communication strategies (Visschers, & Siegrist, 2008).

However, former proponents of the TCC model have recently begun criticizing the model. Siegrist (2010) claims that although the distinction of social trust and confidence is seemingly logical on a conceptual level, it is not feasible in experimental settings. Standing upon this criticism, Siegrist and colleagues (2012) advanced the original TCC model by including a dimension on perceived honesty of the communicator, and they proposed three dimensions of trust: confidence (competence), concern (care), and honesty. According to Siegrist and colleagues, the latter two dimensions correspond to social trust, as discussed in the original TCC model. The inclusion of honesty as a social trust element echoes a prior study (see Renn and Levine, 1991). Furthermore, Siegrist and colleagues' three-dimensional model of trust echoes the model of perceived trustworthiness proposed by Mayer and colleagues (1995), which explained that trustworthiness consists of three factors: ability, benevolence, and integrity (Also see Schoorman, Mayer, and Davis, 2007).

Recognizing the many conceptual overlaps with past trust studies, the current experiments will employ this enhanced version of the TCC model that Siegrist and colleagues

(2012) proposed, assuming that trust consists of the three dimensions: confidence, concern, and honesty. In discussing the influence of emergency preparedness communication on acceptability via trust, this study proposes the following one research question and two hypotheses regarding the concept of trust.

***RQ5:*** *How many and what dimensions does the trust concept hold?*

***H1:*** *Emergency preparedness communication enhances each of the trust dimensions (honesty, concern, and confidence) toward a nuclear power plant.*

***H2:*** *Each of the trust dimensions (honesty, concern, and confidence) is positively correlated to (a) local and (b) general acceptability of a nuclear power plant.*

It is important to mention the relationship between trust and fairness, although this study primarily focuses on trust. Recent studies have shown that, in addition to trust, perceived fairness of the decision process (procedural fairness) also influences the public's opinion regarding favorability and acceptability of a decision on rebuilding and expanding a nuclear power plant (Besley, 2010; 2012). While a number of studies have indicated that increased perceived fairness, especially procedural fairness, leads to more acceptability, Visschers and Siegrist (2012) showed that procedural fairness played only a limited role in molding supportive attitudes toward a decision about rebuilding a nuclear power plant. Instead, they identified that perceptions about benefits and fairness about the outcome (distributive fairness) were more important to predict people's acceptance toward rebuilding nuclear power plants.

Prior research has assumed that the concepts of fairness and trust influence each other (Huijts, Molin, & Steg, 2012). Earle and Siegrist (2008) argued for the interrelated relationship between the two concepts in the environmental risk context. While trust within a group shapes perceptions of fairness (e.g. De Cremer, 1999; Konovsky, 2000; Konovsky & Pugh, 1994),

people also use perceived fairness as a proxy for trust, when fair treatment is only information to interpret trust. In this sense, fairness appears to lead to trust (Earle & Siegrist, 2008).

**Mediator: emotions.** Previous studies have demonstrated that when people are informed of uncontrollable risks, they tend to feel negative emotions such as fear (Witte, 1992). Emotions serve as predictors of acceptability of nuclear power plants. That is, people who feel more positive emotions toward nuclear energy tend to show higher support for nuclear power (Guo, & Ren, 2017; Visschers, Keller, & Siegrist, 2011). Past studies have further demonstrated that positive and negative emotions are related but distinct variables, which separately predict attitudes toward a risk-generating technology (Cropanzano, Weiss, Hale, & Reb, 2003). For example, Sjöberg (2007) found that negative emotions toward nuclear power were positively correlated to people's higher risk perceptions and lower benefit perceptions, which both led to opposing attitudes toward nuclear power. Conversely, positive emotions were shown to enhance benefit perceptions and suppress risk perceptions, but their effect was smaller than negative emotions.

Based on prior research, this study treats positive and negative emotions as separate variables that are influenced by emergency preparedness communication and affect people's acceptability of a nuclear power plant at the local and general levels. The hypotheses for the experiments are proposed as follows:

***H3: Emergency preparedness communication decreases positive emotions toward a nuclear power plant.***

***H4: Positive emotions are positively correlated to (a) local and (b) general acceptability of a nuclear power plant.***

***H5:** Emergency preparedness communication increases negative emotions toward a nuclear power plant.*

***H6:** Negative emotions are negatively correlated to (a) local and (b) general acceptability of a nuclear power plant.*

**Moderator: subjective knowledge.** Prior research has also considered knowledge as one of the significant factors that influences people's acceptability of technologies and risks (e.g. O'Garra, Mourato, & Pearson, 2008). Studies have shown mixed results on the relationship between knowledge and acceptability of risks and technologies. As often seen in many opposition movements, people who know about technologies and their risks are not always proponents of the technology (Ellis, Barry, & Robinson, 2007). However, in the context of nuclear energy, research has found that scientific knowledge is directly linked to higher perceived benefits (Sjöberg & Drottz-Sjöberg, 1991); lower perceived risks (McDaniels, 1988) and positive attitudes towards nuclear power generation (Greenberg & Truelove, 2010).

Scholars (e.g. House, et al., 2005; Stoutenborough & Vedlitz, 2016) have criticized that past studies have not appropriately distinguished between two different types of knowledge: objective and subjective knowledge. Objective knowledge can be captured with knowledge tests by asking questions about a topic. Subjective knowledge can be measured in respondents' self-evaluation of their knowledge; namely, how much they think they know about a topic. Along these same lines, House and colleagues (2005) demonstrated that subjective and objective knowledge were marginally correlated with each other, but only subjective knowledge could predict acceptability of technology. However, Stoutenborough and Vedlitz (2016) reached a completely opposite result: in their analysis, subjective knowledge only weakly predicted acceptability of a technology. Instead, objective knowledge was found to be a strong predictor of

technology acceptance. Thus, the effects of knowledge on acceptability are still uncertain.

Knowledge is related to acceptability, but its influence on acceptability may be more complex.

The levels of subjective or objective knowledge apparently condition the effects of other factors on technology acceptance. Past literature has argued for the possible effects of knowledge on acceptability of risks and technologies. First, studies of message sidedness have illustrated that when people feel they know about an issue, a one-sided message that only addresses the benefits and does not disclose risks, tends to be perceived as less credible and less persuasive (Allen, 1991; Crowley & Hoyer, 1994). Studies on a one-sided message structure indicate that high subjective knowledge leads to high acceptability only when two-sided information is provided. Second, the TCC model (Earle, Siegrist, & Gutscher, 2007) argues that when people think they are unfamiliar with a certain technology or issue, they tend to use the perception of trust to determine their attitude on whether or not they should cooperate and support a technology. In other words, lower subjective knowledge leads to a stronger effect of trust on people's attitude toward accepting a technology. Third, Kahan and colleagues (2007) found an interaction effect between subjective knowledge and emotional evaluations on risk acceptance. In the context of nanotechnology, people with a higher level of subjective knowledge tend to rely on trust and emotions to make their decision of acceptability, than those who have no information about the technology. This finding stands in contrast to that proposed in the TCC model.

As witnessed in prior research, the influence of knowledge on acceptability is unclear. Considering the mixed effects of subjective knowledge, the current study includes subjective knowledge as a moderator that could condition relations among the variables. To examine the effects of subjective knowledge as a moderator, this study uses the following research question:

***RQ6:*** *How does subjective knowledge moderate the following relations?*

*(1) Between emergency preparedness communication and trust dimensions*

*(2) Between trust dimensions and (a) local and (b) general acceptability*

*(3) Between emergency preparedness communication and positive emotions*

*(4) Between positive emotions and (a) local and (b) general acceptability*

*(5) Between emergency preparedness communication and negative emotions*

*(6) Between negative emotions and (a) local and (b) general acceptability*

## **Methods**

### **Procedure, Stimuli and Case**

The current study employed a between-subject experimental design using three fictional websites by a nuclear power station delivering different messages as stimuli. Each participant of this experiment first received a series of questions on the perception of their knowledge (subjective knowledge) about and relevance to nuclear power generation. These questions were placed at the beginning of the experiment to avoid influences from question items or information included in the stimuli.

Then, participants were randomly assigned to one of the following three settings. In the first, and also control condition, participants were exposed to a webpage by a nuclear power plant that only delivered general information about nuclear power generation and its facility. For example, information included how much electricity the nuclear station could generate per year and how old their reactor was (condition 1). In the second condition, which this study labeled the emergency preparedness communication condition (condition 2), respondents were asked to review two webpages. The first webpage was a general information page that was identical to the one in the control condition. In addition to this webpage, respondents were provided another

webpage. This second webpage was, an emergency preparedness communication page that explained what accident risks there were at the plant, what residents near the plant should do in the case of a nuclear emergency, and how the operator of the nuclear power plant would react to the emergency. As described earlier, emergency response planning connotes the existence of accident risks. The last condition, the benefit-emphasis communication condition (condition 3), was prepared to examine whether the content or the amount of information influenced the audiences' perceptions and attitudes toward the plants. Similar to the previous emergency preparedness communication condition (condition 2), respondents assigned to this benefit-emphasis communication condition (condition 3) were asked to review two webpages: a general information page and a benefit-emphasis communication page that explained the benefits of the nuclear power station. This experiment selected benefit information as a case for the third condition because the content analysis in this dissertation (Chapter 3) showed that U.S. nuclear power plants most commonly communicated the benefits of the nuclear power generation. The page length and the numbers of words contained in both the benefit information page of the benefit-emphasis communication condition (condition 3) and the emergency preparedness communication page in the emergency preparedness communication condition (condition 2) were almost identical to make the two conditions comparable. The stimuli used in this experiment can be found in Appendix C.

After reviewing the stimulus materials, respondents were instructed to respond to questions about their perceptions and attitudes toward the fictional nuclear power plant depicted in the stimuli and their opinions on nuclear power in general. The questionnaire also asked for participants' demographic information and their involvement in the nuclear power industry and anti-nuclear campaigns. The survey concluded by debriefing the participants that nuclear power

stations that they reviewed were fictitious. The institutional Review Board (IRB) reviewed and approved the stimuli, question items, and procedures used in the experiment. The full questionnaire is attached in Appendix D.

### **Data Collection and Screening**

The experiment took place online through the Qualtrics survey platform. The participants were recruited using an online sample pool, Amazon Mechanical Turk in February and March 2017. The respondents were provided 50 cents as compensation. A total of 625 people completed the study. Considering the nature of online surveys, an attention-check question (“This is a question to make sure you are not a robot automatically answering these questions. Please pick ‘2’ and move on to the next question.”) was inserted to be sure that the questionnaire was manually and accurately filled out. No respondents selected a wrong number, but 7 participants did not answer the question; therefore, they were removed from the dataset. Furthermore, respondents who stayed less than 5 seconds on a stimulus page ( $n = 39$ ) were also removed from the dataset to make sure that the participants reviewed the stimuli ( $M = 54.63$ ,  $SD = 57.48$ , in seconds, after deletion). The data were screened for univariate outliers and no out-of-range values were detected. After screening data with these checks and using listwise deletion to remove 27 cases that failed to answer any of the question items on dependent or independent variables, this study retrieved 552 cases in the final dataset ( $N = 552$ ). Considering the relatively small number of missing data that showed no particular patterns, this study assumed the data were at least missing at random. There were 182 participants assigned to the control condition (condition 1); 188 were exposed to the emergency preparedness communication condition (condition 2); and 182 respondents reviewed the benefit-emphasis stimulus (condition 3).

## Participants

Participant age ranged from 19 to 84 ( $M = 39.37$ ,  $SD = 13.48$ ) with a median of 36.0. One respondent did not answer the age question. More than half of the participants were male (55.3%). The majority of participants were white (81.9%), followed by Asian (9.1%), African American (7.4%), Hispanic or Latino (4.2%), American Indian or Alaska Native (1.8%), Native Hawaiian or Other Pacific Islander (0.7%), and other (0.7%). Respondents were allowed to choose more than one race/ethnicity. About 38.9 % of the respondents earned a Bachelor's degree; 13.6% held a Master's, 2.2% possessed a Doctorate, and 2.4% possessed a Professional degree.

Regarding physical proximity to and familiarity with nuclear power plants, 2.5% of the respondents reported that they lived within a 10-mile radius of a nuclear power station, 18.5% said that they lived within a 50-mile but not 10-mile radius, and 22.8% did not know whether they lived within a 50-mile distance from the closest nuclear power station. Among the residents who claimed that they resided within a 50-mile radius from a nuclear plant, 57.8% answered that they knew the name of the closest nuclear plant (71.4% for residents within a 10-mile radius and 55.9% for those within a 50-mile but not 10-mile radius), while only 13.3% of the respondents outside the 50-mile radius answered that they knew the name of the closest nuclear power plant.

As for preexisting involvement in nuclear power generation, 6.2% of the respondents claimed that they or their immediate family members were currently working, or had previously worked, in the nuclear industry. Nuclear industry positions included working in nuclear power plants, nuclear waste management sites, and other nuclear-related facilities. Approximately 2.0% of the participants reported that they or their immediate family members were currently or had

been previously involved in anti-nuclear campaigns. As will be explained later, these questions were treated as control variables in the analyses.

## **Measurement**

**Dependent variables: local and general acceptability.** This study examined the two types of acceptability of a nuclear power plant, local acceptability and general acceptability as dependent variables by using the following question items respectively: “Would you favor or oppose building a new nuclear power plant that is identical to the Potter Nuclear Power Plant, close by the place where you live? (e.g. About 10 miles away from your house)” for local acceptability and “Would you favor or oppose building a new nuclear plant that is identical to the Potter Nuclear Power Plant, in other parts of the country?” for general acceptability. Both question items provided scales ranging from “1 = Strongly oppose” to “7 = Strongly favor.” The Potter Nuclear Power Plant described in the questions was the name of the fictitious nuclear station used in the stimulus webpages. The differentiation of the acceptability types corresponds to the differences of socio-political acceptance and community acceptance discussed by past scholars (e.g. Huijts, Molin, Chorus, & Van Wee, 2011; Huijts, Molin, & Steg, 2012; Wolsink, 2010; Wüstenhagen, Wolsink, & Bürer, 2007).

A paired-samples t-test using cases across the three conditions indicated that the general acceptability was higher ( $M = 4.43$ ,  $SD = 1.85$ ) than local acceptability ( $M = 3.35$ ,  $SD = 1.95$ ) at the .05 level of significance ( $t(551) = 17.35$ ,  $n = 552$ ,  $p < .001$ , CI for mean difference to .95 to 1.20,  $d = .74$ ,  $r = .71$ ). Even when examining each condition, general acceptability was always significantly higher than local acceptability (Table 3). This may imply that the NIMBY (Not in My Backyard) syndrome was observed in this experimental setting (e.g. Tanaka, 2004). It is

assumed that local and general acceptability can be treated as different constructs, while the two types of acceptability were moderately correlated across the conditions.

**Table 3.** Descriptive Statistics and t-test Results for General acceptability and Local acceptability across the Conditions

	<u>General Acceptability</u>		<u>Local Acceptability</u>		n	95% CI for Mean Difference	<i>r</i>	<i>t</i>	<i>df</i>	Cohen's <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>						
Control (condition 1)	4.36	1.90	3.31	1.98	182	[.85, 1.25]	.75***	10.29***	181	.76
Emergency Preparedness (condition 2)	4.26	1.90	3.36	1.98	188	[.72, 1.08]	.79***	9.714***	187	.71
Benefit-emphasis (condition 3)	4.67	1.72	3.39	1.92	182	[1.04, 1.53]	.58***	10.302***	181	.76
Overall	4.43	1.85	3.35	1.95	552	[.95, 1.20]	.71***	17.35***	551	.74

Note. \*\*\*  $p < .001$

**Mediator: trust.** The concept of trust was measured using the scale developed by Siegrist, Connor and Keller (2012) combined with items for informational justice suggested by Colquitt (2001). As mentioned earlier, Siegrist and colleagues (2012) identified that the trust construct comprised three factors: confidence, concern, and honesty. The items measuring the honesty component were almost identical to those for informational justice summarized by Colquitt (2001). Therefore, this study added the items for informational justice to examine whether the honesty and informational justice items formed a single factor and constituted an element of trust.

All items were modified to fit the context of nuclear power generation and asked as an umbrella question “How much do you agree or disagree with the following statements on the operator of the nuclear power plant that you reviewed at the beginning”, with scales ranging from “1 = Strongly disagree” to “7 = Strongly agree.” The questionnaire was equipped with 12 items to capture the dimensions which would construct the concept of trust.

**Mediator: positive and negative emotions.** The emotion scale items were developed based on Midden & Huijts (2009)’s study with additional items retrieved from the Modified Differential Emotions Scale (mDES) by Fredrickson (1998) because the mDES has been widely used in capturing people’s emotions influenced by a certain event or information. This study specifically explored respondents’ emotions evoked by the stimulus immediately after reviewing it by asking “After reviewing the website about a nuclear power plant, to what extent does the information on the website evoke the following feelings to you?” with a 7-point scale from “1 = Not at all” to “7 = Very well.” Positive emotions consisted of 3 items: *satisfaction*, *hope*, and *calmness* ( $\alpha = .87$ ) and negative emotions included 7 items: *fear*, *powerlessness*, *worry*, *sadness*, *anger*, *shame*, and *disgust* ( $\alpha = .83$ ).

A Pearson correlation was calculated examining the relationship between positive and negative emotions. As the definitions literally assume, a negative, but only moderate relationship was found ( $r(549) = -.292, p < .01$ ), indicating that respondents who felt positive emotions toward the Potter nuclear plant were less likely to have negative emotions about the plant. However, the relationship was not strong. These results suggest that positive and negative emotions in this experiment are related but separate constructs.

**Moderator: subjective knowledge.** Subjective knowledge on nuclear power, or respondents' perception regarding how much they think they know about the issue of nuclear power, was measured with a single item question: "How knowledgeable would you say you are about the facts and issues concerning nuclear power generation?" with an answering range from "1 = Not at all knowledgeable" to "7 = Extremely knowledgeable" ( $M = 3.51$ ;  $SD = 1.39$ ). The item was adopted from House and colleagues' (2005) study on the effect of subjective and objective knowledge on acceptance of a technology. Measuring concepts using one item is encouraged when the construct is clear and unidimensional (Alexandrov, 2010).

Subjective knowledge is positively correlated with positive emotions, but is weakly correlated ( $r(549) = .156, p < .01$ ). Subjective knowledge is also positively correlated with negative emotions but in a very weak manner ( $r(549) = .093, p < .05$ ). These results imply that people who have higher subjective knowledge on nuclear power generation tend to hold stronger emotions toward a nuclear plant in both positive and negative ways. However, their relations are very weak.

**Control variables.** Six variables were controlled for in this study: age, gender, race, education, work experience in the nuclear industry, and involvement in anti-nuclear campaigns. Past studies and surveys have found acceptability of risk-generating facilities, including nuclear

power plants, varied based on socio demographic information, such as age, gender, race, and education levels. An OECD (2014) report showed that men are more likely than women to accept nuclear power as a safe energy source. Furthermore, the poll also reported that people with higher levels of education tend to answer that countries should build new nuclear power plants. Thus, these demographic variables were added as covariates. Respondents' and their immediate family members' work experience in the nuclear industry and their involvement in anti-nuclear campaigns were also added as covariates in this study because it is naturally expected that respondents' preexisting engagement in nuclear power generation influences their attitudes toward nuclear power stations.

## **Results**

### **Analysis 1: Trust Dimensionality**

This study employed exploratory factor analysis (EFA), rather than confirmatory factor analysis (CFA), to identify the dimensionality of trust. CFA was not used because as witnessed in previous studies, no agreement exists regarding the number of trust dimensions, while this study presumes that trust consists of three elements. Studies have recommended that researchers use EFA as the first step to build scales in the “exploratory” early stages (Cabrera-Nguyen, 2010; Yong & Pearce, 2013)

Before executing EFA, several well-recognized criteria for the factorability of a correlation were examined. First, the amount of data for factor analysis was satisfied with the minimum requirement, providing a ratio of over 43 cases per variable with a final sample size of 552. Second, the communalities for all the 12 trust items were tested. The results indicated above .43 (see Table 4) except one item from the informational fairness scale: “The operator of the nuclear power tailors its communications to the public's specific needs” showing .27 (not

included in Table 4). Therefore, this study removed this item from further analyses. Third, factorability of the 11-item measurement was examined by testing the inter-item correlations. The Cronbach's alpha of this 11-item scale was .90 and all items were correlated at least .49 with at least one other item with a range from .49 to .77. Both results suggest that there is reasonable factorability (see Table 4). Finally, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .89, above the commonly recommended value of .60, indicating the data were sufficient for EFA. The result of the Bartlett's test of sphericity ( $\chi^2(55) = 3509.43, p < .001$ ) also showed that there was a patterned relationship between the 11 items. The diagonals of the anti-image correlation matrix were all over .85 and all the 11 items had VIF values of less than 3.0. Given the results of all the indicators, factor analysis was considered suitable for the 11 trust items.

In answer RQ5, the data were subjected to EFA using the Maximum Likelihood (ML) factor extraction method to determine the factor structure of trust. This study selected the ML extraction method because prior studies has been recommended as the best practice when data are relatively normally distributed (Fabrigar, Wegener, MacCallum, & Strahan, 1999; Osborne, & Costello, 2005). This study employed an oblique Promax rotation because trust was conceived as multidimensional with the dimensions being interrelated (Earle, Siegrist, & Gutscher, 2007).

Using an eigenvalue cut-off of 1.0, three factors were identified that explain a cumulative variance of 73.9%. The scree plot also confirmed the findings of retaining the three-factor solution. The Promax rotation created three factors with sums of squared-loadings ranging from 3.79 to 4.16, and the clustering of items into factors can be easily interpreted (see Table 4). The solution explains 63.6% of variance. Table 4 shows the factor loading after rotation using a significant factor criterion of .40. No item was moderately or highly correlated to two or more

factors. The first factor identified by the rotated solution was highly correlated to the items measuring respondents' perceptions on the nuclear plant operator being knowledgeable and capable of operating their nuclear facilities in a safe manner. Therefore, this study named this factor "confidence". The second factor was correlated to items on social trust, in the sense of concern for the public and the environment, and labelled "concern" in this study. This factor is related to how respondents think about the nuclear plant operator's concern for the public and the environment. The third factor was correlated to items dealing with another social trust dimension, honesty. All four items related to the factor, including one item from informational fairness literature, focused on respondents' perceptions of the nuclear plant operator's information provision, especially openness and trustworthiness of the plant operator. Accordingly, this study labeled the factor "honesty." As expected, these three sub-dimensions of trust were moderately correlated each other (see Table 5).

Based on the result of the EFA, trust has three dimensions: confidence, concern, and honesty. This analysis also suggests that the honesty dimension of trust and informational fairness overlap conceptually, as well as empirically.

**Table 4.** Factor Loadings and Communalities Based on ML Factor Extraction Method with Promax Rotation for the 11 Items (N=552)

Item	<u>Factor 1</u> Confidence	<u>Factor 2</u> Concern	<u>Factor 3</u> Honesty	Communality
1 The operator of the nuclear power plant values financial gain higher than me. [Reverse Coded]		.69		.44
2 The operator of the nuclear power plant does <b>not</b> consider human health to be important. [Reverse Coded]		.80		.70
3 The operator of the nuclear power plant is only interested in their business. [Reverse Coded]		.73		.57
4 The operator of the nuclear power plant is <b>not</b> interested in the consequences for the environment. [Reverse Coded]		.91		.79
5 The operator of the nuclear power plant openly communicates the possible risks of the nuclear power plant.			.79	.50
6 If there was evidence that nuclear power generating is harmful to human health, the operator of the nuclear power plant would inform the public in a timely manner.			.58	.62
7 One can trust information from the operator of the nuclear power plant.			.46	.65
8 The operator of the nuclear power plant is candid in communication with the public.			.66	.59
9 The operator of the nuclear power plant has the required knowledge to estimate the risks of nuclear power generation.	.84			.66
10 The operator of the nuclear power plant has competence to solve problems related to nuclear power generation.	.80			.69
11 The operator of the nuclear power plant has the necessary expertise to make good decisions on nuclear power generation.	.90			.80
Initial Eigenvalues	5.60	1.47	1.06	

Note: Loadings less than .40 are omitted

**Table 5.** Correlations among the Factors (N=552)

Factor	1	2
2	.60	
3	.56	.63

*Note:* All coefficients are significant at  $p < .001$

The factor scores were computed for all three factors and used for further analyses. The details including mean scores and standard deviations are illustrated in Table 6.

**Table 6.** Descriptive Statistics for the Three Trust Factors (N= 552)

Factor	Number of items	<i>M (SD)</i>	Skewness	Kurtosis	Cronbach's $\alpha$
Factor 1 - Confidence	3	5.04 (1.11)	-0.62	0.47	.88
Factor 2 - Concern	4	4.37 (1.27)	-0.24	-0.28	.85
Factor 3 - Honesty	4	4.26 (1.22)	-0.15	-0.29	.83

## **Analysis 2: Effects of Emergency Preparedness Communication on Local and General Acceptability of a Nuclear Power Plant**

**Experiment 1. Effects of emergency preparedness communication.** All hypotheses and research questions were examined using an ordinary linear squares regressions and conditional process modeling with the PROCESS program, which uses an ordinary least squares-based path analytical framework to test for both direct and indirect effects (Hayes, 2013). PROCESS allows researchers not only to explore parallel mediation models including moderation effects but also to detect opposing mediation effects among mediators in the model. The latter point has been overlooked in the traditional Baron and Kenny (1986)'s method for establishing mediation (MacKinnon, 2008). The current analyses specifically employed PROCESS Model 58 (moderated mediation) to explore questions on how (indirect, or mediation effects) and under what circumstance (conditional, or moderation effects) effects of emergency preparedness communication operate on the dependent variables, namely local and general

acceptability. In this study, all indirect effects were subjected to bootstrap analyses with 10,000 bootstrap resampling and 95% bias corrected confidence intervals.

The following analysis compared the control condition (condition 1) and the emergency preparedness communication condition (condition 2) to examine the effect of emergency preparedness communication on respondents' acceptability of a nuclear power plant. The number of cases used in this analysis was 370: 182 for the control condition (condition 1) and 188 for the emergency preparedness communication condition (condition 2).

**Manipulation check.** To determine whether the manipulation of emergency preparedness communication worked, participants were asked to rate the amount of information about nuclear emergency response planning and preparedness that they thought they had received on the webpage (stimulus) using a 7-point scale ranging from 1 (Too little) to 7 (Too much). A test of ANOVA was performed to assess the effects of the manipulation: The result showed that participants in the emergency preparedness communication condition (condition 2) perceived that they had received emergency preparedness information from the web page ( $M = 4.13$ ,  $SD = 1.09$ ,  $F(1,368) = 92.77$ ,  $p < .001$ ,  $\eta^2 = .20$ ) more than those in the control condition (condition 1) ( $M = 2.82$ ,  $SD = 1.49$ ).

**Total effect.** The first analysis investigated how emergency preparedness communication directly influences local and general acceptability, without considering mediation or moderation effects. RQ4 was examined by conducting ordinary least squares (OLS) regressions using local and general acceptability as the dependent variables and emergency preparedness communication as the independent variable, controlling for necessary variables (age, race, education levels, respondents' and their immediate family members' working experience in the nuclear industry, and their involvement in anti-nuclear campaigns). As Table 7 shows,

emergency preparedness communication alone was not a significant predictor of local (y1) or general acceptability (y2).

**Table 7.** Simple Regression Model Predicting Local Acceptability and General Acceptability (N = 370)

	Local Acceptability (y1)		General Acceptability (y2)	
	<i>B</i>	<i>SE B</i>	<i>B</i>	<i>SE B</i>
Constant	4.92***	.54	5.84***	.52
EP Communication	.05	.20	-.10	.19
Covariates				
Age	-.03***	.01	-.02**	.01
Gender (Male)	-.08**	.02	-.08***	.02
Race (White)	.55*	.26	.39	.25
Education (College-educated or more)	.27	.20	.37	.19
Work at the nuclear industry	.54	.39	.66	.38
Involvement in anti-nuclear campaigns	-1.33	.70	-2.18**	.67
<i>R</i> <sup>2</sup>	.11		.12	
<i>F</i> (7, 362)	6.62***		7.31***	

Note. EP stands for Emergency Preparedness, \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

**Conditional indirect effect.** It was hypothesized (H1 - H6) that trust and emotions would mediate the relationship between emergency preparedness communication and local and general acceptability of a nuclear power station. To test the model, local and general acceptability were separately entered as the outcome variable, emergency preparedness communication as the predictor variable, and age, gender, race, education, working experience in the nuclear industry, and involvement in anti-nuclear campaigns as covariates. Furthermore, three dimensions of trust (confidence, concern, and honesty) and positive and negative emotions were entered as mediators. Subjective knowledge was treated as a moderator that would interact with the predictor and the mediators (RQ6). Five parallel regression analyses were conducted for each outcome variable (local or general acceptability).

The models for local acceptability and for general acceptability both yielded statistically significant results (Table 8, Table 9). The direct effects of emergency preparedness

communication on local and general acceptability were still not statistically significant (local acceptability:  $B = .20$ ,  $SE = .17$ , 95% CI  $[-.14, .54]$ , general acceptability:  $B = .10$ ,  $SE = .15$ , 95% CI  $[-.20, .39]$ ). The results suggest that emergency preparedness communication influences both local and general acceptability, but through different paths (Figure 1). Subjective knowledge worked as a moderator on the three paths: the path from emergency preparedness communication to concern (m2); the one from concern (m2) to local acceptability; and the one from negative emotions (m5) to local acceptability. To simplify the understanding of the results, the next section will explain the results by following two steps. First, this dissertation focuses on the effects of emergency preparedness communication on each mediator (m1 - m5). Then, this dissertation elaborates on the effects of mediators (m1 - m5) on local (y1) and general acceptability (y2).

**Table 8.** Moderated Mediation Model of Trust and Emotions on Local and General Acceptability: Mediators (N = 370)

	Outcome: Mediators								
	<u>Confidence (m1)</u>			<u>Concern (m2)</u>			<u>Honesty (m3)</u>		
	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI
Constant	.05	.27	[-.48, .58]	-.04	.29	[-.61, .53]	.74**	.26	[.22, 1.25]
EP Communication	.01	.12	[-.22, .25]	.04	.14	[-.24, .31]	<b>.36**</b>	<b>.13</b>	<b>[.12, .61]</b>
Moderation									
Subjective Knowledge	.05	.04	[-.03, .14]	.00	.05	[-.10, .10]	.07	.05	[-.016, .16]
EP Communication x Subjective knowledge (See Table 10)	.07	.08	[-.09, .23]	<b>.28***</b>	<b>.09</b>	<b>[.09, .46]</b>	.04	.09	[-.13, .22]
Covariates									
Age	.00	.01	[-.01, .01]	.00	.01	[-.01, .01]	-.02**	.01	[-.03, -.01]
Gender (Male)	-.01	.01	[-.03, .02]	.01	.01	[-.02, .04]	.00	.01	[-.03, .02]
Race (White)	-.03	.15	[-.33, .27]	.05	.18	[-.32, .41]	.01	.16	[-.30, .32]
Education (College-educated or more)	-.01	.12	[-.25, .23]	.03	.14	[-.25, .30]	-.16	.13	[-.41, .09]
Work in the nuclear industry	.46**	.16	[.15, .78]	.21	.33	[-.43, .85]	.15	.24	[-.32, .63]
Involvement in anti-nuclear campaigns	-1.90**	.61	[-3.11, -.70]	-1.69*	.67	[-3.02, -.37]	-1.29*	.57	[-2.40, -.18]
<i>R</i> <sup>2</sup>		.07			.07			.10	
<i>F</i> (9, 360)		2.57**			2.04*			4.40***	

Note. EP stands for Emergency Preparedness, Bootstrap resamples = 10,000. \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

**Table 8.** (Cont'd)

	Outcome: Mediators					
	<u>Positive Emotions (m4)</u>			<u>Negative Emotions (m5)</u>		
	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI
Constant	.90*	.35	[-.21, 1.58]	-.34	.26	[-.85, .18]
EP Communication	<b>-.53***</b>	<b>.15</b>	<b>[-.83, -.23]</b>	<b>.45***</b>	<b>.12</b>	<b>[-.21, .69]</b>
Moderation						
Subjective Knowledge	<b>.16**</b>	<b>.05</b>	<b>[-.05, .26]</b>	.06	.04	[-.03, .14]
EP Communication (x) x Subjective knowledge (See Table 10)	.15	.10	[-.05, .35]	-.06	.08	[-.22, .10]
Covariates						
Age	-.02*	.01	[-.03, .00]	.01	.01	[.00, .02]
Gender (Male)	.02	.02	[-.06, .01]	.01	.01	[-.01, .04]
Race (White)	-.07	.20	[-.47, .33]	-.04	.17	[-.38, .30]
Education (College-educated or more)	.24	.16	[-.07, .54]	-.22	.13	[-.47, .03]
Work in the nuclear industry	.18	.26	[-.32, .69]	-.35	.19	[-.72, .02]
Involvement in anti-nuclear campaigns	-1.42**	.45	[-2.31, -.53]	1.74*	.76	[.25, 3.23]
<i>R</i> <sup>2</sup>			.12			.12
<i>F</i> (9, 360)			6.87***			3.82**

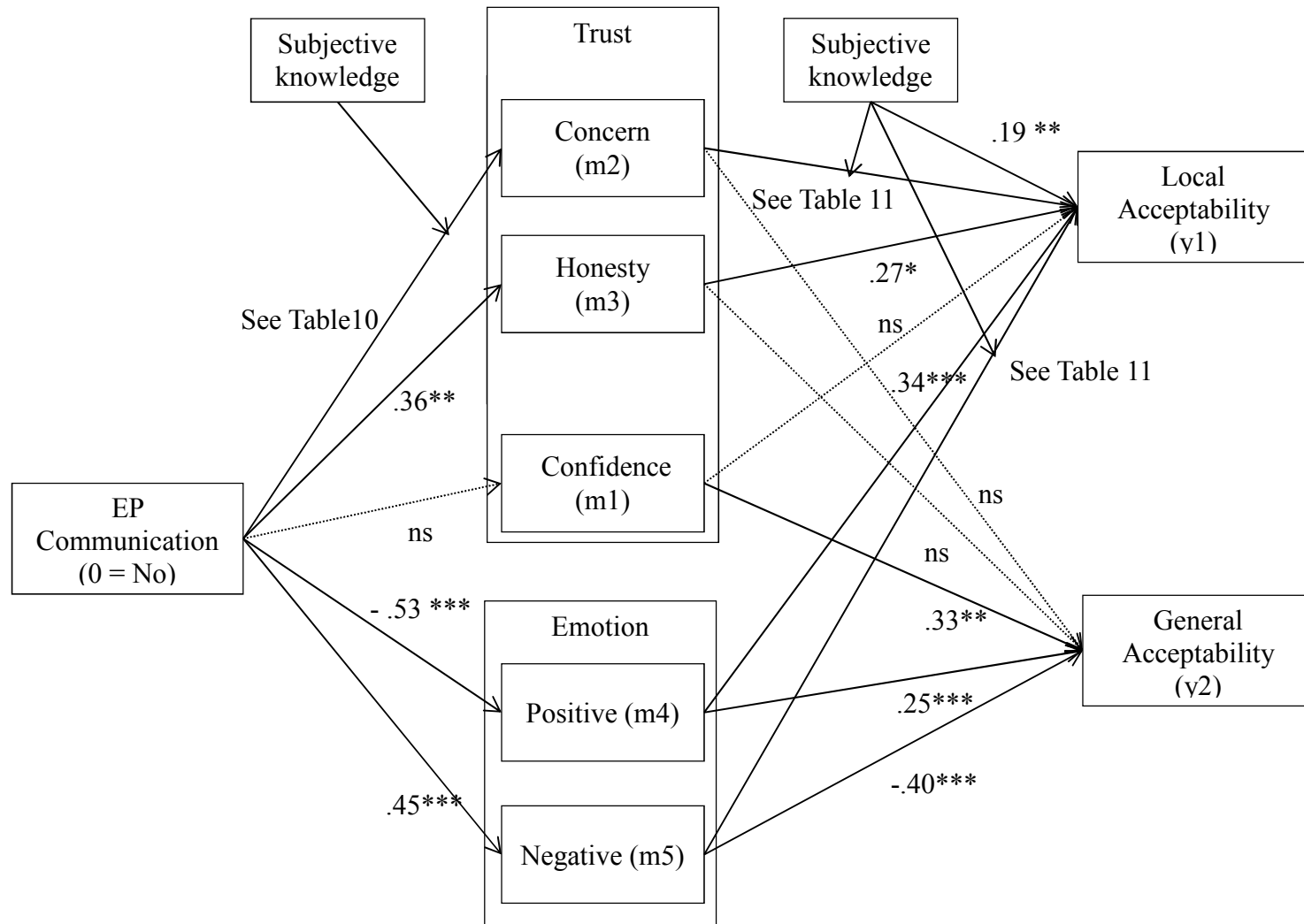
Note. EP stands for Emergency Preparedness, Bootstrap resamples = 10,000. \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

**Table 9.** Moderated Mediation Model of Trust and Emotions on Local and General Acceptability: Dependent Variables (N = 370)

	Local Acceptability (y1)			General Acceptability (y2)		
	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI
Constant	4.23***	.37	[3.52, 4.98]	5.15***	.34	[4.48, 5.82]
EP Communication	.20	.17	[-.14, .54]	.10	.15	[-.20, .39]
Mediation						
Confidence (m1)	.14	.10	[-.05, .34]	<b>.33**</b>	<b>.10</b>	<b> [.13, .53]</b>
Concern (m2)	.08	.09	[-.10, .26]	.14	.08	[-.02, .30]
Honesty (m3)	<b>.27*</b>	<b>.11</b>	<b> [.05, .48]</b>	.17	.11	[-.04, .39]
Positive Emotions (m4)	<b>.34***</b>	<b>.07</b>	<b> [.21, .47]</b>	<b>.25***</b>	<b>.07</b>	<b> [.12, .38]</b>
Negative Emotions (m5)	<b>-.39***</b>	<b>.08</b>	<b> [-.55, -.23]</b>	<b>-.40***</b>	<b>.08</b>	<b> [-.56, -.23]</b>
Moderation						
Subjective Knowledge	<b>.19**</b>	<b>.06</b>	<b> [.07, .31]</b>	.02	.05	[-.08, .13]
Confidence (m1) x Subjective Knowledge	.05	.07	[-.08, .18]	-.10	.07	[-.24, .04]
Concern (m2) x Subjective Knowledge (See Table 11)	<b>.18*</b>	<b>.08</b>	<b> [.03, .34]</b>	.07	.07	[-.06, .20]
Honesty (m3) x Subjective Knowledge	-.12	.08	[-.27, .03]	-.01	.07	[-.16, .13]
Positive Emotions (m4) x Subjective Knowledge	.02	.04	[-.07, .11]	.05	.04	[-.04, .13]
Negative Emotions (m5) x Subjective Knowledge (See Table 11)	<b>.13*</b>	<b>.07</b>	<b> [.003, .26]</b>	-.01	.06	[-.13, .11]
Covariates						
Age	<b>-.02***</b>	.01	[-.04, -.01]	-.01	.01	[-.02, .00]
Gender (Male)	<b>-.04*</b>	.02	[-.07, -.004]	<b>-.06***</b>	.02	[-.09, -.03]
Race (White)	<b>.61**</b>	.20	[.21, 1.01]	<b>.40*</b>	.19	[.02, .77]
Education (College-educated or more)	.08	.17	[-.25, .41]	.26	.16	[-.05, .57]
Work in the nuclear industry	-.11	.41	[-.92, .71]	.10	.28	[-.46, .66]
Involvement in anti-nuclear campaigns	.42	.57	[-.71, 1.54]	-.08	.52	[-1.11, .95]
<i>R</i> <sup>2</sup>		.44			.50	
<i>F</i> (18, 351)		16.22***			20.83***	

Note. EP stands for Emergency Preparedness, Bootstrap resamples = 10,000. \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

**Figure 1.** Conceptual Model for the Effects of Emergency Preparedness Communication on Local (y1) and General (y2) Acceptability



Note. EP stands for Emergency Preparedness, \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$ , ns stands for not significant

*Effects of emergency preparedness communication on mediators (m1- m5).* Table 8 explains the effect of emergency preparedness communication on each mediator. No statistically significant effect was observed in the relation between emergency preparedness communication and confidence (m1). This implies that informing nuclear emergency preparedness does not alter people's perception about the nuclear station operators' ability or expertise.

As for concern (m2), the effect of emergency preparedness communication on this concern mediator relies on the values of subjective knowledge (see Table 10). Further analysis based on the Johnson-Neyman technique suggests that emergency preparedness communication influences concern (m2) in a reverse way depending on people's subjective knowledge. When people do not feel that they have enough knowledge of nuclear power generation, emergency preparedness information lowers the perception that the plant operator is concerned with the public. On the other hand, when people think they are knowledgeable about the issue, being informed of emergency preparedness increases the perception that the nuclear operator is concerned about the public and the environment.

**Table 10.** Conditional Effects of Emergency Preparedness Communication on Concern (m2) at Values of Subjective Knowledge (N = 370)

Moderator		Outcome: Concern (m2)		
Subjective Knowledge		<i>B</i>	<i>SE</i>	95% CI
-1 SD	-1.44	-.32*	.16	[-.62, -.01]
Mean	.00	.01	.11	[-.22, .23]
+1 SD	1.44	.33	.17	[.00, .66]

Note. Variables are mean centered. Bootstrap resamples = 10,000. \*  $p < .05$ .

Other mediators, honesty (m3), positive emotions (m4), and negative emotions (m5) were also significantly correlated to emergency preparedness communication. Informing emergency preparedness enhances the audiences' perception that the nuclear plant operator is honest to the public. However, the results of this analysis show that emergency preparedness communication

decreases people's positive emotions and increases negative emotions. After controlling for appropriate variables, the effects ( $R^2$ ) on honesty (m3), positive emotions (m4), negative emotions (m5) were .10, .12, and .12 respectively, suggesting emergency preparedness communication exerted a strong effect on each mediator, to a similar extent (Cohen, 1988).

Moreover, subjective knowledge (w) was found to be positively correlated with positive emotions (m4). This implies that people with higher subjective knowledge on a nuclear issue tend to feel more positive emotions toward a nuclear power station.

*Effects of mediators (m1 - m5) on local and general acceptability.* Table 9 illustrates both the direct and indirect effects of emergency preparedness communication and mediators (m1 - m5), including moderating effects of subjective knowledge on local (y1) and general (y2) acceptability. The effects ( $R^2$ ) of significant mediators on local (y1) and general (y2) acceptability were .44 and .50. This implied that a large proportion of variance was explained by the mediator variables.

As for local acceptability (y1), considering the fact that the direct effect of emergency preparedness communication was not statistically significant, the effect of emergency preparedness communication on local acceptability (y1) was fully mediated by honesty (m3), positive emotions (m4), and negative emotions (m5). In short, honesty (m3) and positive emotions (m4) are positively correlated with local acceptability, but higher negative emotions (m5) lead to lower local acceptability (y1).

Confidence (m1) was not observed as a significant predictor of local acceptability. Concern (m2) alone was not correlated with local acceptability, either. However, the mediating effects of concern (m2) and negative emotions (m5) on local acceptability were influenced by participants' subjective knowledge, respectively showing complete and partial moderation. Table

11 depicts the conditional indirect effects of concern (m2) and negative emotions (m5) on local acceptability depending on the value of the moderator, subjective knowledge. The results show that concern (m2) functions as a mediator that positively influences local acceptability when people think they are knowledgeable about the issues of nuclear power. However, when people do not perceive that they know about nuclear power, concern (m2) does not exert statistically significant effects on local acceptability. In terms of the effects of negative emotions (m5) on local acceptability, further negative effects of negative emotions on local acceptability were observed when people did not think they were knowledgeable about nuclear issues.

**Table 11.** Conditional Indirect Effects of Mediators (m) on Local Acceptability (y1) at Values of Subjective Knowledge (N = 370)

<u>Moderator</u>		<u>Outcome: Local Acceptability (y1)</u>		
Subjective Knowledge		<i>B</i>	<i>SE</i>	95% CI
Concern (m2)				
-1 SD	-1.44	.06	.06	[-.01, .22]
Mean	.00	.00	.02	[-.02, .06]
+1 SD	1.44	<b>.15</b>	<b>.10</b>	<b>[.02, .41]</b>
Negative Emotions (m5)				
-1 SD	-1.44	<b>-.31</b>	<b>.11</b>	<b>[-.54, -.13]</b>
Mean	.00	<b>-.17</b>	<b>.06</b>	<b>[-.31, -.07]</b>
+1 SD	1.44	-.07	.06	[-.23, .00]

Note. Variables are mean centered. Bootstrap resamples = 10,000.

Regarding general acceptability (y2), confidence (m1), positive emotions (m4), and negative emotions (m5) were identified as significant predictors of this type of acceptability. As confidence (m1) was not influenced by emergency preparedness communication, this analysis treated only positive emotions (m4) and negative emotions (m5) as effective mediators. When people feel more positive and less negative emotions, they tend to show general acceptability (y2) for a nuclear power plant. No moderation effects of subjective knowledge were observed.

**Experiment 2. Effects of benefit-emphasis communication.** The last analysis was conducted to confirm that the effects observed in the previous analysis (Experiment 1) were triggered by the presence of emergency preparedness information, and not by the differences in the amount of information. To explore this question, experiment 2 examined the differences in respondents' trust, emotions, and acceptability between the control condition (condition 1) and the benefit-emphasis communication condition (condition 3). As mentioned earlier, participants in the benefit-emphasis communication condition (condition 3) were exposed to general information on a nuclear power plant as well as a message explaining the benefits of nuclear power generation. The message explaining the benefits of nuclear power generation, included almost the same amount of information that the webpage on emergency response planning and preparedness that the emergency preparedness communication (condition 2) provided. Experiment 2 used responses from condition 1 ( $n = 182$ ) and condition 3, but excluded two cases from condition 3 because they failed to answer questions on either age or subjective knowledge ( $n = 180$ ). Therefore, the total sample used for this analysis was 362.

**Manipulation check.** For the current analysis, two manipulations were investigated: whether participants in the benefit-emphasis communication condition (condition 3) perceived that they had received more benefit information from the stimulus than those in the control condition (condition 1); and whether both condition 1 and 3 perceived that they had been provided the same amount of emergency preparedness information.

To examine the first manipulation, participants were told to answer the question item "How much information does the website give you about the advantages of nuclear power generation" with a 7-point scale from 1 (Too little) to 7 (Too much). The results of the ANOVA showed that participants in the benefit-emphasis communication condition (condition 3)

perceived that they received more information about the benefits of nuclear power generation ( $M = 4.81$ ,  $SD = .99$ ,  $F(1,359) = 40.95$ ,  $p < .001$ ,  $\eta^2 = .10$ ) than those in the control condition (condition 1) ( $M = 4.03$ ,  $SD = 1.29$ ), with one missing case.

As for the manipulation regarding the perceived amount of emergency preparedness information, the result of the ANOVA using the same question item in Analysis 2 indicated that there was no statistical difference between the control condition (condition 1) ( $M = 2.82$ ,  $SD = 1.49$ ) and the benefit-emphasis communication condition (condition 3) ( $M = 3.14$ ,  $SD = 1.71$ ,  $F(1, 360) = 3.49$ ,  $p = .06$ ). The results showed that both manipulations were successfully implemented. Specifically, participants in condition 1 and condition 3 perceived a different amount of benefit-emphasis information, but the same amount of emergency preparedness information from the stimulus webpages.

***Effects of benefit-emphasis communication.*** The conditional mediation analysis was conducted to predict local (y1) and general acceptability (y2) of a nuclear power plant, entering confidence (m1), concern (m2), honesty (m3), positive emotions (m4), and negative emotions (m5) as mediators. Subjective knowledge was treated as a moderator, which affected the relations between benefit-emphasis communication and each mediator as well as between each mediator and local (y1) and general acceptability (y2). Similar to the analysis for experiment 1, age, gender, race, education, work experience in the nuclear industry, and involvement in anti-nuclear campaigns were used as control variables.

First, as conducted in Experiment 1, the total effects of benefit-communication on local and general acceptability were examined using OLS regressions. The result showed that benefit-emphasis communication did not exert significant influence on local (y1) or general acceptability (y2) of a nuclear power plant (Table 12).

**Table 12.** Simple Regression Model Predicting Local Acceptability and General Acceptability (N = 362)

	<u>Local Acceptability (y1)</u>		<u>General Acceptability (y2)</u>	
	<i>B</i>	<i>SE B</i>	<i>B</i>	<i>SE B</i>
Constant	4.15***	.50	4.73**	.47
Benefit-Emphasis Communication	.04	.10	.15	.09
Covariates				
Age	-.02*	.01	-.01	.01
Gender (Male)	-.07**	.20	-.05**	.02
Race (White)	.78**	.28	.46	.26
Education (College-educated or more)	.18	.20	.45*	.19
Work at the nuclear industry	1.05*	.45	.67	.42
Involvement in anti-nuclear campaigns	-.34	.79	-1.58*	.73
<i>R</i> <sup>2</sup>	.07		.08	
<i>F</i> (7, 354)	4.05***		4.22***	

Note. \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

Conditional mediation models for local (y1) or general acceptability (y2) including five mediators (m1 - m5: confidence, concern, honesty, positive emotions, and negative emotions) and a moderator (subjective knowledge) were tested. Table 13 and Table 14 demonstrated that benefit-emphasis communication was not correlated with any of the mediators discussed in Experiment 1. In other words, benefit-emphasis communication did not influence respondents' perceptions of trust toward a nuclear plant operator and their positive and negative emotions.

While none of indirect effects were identified, Table 14 showed the direct effect of benefit-emphasis communication on general acceptability (y2) when controlling for trust and emotion variables. Table 14 also illustrated that respondents' perceptions of the plant operator as concerned about the public and the environment (concern [m2]), and their positive (m4) and negative emotions (m5), were significant predictors of local (y1) and general acceptability (y2) of a nuclear power plant. Another social trust dimension, honesty (m3) predicted only local acceptability (y1). However, conducting benefit-emphasis communication did not affect those variables, concern (m2), honesty (m3), positive emotions (m4), and negative emotions (m5).

**Table 13.** Moderated Mediation Model of Trust and Emotions on Local and General Acceptability: Mediators (N = 362)

	Outcome: Mediators								
	<u>Confidence (m1)</u>			<u>Concern (m2)</u>			<u>Honesty (m3)</u>		
	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI
Constant	.18	.26	[-.34, .70]	-.17	.30	[-.76, .42]	.68*	.26	[.11, 1.26]
Benefit-Emphasis Communication	.03	.06	[-.09, .14]	-.01	.07	[-.14, .12]	-.02	.07	[-.15, .11]
Moderation									
Subjective Knowledge	-.01	.04	[-.10, .07]	-.12*	.05	[-.21, -.02]	.06	.05	[-.04, .15]
Benefit-Emphasis Communication x Subjective knowledge	-.02	.04	[-.10, .06]	.03	.05	[-.06, .12]	.01	.05	[-.08, .10]
Covariates									
Age	.00	.00	[-.01, .01]	.00	.01	[-.62, .94]	-.02**	.01	[-.03, -.01]
Gender (Male)	-.02	.01	[-.04, .01]	.00	.01	[-.03, .03]	.00	.01	[-.03, .03]
Race (White)	.09	.16	[-.23, .41]	.26	.19	[-.12, .64]	.04	.18	[-.30, .39]
Education (College-educated or more)	.08	.12	[-.16, .33]	.00	.14	[-.27, .27]	-.06	.14	[-.34, .21]
Work in the nuclear industry	.21	.27	[-.32, .73]	.16	.40	[-.62, .94]	-.08	.34	[-.76, .60]
Involvement in anti-nuclear campaigns	-1.64	.97	[-3.54, .26]	-1.34	.86	[-3.02, .35]	-.98	.80	[-2.56, .60]
<i>R</i> <sup>2</sup>		.05			.05			.04	
<i>F</i> (9, 352)		.93			1.41			1.59	

Note. Bootstrap resamples = 10,000. \*\*  $p < .01$ , \*  $p < .05$

**Table 13** (Cont'd.)

	Outcome: Mediators					
	Positive Emotions (m4)			Negative Emotions (m5)		
	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI
Constant	.61	.35	[-.13, 1.35]	.12	.28	[-.44, .67]
Benefit-Emphasis Communication	.08	.15	[-.08, .24]	.09	.06	[-.03, .20]
Moderation						
Subjective Knowledge	.10	.05	[-.01, .21]	<b>.08*</b>	<b>.04</b>	<b>[.002, .16]</b>
Benefit-Emphasis Communication x Subjective knowledge	.04	.10	[-.07, .15]	.00	.40	[-.07, .08]
Covariates						
Age	-.01	.01	[-.02, .01]	.00	.00	[-.01, .01]
Gender (Male)	<b>-.05**</b>	<b>.22</b>	<b>[-.08, -.02]</b>	.01	.01	[-.02, .03]
Race (White)	.25	.22	[-.19, .68]	-.18	.17	[-.52, .16]
Education (College-educated or more)	.26	.17	[-.07, .60]	-.24	.13	[-.49, .003]
Work in the nuclear industry	.45	.29	[-.13, 1.03]	-.30	.21	[-.72, .11]
Involvement in anti-nuclear campaigns	-.87	.75	[-2.34, .60]	<b>3.29***</b>	<b>.47</b>	<b>[2.37, 4.22]</b>
<i>R</i> <sup>2</sup>		.07			.18	
<i>F</i> (9, 352)		<b>2.86*</b>			<b>7.81***</b>	

Note. Bootstrap resamples = 10,000. \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

**Table 14.** Moderated Mediation Model of Trust and Emotions on Local and General Acceptability: Dependent Variables (N = 362)

	Local Acceptability (y1)			General Acceptability (y2)		
	<i>B</i>	<i>SE</i>	95% CI	<i>B</i>	<i>SE</i>	95% CI
Constant	<b>3.96***</b>	<b>.44</b>	<b>[3.10, 4.82]</b>	<b>4.82***</b>	<b>.36</b>	<b>[4.12, 5.52]</b>
Benefit-Emphasis Communication	.06	.09	[-.13, .24]	<b>.16*</b>	<b>.07</b>	<b>[.01, .30]</b>
Mediation						
Confidence (m1)	.04	.11	[-.21, .28]	.21	.11	[-.001, .42]
Concern (m2)	<b>.23*</b>	<b>.12</b>	<b>[.02, .43]</b>	<b>.28**</b>	<b>.09</b>	<b>[.11, .45]</b>
Honesty (m3)	<b>.32*</b>	<b>.13</b>	<b>[.07, .58]</b>	.18	.10	[-.01, .37]
Positive Emotions (m4)	<b>.17*</b>	<b>.08</b>	<b>[.01, .33]</b>	<b>.22**</b>	<b>.07</b>	<b>[.07, .36]</b>
Negative Emotions (m5)	<b>-.28**</b>	<b>.09</b>	<b>[-.46, -.11]</b>	<b>-.43***</b>	<b>.08</b>	<b>[-.59, -.27]</b>
Moderation						
Subjective Knowledge	<b>.22**</b>	<b>.07</b>	<b>[.08, .35]</b>	.02	.05	[-.09, .13]
Confidence (m1) x Subjective Knowledge	.07	.08	[-.09, .24]	-.11	.08	[-.25, .04]
Concern (m2) x Subjective Knowledge	.07	.63	[-.06, .19]	.03	.06	[-.08, .14]
Honesty (m3) x Subjective Knowledge	-.06	.09	[-.23, .11]	.04	.06	[-.07, .16]
Positive Emotions (m4) x Subjective Knowledge	-.02	.05	[-.12, .08]	.02	.05	[-.07, .12]
Negative Emotions (m5) x Subjective Knowledge	.05	.07	[-.08, .18]	.00	.06	[-.13, .13]
Covariates						
Age	-.01	.01	[-.03, .003]	.00	.01	[-.02, .01]
Gender (Male)	<b>-.05*</b>	<b>.02</b>	<b>[-.08, -.01]</b>	<b>-.04*</b>	<b>.02</b>	<b>[-.07, -.01]</b>
Race (White)	<b>.56*</b>	<b>.24</b>	<b>[.09, 1.04]</b>	.25	.21	[-.17, .66]
Education (College-educated or more)	.04	.19	[-.35, .42]	.31	.16	[-.001, .62]
Work in the nuclear industry	.76	.49	[-.21, 1.73]	.34	.35	[-.35, 1.04]
Involvement in anti-nuclear campaigns	1.04	.77	[-.47, 2.54]	.86	.67	[-.47, 2.18]
<i>R</i> <sup>2</sup>		.32			.48	
<i>F</i> (18, 351)		<b>12.80***</b>			<b>24.71***</b>	

Note. Bootstrap resamples = 10,000. \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

## Summary of Findings and Results

This chapter posited three research questions (RQ4, RQ5, and RQ6) and six hypotheses (H1 - H6) to examine the effects of emergency preparedness communication. This section summarize the findings and results of the experiments by reviewing the research questions and hypotheses.

The first research question in this chapter, **RQ4** (*How does emergency preparedness communication influence local and general acceptability of a nuclear power plant?*) was set to explore the total effect of emergency preparedness communication on local and general acceptability of a nuclear power plant. The analysis showed no significant influence of emergency preparedness communication on local or general acceptability. This result corresponds with past literature showing contradictory findings on the influence of disclosing risk on the public's perceptions and emotions. Therefore, this study particularly focused on the concept of trust and positive and negative emotions as mediators that could bridge the effects of emergency preparedness communication and people's acceptability of nuclear power.

Based on past literature on the dimensionality of the trust concept, **RQ5** (*How many and what dimensions does the trust concept hold?*) was examined so as to define and conceptualize the concept of trust in the current study. The results of EFA identified three dimensions of trust: confidence, concern, and honesty. While confidence is based on people's perception of the trustee's ability and expertise, the latter two, concern and honesty, are related to social trust, which derive from non-performance aspects of trust, such as value similarity. This study employed this trust dimensionality and treated the elements of trust as key variables in the following experiments.

Experiment 1 examined the effect of emergency preparedness communication on local and general acceptability of a nuclear power plant, using the three trust dimensions and emotions (positive and negative) as mediator and subjective knowledge as a moderator.

The findings from Experiment 1 provided clear answers to the hypotheses and the rest of the research questions. As for trust dimensions, the author hypothesized that emergency preparedness communication would enhance trust (H1) and that enhanced trust would increase local (H2a) and (H2b) general acceptability of a nuclear power plant. Furthermore, RQ6 (1) and (2) asked about the moderating influences of subjective knowledge on the relation between (1) emergency preparedness communication and trust dimensions and (2) trust dimensions and (a) local and (b) general acceptability.

The results of the analyses showed that emergency preparedness communication was related to two of the three trust dimensions: concern and honesty. Emergency preparedness communication was always a positive predictor of honesty. However, emergency preparedness communication was positively correlated to concern only when respondents claimed that they were very knowledgeable about the issue of nuclear power. When respondents felt that they were unfamiliar with the issue, being informed of emergency preparedness decreased their perception of the plant operator as concerned about the public and the environment. There was no significant relation between emergency preparedness communication and the Confidence dimension of trust. Combined with the finding related to **RQ6 (1)**, this study concluded that **H1** was partially supported.

As for the mediation effects of the trust dimensions between emergency preparedness communication and local (H2a) and general acceptability (H2b) of a nuclear station, the results demonstrated that the honesty dimension of trust was a mediator between emergency

preparedness communication and local acceptability: Higher honesty led to high local acceptability. The concern dimension also positively predicted local acceptability but only when respondents' subjective knowledge was high (**RQ6 (2) (a)**). Confidence had no significant effects on local acceptability. Therefore, **H2a** was partially supported. Regarding general acceptability, neither concern nor honesty was correlated with this type of acceptability. Confidence was a positive predictor of general acceptability, while this trust dimension was not related to emergency preparedness communication. Although the confidence dimension of trust did not function as a mediator between emergency preparedness communication and general acceptability, **H2b** was partially supported.

**H3** (*Emergency preparedness communication decreases positive emotions toward a nuclear power plant*) and **H4** (*Positive emotions are positively correlated to (a) local and (b) general acceptability of a nuclear power plant*) focused on positive emotions, instead of the trust dimensions. The results showed that **H3**, **H4(a)**, and **H4(b)** were all supported. Positive emotions were full mediators between emergency preparedness communication and (a) local and (b) general acceptability of a nuclear power station.

This study also hypothesized that the emergency preparedness communication increased negative emotions (**H5**: *Emergency preparedness communication increases negative emotions toward a nuclear power plant.*), which would be negatively correlated to (a) local and (b) general acceptability (**H6**: *Negative emotions are negatively correlated to (a) local and (b) general acceptability of a nuclear power plan*). The results showed that strong, but limited effects of negative emotions. Emergency preparedness communication increased negative emotions (**H5** was supported). Such negative emotions contributed to (a) local and (b) general acceptability, but as for (a) local acceptability the influence of negative emotions was significant only when

participants' subjective knowledge was low. Therefore, considering the moderating effect of subjective knowledge (**RQ6 (6) (a)**), **H6a** was partially supported and **H6b** was fully supported.

Regarding **RQ6**, no moderation effects were found in the relations between variables except those mentioned above; namely, in the relations between the concern dimension of trust and (a) local acceptability (**RQ6 (2)(a)**) and between negative emotions and local acceptability (**RQ6 (6)(a)**).

Experiment 2 replicated Experiment 1, but changed the treatment condition to benefit-emphasis communication and confirmed that the effects observed in Experiment 1 were triggered by the content of communication (emergency preparedness), not simply by the presence of additional information.

## **Chapter 5 Discussion and Future Studies**

Independent, but conceptually related, the two studies in Chapter 3 (content analysis) and Chapter 4 (experiments) revealed what nuclear power plants in the United States have primarily communicated with the public and what communication should be conducted to achieve public support for nuclear power plants. This chapter integrates findings and discussion from both methods to generate a holistic discussion on emergency preparedness communication. This section functions as a bridge between both chapters and concludes the current dissertation by discussing how studies on emergency preparedness communication can be advanced in the future.

### **Discussion**

#### **Counterbalancing the Effects between Trust and Emotions**

The results of moderated mediation analyses in Chapter 4 explained that emergency preparedness information influences local acceptability through the opposing mediating effects between emotions and trust dimensions: Emergency preparedness communication increased negative emotions, and also decreased positive emotions among the audience. However, emergency preparedness communication concurrently enhanced the public's perception of social trust (concern and honesty) toward the communicator. As a result, the negative effects of emergency preparedness communication on local acceptability exerted through decreased positive and increased negative emotions were balanced out with enhanced trust.

As risk communicators have assumed, it is true that communicating emergency-related information does impact the audiences' emotions. In this sense, it seems reasonable for nuclear plant operators to place little emphasis on past accidents and emergency preparedness in their communication efforts, as observed in Chapter 3. However, people shape their attitude about

acceptability using not only their emotions, but also their perception of trust toward the plant operator. While positive and negative emotions consistently predicted both local and general acceptability, as Greenburg (2013) also argued, risk communicators should consider gaining the public's trust as one of the communication goals when attempting to achieve local acceptability of nuclear power stations.

The opposing mediation effect may not be appealing to risk communication managers, but it nevertheless provides an important implication to risk communication researchers and practitioners. By distributing emergency preparedness information to the public, the motives behind local acceptability shift from emotion-based evaluations, such as positive and negative feelings, to trust-based judgements. Namely, it shifts perceptions of the communicator as concerned and honest. Studies have shown that when people feel more trust toward the authorities and the industry, they are more likely to prepare for a possible accident (Paton, 2008) and follow instructions and directions during a disaster (Coppola & Maloney, 2009; Haddow & Haddow, 2014).

In fact, as Palenchar and Heath (2007) claimed, it is ethically questionable that negative emotions such as fear and anxiety should be erased so as to encourage local residents to accept a risk-generating facility. Nuclear power plants indeed entail some risk and cannot (and should not) be guaranteed as completely safe. Along these lines, nuclear power plants need to be “adequately” feared. Negative emotions help to keep residents vigilant about the possibility of an emergency event and motivate the public to learn about emergency response planning and preparedness (Heath & Palenchar, 2000, 2009).

### **Different Mechanisms behind General and Local Acceptability**

The study demonstrated that when people think about accepting a nuclear power plant as a general issue, the ability-based trust dimension, confidence, only influenced the acceptability along with positive and negative emotions. Either dimension of social trust, concern or honesty did not function as a predictor of this type of acceptability. In contrast, when people were asked whether they would accept a nuclear power plant within their community, social trust dimensions, namely, concern and honesty contributed to enhancing their local acceptability. However, confidence became a non-significant predictor of this type of acceptability. Therefore, these findings suggest that it is crucial for nuclear plant operators to show empathic concerns to the public and be transparent and honest about their operation as much as possible if they seek acceptance from local residents for a new nuclear power station. Demonstrating expertise and knowledge, as seen in the websites of nuclear power plants explaining accident prevention measures (see Chapter 3), may be effective to acquire general acceptance, but not effective to achieve local support for nuclear stations. This echoes Engdahl and Lidskog (2014)'s recommendation, which claimed that risk messages can explicitly appeal to moral emotions such as sympathy and compassion, to be effective and ethical.

### **Importance of Subjective Knowledge**

This study also suggested the non-negligible influences of subjective knowledge on key predictors of local acceptability. As the experiment showed, when people think that they know about nuclear issues, they perceive that nuclear plant operators are concerned about the public and the environment, if they are informed of possible emergencies and response plans. The knowledgeable public loses their trust if they are not informed about emergency preparedness by

the operator. On the flip side, when people do not feel that they are knowledgeable about the issue, communicating emergency preparedness may have negative impacts on their trust.

This discussion provides two important suggestions to risk communicators in the nuclear industry. First, as literature on message sidedness posits (Allen, 1991; Crowley & Hoyer, 1994), people who know about the issue tend to demand two-sided information, such as information on both benefits and risks of nuclear power generation. However, a less knowledgeable public may not be favorable toward such two-sided information. Risk communicators should examine audiences' knowledge levels before crafting the message. Second, contrary to the assumption in the TCC model, which postulates that people rely on trust to make their decision when they feel that they are not knowledgeable about a certain issue, this study demonstrated that people always use trust to shape their attitude toward local acceptance of a nuclear plant. This is especially true when they are knowledgeable about the nuclear issue. These results imply that people never place blind trust in the communicator. In addition, people may start evaluating the dimensions of trust toward the communicator only when they feel they know about the topic. In this sense, building subjective knowledge can be regarded as a starting point for constructing trust. Furthermore, the experiment showed that the effect of negative emotions was alleviated by making the public think that they have enough knowledge about the issue. Building subjective knowledge can also be a way of overcoming the influences of emotions. Therefore, nuclear plant operators should strive to enhance the public's self-evaluation of their knowledge and understanding of the issue of nuclear power generation, rather than only providing technical information. Websites and other online media is one of the most suitable channels to achieve this goal.

## **Effects of Benefit-Emphasis Communication**

As an additional finding, benefit-emphasis communication was shown to increase general acceptability, but was not effective in influencing local acceptability. The effect of benefit-emphasis communication on local and general acceptability was not mediated by the trust dimensions or emotions that this study analyzed. The findings showed that if nuclear plant operators are seeking local support for building a new nuclear power plant in their area, communicating benefits does not effectively influence people's attitude about accepting the plant; it only impacts their attitude about their acceptance of nuclear power plants as a general issue. Moreover, regarding the effect on general acceptability, the findings demonstrated that trust and emotions do not explain the effect of benefit-information. There might be other variables that explain why benefit-emphasis communication leads to higher general acceptability of nuclear power plants.

This study suggests that emphasizing the benefits of nuclear power generation, as many websites of the U.S. nuclear power plants currently do (Chapter 3), helps to increase general acceptability of nuclear power plants. However, it does not contribute to enhancing trust or even positive emotions among the audience. Nuclear plant operators should understand the limitation of focusing on the benefits of nuclear power in their communication efforts.

## **Practical Implications**

Nuclear power plants in the United States provide emergency preparedness information to the public and exert effort beyond regulatory requirements. However, they do not appear to proactively disclose the information to a wider audience, namely to the general public outside the neighborhood. Instead, U.S. nuclear power plants tend to emphasize the benefits of nuclear power generation in their communication.

The current communication style of nuclear power plant operators, which places much stress on communication regarding the benefits rather than on the risks and emergency preparedness, may contribute to the acquisition of supportive public attitudes toward nuclear power generation in general. However, when it becomes an issue directly related to people's lives and environment, namely, when people need to decide whether they would accept a nuclear power plant within their community, communication focused on benefits does not help to force their acceptability toward a nuclear power plant. As experiments in this study have shown, although emergency preparedness communication does not increase general or local acceptability by proactively disclosing emergency response planning and preparedness to the public, nuclear companies can enjoy local acceptability based on public trust. Local acceptability based on public trust are beneficial to the company, as well as the public since such trust is crucial to encouraging the public to prepare for a possible disaster and follow instructions during an emergency (Paton, 2008). For this reason, nuclear power plants should take a further step to initiate emergency preparedness communication on a larger scale. For example, nuclear power plants can place more information on emergency response planning on their websites and other communication outlets.

### **Future studies**

Pre-crisis communication, such as emergency preparedness communication, is an important research area. Nevertheless, few studies have empirically discussed the status and the effects of pre-crisis communication. This dissertation is one of the first attempts to tackle this area of research and should be positioned as a cornerstone in the field. To advance the current dissertation and further develop research, future studies should explore the following points and perspectives.

## **Communication Objectives**

This study conducted a content analysis on online communication materials provided by U.S. nuclear power plants from an audience perspective (Chapter 3). Future studies can investigate the objectives and purposes that communicators (nuclear plant operators) intend in the messages. For example, this study discussed that nuclear plant operators did not stress emergency preparedness information on their websites. This was evidenced by the findings that the information was less observed than other themes on websites, and even when observed, it was usually placed in the pages that required more than two clicks to reach. Future, more detailed studies, can explore what plant operators think about informing the public of emergency preparedness and why such information is not delivered on their websites. In-depth interviews with key persons at nuclear companies would help to establish a clearer picture of online communication efforts.

## **Predictors of Subjective Knowledge**

This study treated subjective knowledge of nuclear power, or how much people think that they know about issues of nuclear power generation, as an important moderation term. The results of the experiments also suggested that subjective knowledge exerts various influences related to local acceptability. While this finding was valuable, one question arose. What makes people feel that they are knowledgeable about the issue? It was beyond the scope of the current dissertation to answer this question. From a practical perspective, future studies would help to advance research on emergency preparedness communication by revealing the antecedents of subjective knowledge and exploring the ways to equip the public with subjective knowledge.

Ho and her colleagues' study (Ho, Liao, & Rosenthal, 2015; Ho, Scheufele, & Corley, 2011) may shed light on the question on what makes subjective knowledge. Ho, Liao, and

Rosenthal (2015) observed traditional media attention and the amount of interpersonal communication as moderators that influence the perceived message effects on people's intention toward pro-environmental purchasing. Ho, Scheufele, and Corley (2011) also analyzed the influence of the attention people paid to the news media and interpersonal communication on people's risk-benefit assessment of nanotechnology. The results showed that the effect was moderated by elaborative processing of science related news. Both studies did not specifically touch upon the relation to subjective knowledge. However, it can be assumed that people's attention to the news media, interpersonal discussion, and their cognitive effort in processing information may be significantly related to people's perceptions that they know about a certain issue.

### **Influences of “Surface Psychology”**

While this study focused on analyzing the effects of emergency preparedness communication on audiences' trust and emotions toward a nuclear power plant as mediators, future research could scrutinize how such trust and emotion influences local and general acceptability in further detail. Past literature has argued that trust and emotions lead to acceptability via perceived risks and benefits, which Guo and Ren (2017) called “surface psychology” (p.115). By including the second-level of mediating effects by perceived risks and perceived benefits of nuclear power, future analyses could reveal how and why the trust dimensions and emotions lead to general and local acceptability. Furthermore, such analysis may explain why benefit-emphasis communication enhanced general acceptability without being mediated by trust or emotions.

## **Cultural Influences**

Lastly, this study only focused on the U.S. population, yet the author believes that cultural comparison would bring insightful implications on the effects of emergency preparedness communication on local and general acceptability of a nuclear power plant. Future researchers should be careful to see if the findings and practical implications retrieved from this dissertation can be applied to other cultural contexts.

There are many cultural contexts that future researchers need to be consider. For example, effects of trust in a nuclear power station may work in a different manner, depending on the public perceptions and expectations toward organizations and authorities in general. In a more hierarchical culture with higher power distance index scores using Hofstede's measurement (1991; 2001), people might expect nuclear plant operators to demonstrate ability-based trust (i.e. confidence) more than value-based trust (i.e. concern and honesty) to accept their operation. Furthermore, people in a country where the scores for uncertainty avoidance are high, such as Japan, might also respond to risk-related messages differently than those in low-uncertainty avoidance countries. People who are high in uncertainty avoidance might prefer to be informed of accident risks more than those who are low in uncertainty, only if the communicators can explicitly demonstrate that the risks are under control by communicating what response plans are in place.

Another factor to be taken in account in future research is people's familiarity and experience of nuclear power. For example, in Japan where one of the worst nuclear accidents in history occurred only six years ago, emergency-related information may trigger stronger negative emotions and weaker positive emotions, leading to lower local acceptability of a nuclear power plant. Overall, this study's framework should be further tested in other cultural contexts. In

examining the commonalities and differences in factors influencing people's feelings and attitudes depending on the context, future research could discuss how emergency preparedness information should be delivered to people with various cultural backgrounds.

## **APPENDICES**

## APPENDIX A. List of Nuclear Power Plants Analyzed in the Content Analysis

**Table 15.** List of Nuclear Power Plants Analyzed in the Content Analysis

Names of Nuclear Power Plant (in alphabetical order)	
Arkansas Nuclear	Millstone
Beaver Valley	Monticello
Braidwood	Nine Mile Point
Browns Ferry	North Anna
Brunswick	Oconee
Byron	Oyster Creek
Callaway	Palisades
Calvert Cliffs	Palo Verde
Catawba	Peach Bottom
Clinton	Perry
Columbia	Pilgrim
Comanche Peak	Point Beach
Cooper	Prairie Island
D.C. Cook	Quad Cities
Davis-Besse	River Bend
Diablo Canyon	Robinson
Dresden	Saint Lucie
Duane Arnold	Salem
Farley	Seabrook
FitzPatrick	Sequoyah
Fort Calhoun	South Texas
Ginna	Summer
Grand Gulf	Surry
Harris	Susquehanna
Hatch	Three Mile Island
Hope Creek	Turkey Point
Indian Point	Vogtle
La Salle	Waterford
Limerick	Watts Bar
McGuire	Wolf Creek

## APPENDIX B. Coding Sheet

### Nuclear Power Plant Website Analysis

Please code Yes = 1, No = 0 in the excel sheet too.

#### 0. Coding Information

Coding Date \_\_\_\_\_

Name of Coder \_\_\_\_\_

Name of Plant \_\_\_\_\_

Plant Owner \_\_\_\_\_

Plant Operator \_\_\_\_\_

Website URL \_\_\_\_\_

- Please browse all the pages of the plant website. If the plant has several websites (such as a corporate website and a plant website), please review all.

## 1. Communication

(1). Does the website provide an emergency booklet / guidebook in PDF format?

(a) In English? **Yes / No**

<b>(b) In Spanish?</b>	<b>Yes / No</b>
------------------------	-----------------

(c) In other languages? **Yes (Specify: \_\_\_\_\_) / No**

(2). Does the website have links to Social Media sites?

(a) Facebook? **Yes / No**

(b) Twitter?	Yes / No
1. Do you have a Twitter account?	
2. Do you use Twitter?	
3. Do you follow any Twitter accounts?	
4. Do you tweet?	
5. Do you retweet?	
6. Do you use Twitter for work?	
7. Do you use Twitter for personal use?	
8. Do you use Twitter for entertainment?	
9. Do you use Twitter for education?	
10. Do you use Twitter for research?	
11. Do you use Twitter for business?	
12. Do you use Twitter for social networking?	
13. Do you use Twitter for news?	
14. Do you use Twitter for politics?	
15. Do you use Twitter for sports?	
16. Do you use Twitter for health?	
17. Do you use Twitter for travel?	
18. Do you use Twitter for food?	
19. Do you use Twitter for art?	
20. Do you use Twitter for music?	
21. Do you use Twitter for science?	
22. Do you use Twitter for technology?	
23. Do you use Twitter for environment?	
24. Do you use Twitter for culture?	
25. Do you use Twitter for history?	
26. Do you use Twitter for literature?	
27. Do you use Twitter for philosophy?	
28. Do you use Twitter for psychology?	
29. Do you use Twitter for sociology?	
30. Do you use Twitter for anthropology?	
31. Do you use Twitter for linguistics?	
32. Do you use Twitter for biology?	
33. Do you use Twitter for chemistry?	
34. Do you use Twitter for physics?	
35. Do you use Twitter for mathematics?	
36. Do you use Twitter for computer science?	
37. Do you use Twitter for engineering?	
38. Do you use Twitter for architecture?	
39. Do you use Twitter for design?	
40. Do you use Twitter for fashion?	
41. Do you use Twitter for beauty?	
42. Do you use Twitter for health and fitness?	
43. Do you use Twitter for food and drink?	
44. Do you use Twitter for travel and tourism?	
45. Do you use Twitter for art and culture?	
46. Do you use Twitter for music and entertainment?	
47. Do you use Twitter for science and technology?	
48. Do you use Twitter for environment and nature?	
49. Do you use Twitter for culture and history?	
50. Do you use Twitter for literature and philosophy?	
51. Do you use Twitter for psychology and sociology?	
52. Do you use Twitter for anthropology and linguistics?	
53. Do you use Twitter for biology and chemistry?	
54. Do you use Twitter for physics and mathematics?	
55. Do you use Twitter for computer science and engineering?	
56. Do you use Twitter for architecture and design?	
57. Do you use Twitter for fashion and beauty?	
58. Do you use Twitter for health and fitness?	
59. Do you use Twitter for food and drink?	
60. Do you use Twitter for travel and tourism?	
61. Do you use Twitter for art and culture?	
62. Do you use Twitter for music and entertainment?	
63. Do you use Twitter for science and technology?	
64. Do you use Twitter for environment and nature?	
65. Do you use Twitter for culture and history?	
66. Do you use Twitter for literature and philosophy?	
67. Do you use Twitter for psychology and sociology?	
68. Do you use Twitter for anthropology and linguistics?	
69. Do you use Twitter for biology and chemistry?	
70. Do you use Twitter for physics and mathematics?	
71. Do you use Twitter for computer science and engineering?	
72. Do you use Twitter for architecture and design?	
73. Do you use Twitter for fashion and beauty?	
74. Do you use Twitter for health and fitness?	
75. Do you use Twitter for food and drink?	
76. Do you use Twitter for travel and tourism?	
77. Do you use Twitter for art and culture?	
78. Do you use Twitter for music and entertainment?	
79. Do you use Twitter for science and technology?	
80. Do you use Twitter for environment and nature?	
81. Do you use Twitter for culture and history?	
82. Do you use Twitter for literature and philosophy?	
83. Do you use Twitter for psychology and sociology?	
84. Do you use Twitter for anthropology and linguistics?	
85. Do you use Twitter for biology and chemistry?	
86. Do you use Twitter for physics and mathematics?	
87. Do you use Twitter for computer science and engineering?	
88. Do you use Twitter for architecture and design?	
89. Do you use Twitter for fashion and beauty?	
90. Do you use Twitter for health and fitness?	
91. Do you use Twitter for food and drink?	
92. Do you use Twitter for travel and tourism?	
93. Do you use Twitter for art and culture?	
94. Do you use Twitter for music and entertainment?	
95. Do you use Twitter for science and technology?	
96. Do you use Twitter for environment and nature?	
97. Do you use Twitter for culture and history?	
98. Do you use Twitter for literature and philosophy?	
99. Do you use Twitter for psychology and sociology?	
100. Do you use Twitter for anthropology and linguistics?	

(c) Instagram? **Yes / No**

(d) Pinterest? **Yes / No**

(e) YouTube?	Yes / No

(f) Other social media? **Yes (Specify: \_\_\_\_\_) / No**

## 2. Risk /Accident

(1). Does the website refer to accidents/incidents which actually occurred within the plant?

**Yes / No**

If Yes:

**How many times?** ( )

**When did the accident/incident happen?**

**(List all** )

(2). Does the website refer to the following major nuclear accidents?

(a) Three Mile

**Yes / No**

If Yes:

**How many times?** ( )

(b) Chernobyl

**Yes / No**

If Yes:

**How many times?** ( )

(c) Fukushima

**Yes / No**

If Yes:

**How many times?** ( )

(3). Does the website refer to any other accidents/incidents?

**Yes / No**

If Yes:

▪ **How many times?** ( )

▪ **What is the accident/incident?**

**(List all** )

▪ **When did the accident/incident happen?**

**(List all** )

### 3. Accident Prevention

(1) Does the website have information on accident prevention against technical failure?

**Yes / No**

If Yes:

- **What technical failure?**

(List all \_\_\_\_\_ )

- **If the information is also provided in other languages, please specify:**

(List all \_\_\_\_\_ )

(2) Does the website have information on accident prevention against human error?

**Yes / No**

If Yes:

- **What human error?**

(List all \_\_\_\_\_ )

- **If the information is also provided in other languages, please specify:**

(List all \_\_\_\_\_ )

(3) Does the website have Information on accident prevention against human factor? (E.g. Terrorism)

**Yes / No**

If Yes:

- **What human factor?**

(List all \_\_\_\_\_ )

- **If the information is also provided in other languages, please specify:**

(List all \_\_\_\_\_ )

(4) Does the website have information on accident prevention against natural disaster?

**Yes / No**

If Yes:

- **What natural disaster?**

(List all \_\_\_\_\_ )

- **If the information is also provided in other languages, please specify:**

(List all \_\_\_\_\_ )

#### 4. Preparedness / Emergency Plant

Excluding in Emergency Booklet/guidebook provided in PDF...

(1) Does the website have information on emergency sirens?

**Yes / No**

If Yes:

- **If the information is also provided in other languages, please list:**  
**(List all** )

(2) Does the website have information on evacuation plans? (E.g. shelters, routes, meeting points)

**Yes / No**

If Yes:

- **If the information is also provided in other languages, please list:**  
**(List all** )

(3) Does the website have information on emergency radio/TV stations?

**Yes / No**

If Yes:

- **If the information is also provided in other languages, please list:**  
**(List all** )

(4) Does the website have information on potassium iodide (KI) for thyroid protection?

**Yes / No**

If Yes:

- **If the information is also provided in other languages, please list:**  
**(List all** )

(5) Does the website have information on reparation / recovery plans?

**Yes / No**

If Yes:

- **If the information is also provided in other languages, please list:**  
**(List all** )

## 5. Other messages

(1) Does the website have information on community Involvement? (E.g. sponsorship, volunteerism)

**Yes / No**

If Yes:

- **What is it? (List all )**

(2) Does the website have information on environmental benefits? (E.g. Low carbon emission, harmony with nature)

**Yes / No**

If Yes:

- **What is it? (List all )**

(3) Does the website have information on economic impacts? (E.g. job opportunities)

**Yes / No**

If Yes:

- **What is it? (List all )**

(4) Does the website have visitor information? (E.g. Plant tours)

**Yes / No**

If Yes:

- **What is it? (List all )**

## APPENDIX C. Stimuli

Control condition (Condition 1)

SPT Energy Company

Potter Nuclear Power Plant

Home

About Us

How Nuclear Plants Work

Community Benefits


Environment

Safe and Secure

News and Resources

Frequent Questions


clean



air

water

energy



**Potter Nuclear Power Plant:**

Our Potter nuclear facility produces 1,212 megawatts of safe, reliable, and cost-effective power to our customers. For more than 20 years, the plant has produced the only source of carbon-free baseload power. Our top priority at Potter is the health and safety of the public and our workers. Please explore our website to learn more about Potter. In our website, you will find: operations, safety programs, security procedures and our environmental commitment. If you have question or comments, please send us an [e-mail](#).

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## Emergency preparedness communication condition (Condition 2)

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Potter Nuclear Power Plant

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Frequent Questions

Emergency Plan

clean



air  
water  
energy



**Potter Nuclear Power Plant:**

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- If you hear the sirens

+ If told to "go inside - stay inside"

+ If you're advised to take shelter indoors

+ If you're told to leave (evacuate)

+ School children

+ Where to go

+ While you are away

+ Evaluation zones and routes

Emergency Plan:

Potter Nuclear Emergency Preparedness

This information is provided to ensure that the public is aware of what they should do in the unlikely event of an emergency at the Potter Nuclear Power Station.

- If you hear the sirens

**Check it out.** – It could be only a test. Siren tests last for approximately three minutes and occur in your area on the first Monday of each month at noon. The sirens may not be tested if there is severe weather in your area.

**Tune to one of your local radio or television stations and listen for instructions.** These local radio and television stations will carry the emergency broadcasts. Initially, information also will be broadcast over the XXYZ weather radio system (161.400 and 162.475 MHz). Remember, if you are not sure about the sirens, assume the warning is real.

WAAM-FM (104.3)

WBBM-FM (102.1)

WWCM-AM (1400)

WRJL-FM (99.9)

WDDW-FM (98.3)

**Check on your neighbors.**

**If the warning involves an incident at Potter,** you might be advised by radio, television or emergency responders' loudspeakers to go indoors and close all windows, doors and other sources of outside air.

**Do not use the phone unless absolutely necessary.** The phone lines need to be open for emergency workers.

**Do not call 911** for information if you hear the sirens.

**Familiarize yourself with the Prompt Notification System.**

+ If told to "go inside - stay inside"

+ If you're advised to take shelter indoors

+ If you're told to leave (evacuate)

+ Schoolchildren

+ Where to go

+ While you are away

+ Evacuation zones and routes

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## Benefit-emphasis communication condition (Condition 3)

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clean



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Frequent Questions

Why Nuclear Power?

- Benefits of Nuclear Energy

+ Lower Greenhouse Emissions

+ Powerful and Reliable

+ Economic Benefits

Why Nuclear Power?

- Benefits of Nuclear Energy

Nuclear energy accounts for roughly 20 percent of U.S. electricity generation and more than 11 percent of electricity worldwide. Using nuclear power to generate electricity provides many benefits: it's low carbon, it diversifies our electricity supply, it operates reliably on a constant basis, and it provides substantial economic benefits in communities where plants operate and to U.S. companies who supply the global nuclear industry.

Unlike fossil fuels, nuclear energy does not create greenhouse gases when generating clean, reliable baseload electricity. If all the nuclear plants operating worldwide were replaced with plants using natural gas, more than 1.3 billion additional tons of carbon dioxide would be emitted into the atmosphere each year.

Currently, there are more than 440 operating nuclear power reactors worldwide, most of which use enriched uranium for fuel, including 99 reactors in the United States. Operating nuclear power reactors have a generating capacity of more than 380,000 megawatts of electric power. Thirty-one nations rely on nuclear energy for a portion of their electricity supply.

There are more than 60 reactors under construction in 15 countries around the world including China, Russia, India, France, Finland and Korea. In the United States, five reactors are under construction and expected to begin operations by the end of the decade.

Rising global demand for electricity will make nuclear an increasingly important source of energy in coming years. For example, China expects its need for electricity to quadruple in the next 20 years. Meeting this demand without causing extensive air pollution or additional carbon emissions will require expanded use of nuclear power.

+ Lower Greenhouse Gas Emissions

+ Powerful and Reliable

+ Economic Benefits to Local Communities

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## APPENDIX D. Questionnaire

### Consent form

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

We invite you to participate in a study that involves your opinion about nuclear energy. The research is being conducted by a team of researchers at Michigan State University. The purpose of the research is to contribute to our better understanding of public perceptions and attitudes toward nuclear power. Your participation will take about 15 minutes. You must be 18 or older in order to participate.

As university based research, we are obligated to inform you of the following:

1. Your participation in this study is voluntary. You may choose not to participate at all, or you may refuse to answer certain questions or discontinue your participation at any time without consequences, but you need to complete the bulk of the survey to receive payment.
2. Your participation in this study is not expected to cause you any risk greater than those encountered in everyday life. Your answers will not harm you in any way. If you feel any discomfort in answering any question, you can withdraw from the study without any consequences.
3. If you have any questions about your rights as a participant, please contact Dr. Manuel Chavez by email: [chavez1@msu.edu](mailto:chavez1@msu.edu). Further, if you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 5173552180, Fax 5174324503, or email [irb@msu.edu](mailto:irb@msu.edu) or regular mail at 408 W. Circle, 207 Olds Hall, MSU, East Lansing, MI 48824.

**By clicking next at the bottom of this screen, you indicate that you have voluntarily agreed to participate in this study.**

>>

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Issue relevance [Not used] (The order of items was randomized in the actual questionnaire.)

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

What do you think about the issues of the commercial use of nuclear power?

Not <u>important</u> to me at all	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Very <u>important</u> to me
Not <u>relevant</u> to me at all	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Very <u>relevant</u> to me
Not <u>interesting</u> to me at all	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Very <u>interesting</u> to me
Not <u>meaningful</u> to me at all	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Very <u>meaningful</u> to me
Not <u>valuable</u> to me at all	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Very <u>valuable</u> to me
Not <u>involving</u> to me at all	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Very <u>involving</u> to me

>>

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Subjective knowledge - general

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

How knowledgeable would you say you are about **the facts and issues** concerning nuclear power generation?

Not at all knowledgeable

Moderately knowledgeable

Extremely knowledgeable

☐ ☐ ☐ ☐ ☐ ☐ ☐

>>

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Subjective knowledge - benefits [Not used]

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

How knowledgeable would you say you are about the **benefits** of nuclear power generation?

Not at all knowledgeable      Moderately knowledgeable      Extremely knowledgeable

1 2 3 4 5 6 7

>>

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## Subjective knowledge - risks [Not used]

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

How knowledgeable would you say you are about the **risks** of nuclear power generation?

Not at all knowledgeable      Moderately knowledgeable      Extremely knowledgeable

1 2 3 4 5 6 7

>>

## Introduction - stimulus

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

Now you are going to see a website of a nuclear power plant.

Later, you will be asked to respond to questions about your opinions about the plant and nuclear energy in general. We will also ask about yourself at the end of questionnaire.

**Please review the website completely** so that you are able to answer the follow-up questions.

>>

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## Stimulus

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

[One of the stimuli (see Appendix C) was inserted here. ]

>>

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## Introduction - response

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

Now, please tell us your thoughts about **the nuclear power plant** (Potter Nuclear Power Plant) **that you just reviewed on the website.**

Please note that when we refer to the company that owns and runs the nuclear plant, we call it "operator."

>>

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## Manipulation check - Emergency preparedness communication

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much information does the website give you about **nuclear emergency preparedness and responses?**

Too little | ☐ ☐ ☐ ☐ ☐ ☐ ☐ Too much

>>

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## Manipulation check - Benefit-emphasis communication

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much information does the website give you about **the advantages of nuclear power generation**?

Too little | ● ● ● ● ● ● ● | Too much

>>

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## Emotions (The order of items was randomized in the actual questionnaire.)

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

After reviewing the website about a nuclear power plant, to what extent does the information on the website evoke the following feelings to you?

	Not at all				Moderately				Very well
Fear	●	●	●	●	●	●	●	●	●
Powerlessness	●	●	●	●	●	●	●	●	●
Worry	●	●	●	●	●	●	●	●	●
Satisfaction	●	●	●	●	●	●	●	●	●
	Not at all				Moderately				Very well
Hope	●	●	●	●	●	●	●	●	●
Calmness	●	●	●	●	●	●	●	●	●
Sadness	●	●	●	●	●	●	●	●	●
Anger	●	●	●	●	●	●	●	●	●
	Not at all				Moderately				Very well
Shame	●	●	●	●	●	●	●	●	●
Interest	●	●	●	●	●	●	●	●	●
Disgust	●	●	●	●	●	●	●	●	●

>>

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Trust dimensions (The order of items was randomized in the actual questionnaire.)

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much do you agree or disagree with the following statements on the operator of the nuclear power plant that you reviewed at the beginning?

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
The operator of the nuclear power plant values financial gain higher than me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The operator of the nuclear power plant does <b>not</b> consider human health to be important.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The operator of the nuclear power plant is only interested in their business.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The operator of the nuclear power plant is <b>not</b> interested in the consequences for the environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
The operator of the nuclear power plant openly communicates the possible risks of the nuclear power plant.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If there was evidence that nuclear power generating is harmful to human health, the operator of the nuclear power plant would inform the public in a timely manner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
One can trust information from the operator of the nuclear power plant.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The operator of the nuclear power plant has the required knowledge to estimate the risks of nuclear power generation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
The operator of the nuclear power plant has competence to solve problems related to nuclear power generation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The operator of the nuclear power plant has the necessary expertise to make good decisions on nuclear power generation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The operator of the nuclear power plant is candid in communication with the public.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The operator of the nuclear power tailors its communications to the public's specific needs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

>>

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## Introduction - opinion

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

Please tell us your opinions **about nuclear power plants** in general.

>>

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## Affective association -1 [Not used]

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

What are the **first three (3) words or phrases** that come to your mind when you hear the words "nuclear power plant"?

Association 1	<input type="text"/>	Association 1
Association 2	<input type="text"/>	Association 2
Association 3	<input type="text"/>	Association 3

>>

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## Affective association -2 [Not used]

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

If you think of the following words or phrases, do they evoke **negative or positive feelings** for you?

	Extremely negative	Moderately negative	Slightly negative	Neither positive nor negative	Slightly positive	Moderately positive	Extremely positive
Association 1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Association 2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Association 3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

>>

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## Risk perception - general [Not used]

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much do you agree or disagree that **nuclear power plants cause risks to the society?**

Strongly disagree   Disagree   Somewhat disagree   Neither agree nor disagree   Somewhat agree   Agree   Strongly agree

>>

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## Risk perception – local [Not used]

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much do you agree or disagree that **nuclear power plants cause risks to yourself** when they are built close by the place where you live? (e.g. About 10 miles away from your house)

Strongly disagree   Disagree   Somewhat disagree   Neither agree nor disagree   Somewhat agree   Agree   Strongly agree

>>

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## Attention check

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

This is a question to make sure you are not a robot automatically answering these questions. Please pick "2" and move on to the next question.

1



2



3



>>

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Benefit perception - general [Not used]

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much do you agree or disagree that nuclear power plants bring benefits to the society?

Strongly disagree

Disagree

Somewhat disagree

Neither agree nor disagree

Somewhat agree

Agree

Strongly agree

>>

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## Benefit perception -local [Not used]

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much do you agree or disagree that nuclear power plants bring benefits to yourself when they are built close by the place where you live? (e.g. About 10 miles away from your house)

Strongly disagree

Disagree

Somewhat disagree

Neither agree nor disagree

Somewhat agree

Agree

Strongly agree

>>

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## General acceptability

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

Would you favor or oppose building a new nuclear plant that is identical to the Potter Nuclear Power Plant, in other parts of the country?

Strongly oppose

Moderately oppose

Slightly oppose

Neither favor nor oppose

Slightly favor

Moderately favor

Strongly favor

>>

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## Local acceptability

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

Would you favor or oppose building a new nuclear power plant that is identical to the Potter Nuclear Power Plant, close by the place where you live? (e.g. About 10 miles away from your house)

Strongly oppose

Moderately oppose

Slightly oppose

Neither favor nor oppose

Slightly favor

Moderately favor

Strongly favor

>>

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## Introduction - demographic

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

We would like to ask several questions about your family and yourself.

>>

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## Proximity- 10 miles

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

Do you live within a **10-mile** radius of the closest nuclear power plant?

☐ Yes

☐ No

☐ I don't know

>>

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Proximity- 50 miles (This question was not displayed if respondents answered “Yes” on the prior 10-mile proximity question.)

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

Do you live within a **50-mile** radius of the closest nuclear power plant?

☐ Yes

☐ No

☐ I don't know

>>

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## Perceived reception of emergency preparedness information

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

Have you received information on nuclear emergency preparedness from your closest nuclear power plant?

☐ Yes

☐ No

☐ I don't know

>>

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## Knowledge about the closest nuclear power plant

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

Do you know the name of the nuclear power plant closest to the place where you live?

☐ Yes : Please write the name of the plant.

☐ No

>>

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## Familiarity with nuclear power plants' websites

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

How often do you check the websites of nuclear power plants?

Never

Rarely

Sometimes

Frequently

Very frequently

>>

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## Work in the nuclear industry/Participation in anti-nuclear campaigns

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS & SCIENCES

Do you or any of your immediate family members currently work, or have previously worked, in the nuclear industry (e.g. nuclear power plant, nuclear waste site, and other nuclear facilities)?

☐ Yes

☐ No

☐ I don't know

Do you or any of your immediate family members currently participate, or have previously participated, in any **anti**-nuclear power campaigns?

☐ Yes

☐ No

☐ I don't know

>>

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Cultural cognition [Not used] (The order of items was randomized in the actual questionnaire.)

**MICHIGAN STATE UNIVERSITY**  
 COLLEGE OF COMMUNICATION ARTS & SCIENCES

How much do you agree or disagree with the following statements?

	Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree
The government interferes far too much in our everyday lives.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sometimes government needs to make laws that keep people from hurting themselves	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It's not the government's business to try to protect people from themselves.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The government should stop telling people how to live their lives.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree
The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have gone too far in pushing equal rights in this country.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Our society would be better off if the distribution of wealth was more equal.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree
We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Discrimination against minorities is still a very serious problem in our society.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It seems like blacks, women, homosexuals and other groups don't want equal rights, they want special rights just for them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Society as a whole has become too soft and feminine.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

>>

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## Political orientation [Not used]

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

In general, would you describe your views about political issues as ...

Very conservative   Conservative   Neither conservative  
nor liberal   Liberal   Very liberal   Don't know

>>

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## Demographics

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

What is your gender?

☐ Male

☐ Female

Which of the following describes your race/ethnicity? You may select as many as apply.

☐ White   ☐ Asian

☐ Black or African American   ☐ Native Hawaiian or Other Pacific Islander

☐ Hispanic or Latino   ☐ Other

☐ American Indian or Alaska Native

In what year were you born (e.g. 1990)?

>>

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## Education

### MICHIGAN STATE UNIVERSITY COLLEGE OF COMMUNICATION ARTS & SCIENCES

What is the highest degree or level of school you have completed? If currently enrolled, mark the previous grade or highest degree received.

- ☐ No schooling completed
- ☐ Nursery school to 8th grade
- ☐ High school graduate, diploma or the equivalent (for example, GED)
- ☐ Some college credit, no degree
- ☐ Trade/technical/vocational training
- ☐ Associate degree
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Doctorate degree
- ☐ Professional degree (MD, JD etc)

>>

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## Income [Not used]

### MICHIGAN STATE UNIVERSITY COLLEGE OF COMMUNICATION ARTS & SCIENCES

In which income group do you belong? (Household annual income)

- ☐ Less than \$10,000
- ☐ \$10,000 - \$29,999
- ☐ \$30,000 - \$49,999
- ☐ \$50,000 - \$69,999
- ☐ \$70,000 - \$89,999
- ☐ \$90,000 - \$109,999
- ☐ More than \$110,000
- ☐ Prefer not to answer

>>

Survey Powered By Qualtrics

Zip code [Not used]

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

What is your ZIP code (e.g. 48824)?

>>

Survey Powered By Qualtrics

Comment [Not used]

**MICHIGAN STATE UNIVERSITY**  
COLLEGE OF COMMUNICATION ARTS & SCIENCES

Did you have any problems taking the questionnaire or is there anything else you would like to tell the researchers?

>>

Survey Powered By Qualtrics

## Debrief

**MICHIGAN STATE UNIVERSITY**  
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Thank you for taking this questionnaire.

We presented you a website about a nuclear power plant. Please note that the website was fictional and all entities, including the nuclear power plant, on the website do not exist.

☐ I understand that the website and the entities described in this survey are fictional, thus, do not exist.

>>

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## Closing

**MICHIGAN STATE UNIVERSITY**  
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Thank you for participating.

Your validation code is:

To receive payment for participating, click "Accept HIT" in the Mechanical Turk window, enter this validation code, then click "Submit".

Survey Powered By Qualtrics

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