Leadership Roles
in Energy and Environmental Projects

Hisae Takeuchi

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Hisae Takeuchi

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Wisdom to serve the world together

April 8th, 2020

Maria RH Takeuchi

Humans have been fighting over wealth and fame.
The world is dived into selfish communities.
The world is contaminated by our infinite desires.
Humans are blind to the scars of others.

Heaven is raising the alarm that awakens our wisdom
to learn from nature
to share all that we have gathered and obtained.
Our wisdom to serve the world together.

From time to time,
our reason waxes and wanes.
But it never disappears.
It will stream into the world.

We shall spring back to life
when we are united
full of wisdom and love.
We shall breathe tomorrow.
We shall breathe together.

General Abstract

Throughout history, it has been a considerable challenge to align people in order to make those from different organizations or different countries act on the same vision and achieve common goals. Merging two different cultures is the most significant task associated with an acquisition of any size of company according to Kotter. To align people, sound leadership is necessary, not only for commercial projects but also for projects in the public sector. This study focuses on some public energy and environmental projects in which I have been involved directly (as a project manager) or indirectly in order to investigate problems encountered and the solutions adopted from a perspective that highlights what were, in retrospect, missed opportunities in each project. A further goal is to look to the future and, from lessons learned, to determine primary leadership roles in energy and environmental projects.

The Nuclear Waste Management Organization of Japan (NUMO) was established in 2000 as the organization responsible for the deep geological disposal of specified radioactive waste. Their siting process was initiated through open solicitation of volunteer host communities. However, no communities came forward, with the exception of Toyo Town, which applied for a literature survey, the first step in a staged programme for selecting a disposal site, but then withdrew the application due to strong opposition in 2007.

The situation deteriorated after the Fukushima Daiichi accident. NUMO has suffered a loss of national/international credibility in the context of the geological disposal project. For this project, I first examined the history of high-level radioactive waste (HLW) management in Japan through a literature review based on key papers and reports on HLW management in Japan and the book authored by the then mayor of Toyo Town. This review was complemented by interviews with three key leaders of NUMO and the Agency for Natural Resources and Energy (ANRE), and I assessed how leaders in different key organizations communicated with each other and identified the rationale for the resulting characteristics of the overall programme. The objective is to investigate problems encountered and the solutions adopted from a perspective that highlights what were missed opportunities. A further goal is to determine a leadership role to allow HLW

management to move forward to the next stage of selecting candidate sites. Communication for correct scientific input between leaders of relevant organizations is of critical importance. Alliance with key organizations and commitment by the Government are also required. To win credibility and understanding for geological disposal, ethical responsibilities should be taken seriously by leaders of these organizations.

I also attempted to identify why the then mayor of Toyo Town failed and analyzed his behavior and leadership characteristics, including how he collaborated with NUMO and ANRE. I identified the pattern of Machiavellian leadership, which was most likely the reason why he lost credibility and public trust. To improve the future siting process, I identified suitable leadership for HLW management based on leadership theories. I determined that servant leadership is suitable because of its focus on the followers, with the achievement of organizational objectives being a subordinate outcome. With servant leadership characteristics, the leaders of NUMO, ANRE, and candidate municipalities may win trust because they value the people of the host communities and empower them to engage in decision-making during the siting process, which can help raise public acceptance.

Finally, I focus on the public project of the off-site environmental remediation in Fukushima because the reconstruction of Fukushima is one of the most important national projects in Japan.

The Japanese Government decided to implement environmental remediation after the Fukushima Daiichi Nuclear Power Plant (termed “1F” in Japan) accident on 11th of March 2011. As the initial additional annual dose target was set to be 1 mSv or less as a long-term goal, I examined the decision-making process taken by the then leaders, particularly the Minister of the Ministry of the Environment (MOE) who was responsible for the final decision. I found that technically based assessment of dose targets, health effects and risk-based approaches justified by experts were not communicated to the then Minister and officials of the MOE before the strategy of remediation was decided. I defined how such a decision was made based on leadership theories such as the Role Theory and the Cognitive Resources Theory. Academic leaders could have examined the Windscale accident (UK, 1957), which could be considered comparable to the 1F accident.

Environmental remediation could have been planned and implemented effectively while maintaining the highest possible safety standards and balancing the economic burden. Appropriate scientific input should have been provided by academic leaders to political and administrative leaders and such scientific justification should have been disclosed to the general public (especially the residents of Fukushima prefecture) so that the general public could develop trust in their leaders and more readily accept the decisions made.

When leaders implement complex energy and environmental projects, the most important leadership roles involve finding solutions based on scientific justifications under the given constraints, assessing the gain by the public using a smoothing approach based on ethics, and encouraging all stakeholders to change existing values to achieve such solutions, thus serving the well-being of the public. As leadership without scientific justification cannot be practical or effective for such projects, communication between leaders of relevant organizations is crucial for correct scientific input, and the roles of academic leaders need to be looked upon as more important for the future.

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Nomenclature

AEC	ASEAN Economic Community
AEC	Atomic Energy Commission
ANG	Adsorbed Natural Gas
ANRE	Agency for Natural Resources and Energy under the Ministry of Economy, Trade and Industry
ASEAN	Association of Southeast Asian Nations
Bq	Becquerel
CEZ	Chernobyl Exclusion Zone
COVID	Coronavirus
Cs	Cesium
DTAC	Domestic Technical Advisory Committee
FEPC	Federation of Electric Power Companies of Japan
HLW	High-level Radioactive Waste
I	Iodine
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ICSA	Intensive Contamination Survey Areas
ISF	Interim Storage Facility

ITAC	International Technical Advisory Committee
JAEA	Japan Atomic Energy Agency
JNC	Japan Nuclear Cycle Development Institute, renamed JAEA in 2005
METI	Ministry of Economy, Trade and Industry
MOE	Ministry of Environment
mSv	milliSievert
NEA	Nuclear Energy Agency
NIMTOO	Not in My Term of Office
NISA	Nuclear and Industrial Safety Agency
NPP	Nuclear Power Plant
NSC	Nuclear Safety Commission
NUMO	Nuclear Waste Management Organization of Japan
OECD	Organization for Economic Co-operation and Development
PNC	Power Reactor and Nuclear Fuel Development Corporation, reorganised as JNC in 1998
Po	Polonium
Pu	Plutonium
RWMC	Radioactive Waste Management Funding and Research Center
SDA	Special Decontamination Areas

STA	Science and Technology Agency, now Ministry of Education, Culture, Sports, Science and Technology
TEPCO	Tokyo Electric Power Co., Inc.
TRU	transuranic
U	Uranium
URL	Underground Research Laboratory

Chapter 1

Introduction

1.1. Background

1.1.1. Definitions of leadership and the field of leadership

“There are almost as many definitions of leadership as there are persons who have attempted to define the concept” according to Stogdill (1974). Bass (2008) concluded that how to define leadership generates drawn-out discussions and we must thus continue to accept both broad and narrow definitions, making sure we understand which kind is being used in any particular analysis. Differences in definitions reflect deep disagreement about identification of leaders and leadership processes among scholars (Yukl, 1989). For example, some theorists consider leadership to be a collective process shared among the members, while others believe that all groups have role specialization, including a specialized leadership role (Yukl, 1989). I believe that there are persons who have a great influence on those around them and such persons are usually open to specialized leadership roles in different projects. Whether or not such specialized leadership roles can be shared with other members depends on whether they can develop the next generation of leaders in their organizations (or project teams) during their projects. In any case, the definition of leadership should depend on the purpose to be fulfilled (Bass, 2008). Hence, at the point of departure for this study, I simply define leadership as the mind to serve others and the art to unite people and make people act on a vision for achieving a goal.

The confused state of the field of leadership is attributed to the disparity of approaches (e.g. Power-Influence Approach, Behavioral Approach, Trait Approach, Situational Approach), the narrow focus of most researchers, and the absence of broad theories that integrate findings from the different approaches (Yukl, 1989). Stogdill (1974) claimed that the endless accumulation of empirical data has not produced an integrated understanding of leadership. Gordon and Yukl (2004) pointed out the slow progress despite the attempts to identify the aspects of leadership that improve organizational performance by researchers in leadership over a half century. Researchers are still conducting research in different ways and new fields such as leader and leadership development have been emerging (e.g. Day *et al.*, 2014).

Nonetheless, it is obvious that leadership plays a critical role in the real world. Leadership is important not only for politics or business but also in our daily lives. As we make a living in society, we are influenced by many leaders from various organizations, even by scientific leaders from public organizations. Various types of leadership have been observed and discussed in our society. People often criticize a lack of leadership, in particular when they are faced with a crisis. Bill Gates stated that leaders have two equally important responsibilities in any crisis: solving the immediate problem and keeping it from happening again, and the COVID-19 pandemic is a case in point (Gates, 2020). Leadership by politicians and/or officials is often supported or spoiled (e.g. due to lack of scientific input or wrong scientific input) by scientific leaders; this is because political and/or administrative leaders cannot solve the immediate problem and prevent it from happening again by themselves. Actually, scientific input often affects their decision-making, not only in crisis but also in peacetime.

Interestingly, there is controversy regarding the importance of leadership, except for the definitions of leadership and approaches introduced above. For example, Pfeffer (1977) argued that organizational effectiveness depends primarily on factors beyond the leader's control, such as the economic conditions, governmental policies and technological change. In this study, I selected complex public projects in which such factors not be ignored. In other words, I am attempting to identify leadership roles in energy and environmental projects under such constraints under the assumption that leadership is important and that leadership can enhance the quality of project management in a public sector area.

As a project manager, I have observed many public leaders and scientific leaders who have tried but failed to solve critical problems in their energy and environmental projects. How should public leaders and scientific leaders play a leading role in order to achieve a solution? What are the leadership roles in their energy and environmental projects? Can academic leadership theories provide solutions to such problems? Bass (2008) stated that theories of leadership attempt to explain its nature and consequences and can be useful in improving prediction and control in the development and application of leadership. In order to consider the theses above, I first review studies on leadership and introduce changes in leadership theories.

1.1.2. Studies on leadership

Written principles of leadership go back nearly as far as the emergence of civilization and can be found in Egypt in the Instruction of Ptahhotep (2300 B.C.E) according to Bass (2008). Confucius in China of the sixth century B.C.E taught that leaders must set a moral example and Plato in Greece looked at the requirements for the ideal leader of the ideal state (Bass, 2008). Nowadays, students learn these kinds of philosophies at school. A great number of people read biographies of heroes or heroines and admire some specific leaders in history. Such reading provides readers with good opportunities to think about leaders' traits or behavior and readers often discuss whether such traits or behavior might be useful for current and future politics or business. From ancient times, leadership has been an important topic for politicians, military officers, scholars, managers, workers, etc. in addition to the general public.

In the academic field, books, articles, and papers on leadership already numbered in the several thousand by the time of 1989 (Yukl, 1989). I review the history of leadership theories briefly, but this study is carried out from the viewpoint of a practitioner, particularly as a project manager, and not from the viewpoint of a leadership theorist. The truth is that the field of leadership is an interdisciplinary one and publications on leadership can be found in a large variety of professional and practitioner journals covering several disciplines (Yukl, 1989).

A range of leadership theories has been developed and discussed throughout history. Trait theory was the mainstream among scholars for a long time, from the age of the ancient Greeks to the 1940s (e.g. Plato, Machiavelli). Those who believed that a "leader was born, not made" tried to define common traits of great leaders; however, how to measure or evaluate such traits was not clear. Despite a huge amount of research, traits that could ensure successful leadership were not found (Stogdill, 1974). Contrary to the trait theory, behavioral theory, which emerged in the 1940s, focused on the nature of managerial work, the classification of managerial behavior, and the relationship between managerial behavior and managerial effectiveness (Yukl, 1989). For example, task-oriented behavior and relationship-oriented behavior were compared and the relationship between each type of behavior and leadership effectiveness was examined (e.g. Misumi, 1985). However, a leader's behavior is not the only factor that influences effectiveness. Although traits of leaders influence their behavior, the behavioral approach seldom included traits of leaders (Yukl, 1989).

The situational theory emerged in the 1960s with the assumption that there was not an absolute and only leadership style which could be adapted to all situations. The situational approach focuses on situational factors such as time, leader discretion, and circumstances, which were considered to determine the emergence of a leader. For example, role theory describes how a situation influences managerial behavior and cognitive resource theory examines the conditions under which a leader's cognitive resources such as intelligence and experience are related to group performance (Yukl, 1989).

In the 1970s, when the US was facing a prolonged economic slump, the charismatic leadership theory and transformational leadership theory attracted a lot of attention. Many companies needed to change drastically in order to win the economic competition with foreign companies. According to Yukl (1989), in contrast with the leadership theories introduced above, charismatic and transformational theories are "broader in scope; they simultaneously involve leader traits, power, behavior, and situational variables." Charismatic leaders must be "persons of strong convictions, determined, self-confident, and emotionally expressive" (Bass, 2008) and their followers accept and obey such leaders without question. Transformational leadership is described as a process of influencing followers and major changes in the culture and strategies of an organization or social system (Yukl, 1989). According to Burns (1978), who created a sensation with his transformational leadership theory, transformational leaders "motivate their followers by raising their followers' concerns from security and belonging to achievement and self-actualization, and by moving them beyond self-interest to concerns for their group, organization, or society" (Bass, 2008). Burns contrasted transformational leadership to transactional leadership (transactional leadership emphasizes the exchange that occurs between a leader and followers), but Bass demonstrated that empirically transformational leadership and transactional leadership were two positively correlated dimensions (Bass, 1985). The transformational leadership theory has been developed in many studies such as Bass's and is still popular among both academic researchers and practitioners.

Also emerging in the late 1970s was the servant leadership theory, which emphasizes ethics and the highest priority of other's needs. Although there are many similarities between servant leadership and transformational leadership, servant leadership has been less studied compared with transformational leadership.

Besides the leadership theories introduced above, a great number of leadership theories (e.g. Leader-Member Exchange Theory, Contingency Theory) have been developed and discussed all over the world. Effective leadership and how to develop leadership have been prominent concerns, not only to academics but also to practitioners.

Day *et al.* stated that leadership development emerged as an active field of theory building and research which provides a more scientific and evidence-based foundation to increase long-term practitioner interest in the topic (Day *et al.*, 2014). Based on a review of twenty-five years of research and theory (focusing on research published in the journal of "The Leadership Quarterly") to identify advances in scholarly approaches to leader and leadership development, they concluded that the field of leadership development is still relatively immature despite the significant advances in understanding it.

The field of public leadership is also immature. Vogel and Masal (2015) claimed that public leadership remains an elusive concept despite of a great number of publications on this topic and the fragmented state of this field makes it difficult to gain an overview of the various streams of research and how they relate to each other. They also stated that, in research on public leadership, the emphasis is still on the aspect of leadership rather than on the public element and very few works provide insights into the particularities of leadership in the public sector. For example, the least explored element of public leadership concerns followers (Vogel and Masal, 2015). However, to implement energy and environmental projects, public leaders need to encourage various stakeholders to become followers. This is one of the most important elements of public leadership to be explored.

Furthermore, Gordon and Yukl pointed out that researchers have started to recognize the need to merge leadership theory and practice (e.g. Zaccaro and Horn, 2003) but there is a lack of collaborative effort between academics and practitioners. They therefore suggested that academic researchers should include alternative methodologies such as comparative case studies (Gordon and Yukl, 2004). It should be meaningful to conduct qualitative research such as comparative case studies and gain insights into the particularities of leadership in public energy and environmental projects both for academics and practitioners.

1.1.3. Leadership theories related to this study

Discussions on past leadership, both on successful and unsuccessful leadership, may help us to solve current or future problems. As might be expected, there is not an absolute single leadership theory that can lead to a solution to all problems. Nonetheless, it can be fruitful to discuss how leadership theories can help to achieve the solution to each problem from the perspective of a project manager.

To implement public energy and environmental projects, building and maintaining acceptance by a wide range of stakeholders is generally required and scientific justification is important. This study focuses on HLW disposal in Japan and environmental remediation in Fukushima of Japan. As radionuclide is hazardous to life and the environment, it is crucial for leaders to gain the understanding of the general public in order to implement such formidable projects, and leadership which emphasizes valuing people and ethical responsibilities to society is required by the general public.

In this study, the processes of such public projects and leaders' behaviour are analyzed based on existing leadership theories. In particular, the three leadership theories below are selected because two of them have been well-studied for public projects due to the characteristics of both leadership (e.g. Slack *et al*., 2020, Wright and Pandey, 2009). The other theory has been compared with the two theories (e.g. Sendjaya and Cooper, 2011). These three theories are fully examined and used in this study in order to achieve a solution to each problem.

1.1.3.1. Machiavellian leadership and related research

Machiavellian leaders' motivation is to obtain power and use it skillfully. Typical Machiavellian leaders are pragmatic and try to maximize their self-interests. They believe they can manipulate or deceive others because the ends justify the means (Machiavelli, 1961). Bass (2008) explained that highly Machiavellian presidents, as measured on the Mach Scale developed by Christie and Geis (1970), were high in their levels of expressive activity, self-confidence, emotional regulation, and the desire to be influential. Due to its controversial characteristics and effectiveness, there remain many heated debates about Machiavellian leadership (e.g., President Trump (Brunello, 2019, Ignatius, 2016)).

Sendjaya and Cooper (2011) surveyed two for-profit and two not-for-profit organizations in Australia to examine the dimensionality and demonstrate the validity of the Servant Leadership Behavior Scale (SLBS). They measured "Machiavellian leadership orientation" and "Servant leadership behavior" using the Machiavellianism scale (Mach IV) (Deluga, 2001) and SLBS, respectively (they also measured other factors such as social desirability, but these measurements were excluded because they are irrelevant to this study). Mach IV consists of 20 items and they used this scale (e.g. gets ahead by cutting corners here and there) to assess the respondents' direct leaders, where each item is rated on a 7-point scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). On the other hand, SLBS consists of 35 items, comprising six factors such as responsible morality (e.g. takes a resolute stand on moral principles) with which respondents rate their direct leaders' or supervisors' servant leadership behavior on a 5-point scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree") (Sendjaya and Cooper, 2011). They found a strong negative correlation ($r = -0.65$, $p < 0.5$) between servant leadership and Machiavellian leadership orientation, which suggests that "Machiavellian behaviors squarely contradict those of servant leadership". Considering the contrast between the two theories, they determined that servant leadership has many appeals both for researchers and practitioners as a holistic model which incorporates various dimensions such as morality and integrity (Sendjaya and Cooper, 2011).

1.1.3.2. Brief review of the servant leadership theory and related research

According to Wart (2003), the major characteristic of the servant leadership theory is the emphasis on ethical responsibilities to followers, stakeholders, and society. Bass (2008) describes servant leaders (in this study, a servant leader means a leader who shows servant leadership) as those who are especially concerned about their constituencies with less power or at a disadvantage. Robert K. Greenleaf, the founder of the servant leadership theory, said that Hermann Hesse's novel *Journey to the East* inspired his idea of servant leadership, which emerged after he became deeply involved in colleges and universities during the period of campus disputes in the late 1960s and early 1970s. According to Greenleaf (1977), "the servant-leader is servant first. It begins with the natural feelings that one wants to serve, to serve first." Greenleaf's theory is based on his own experience at AT&T as well as acting as a consultant for businesses, foundations, professional societies, church organizations, and universities in the US, Europe, and developing nations. The core of Greenleaf's theory is the dimension of moral authority (conscience) as described by Stephen R. Covy in the foreword to Greenleaf's book *Servant Leadership*. He defines moral authority as "Our Moral Nature + Principles + Sacrifice". A servant leader believes that the ends and means cannot be separable in the light of conscience. Followers of the principle of servant leadership will willingly respond to a leader who is proven and trusted as a servant, and not the authority of an existing organization behind the leader (Greenleaf, 1977). Although Greenleaf first coined his philosophy of servant leadership in the 1970s, its academic progress is still at its earliest stage (Stone *et al.*, 2004). Parris and Peachey (2013) claimed the absence of empirical studies about servant leadership across all the databases searched before 2004. Most studies on servant leadership are either a definition of its concept for modeling it or development of measurement tools to empirically test it (Parris and Peachey, 2013).

1.1.3.3. The characteristics of servant leadership

"Ten Characteristics of a Servant Leader" were identified by Spears (2010) and "Primary Characteristics" were identified by Focht and Ponton (2015) through a Delphi study (Table 1.1). Parris and Peachey (2013) found through a systematic literature review of servant leadership that Spears' definition of servant leadership was the second most referenced after Greenleaf. Spears' characteristics of a servant leader are "listening, empathy, healing, awareness, persuasion, conceptualization, foresight, stewardship, commitment to the growth of people, and building community." To better define servant leadership, Focht and Ponton (2015) conducted a Delphi study (Adler and Ziglio, 1996, Hsu and Sanford, 2007) with multiple rounds by asking a panel of scholars who had extensive publications on servant leadership characteristics. Twelve primary characteristics emerged among the 100 characteristics of servant leadership previously identified by Sendjaya (2003). These 12 primary characteristics of servant leadership were identified as the most essential characteristics that should be exhibited by a servant leader.

Although Coetzer *et al*. (2017) pointed out that researchers have not yet reached a consensus about the characteristics, competencies and measurement, the characteristics of servant leadership introduced above are noteworthy when leadership of public servants for complex public projects with various stakeholders is involved, in particular when public acceptance is required.

Table 1.1. The ten characteristics of a servant leader as identified by Spears (2010) and twelve primary characteristics of servant leadership as identified by Focht and Ponton (2015).

Characteristics of a Servant Leader	
Identified by Spears	Identified by Focht and Ponton
Listening	Value people
Empathy	Humility
Healing	Listening
Awareness	Trust
Persuasion	Caring
Conceptualization	Integrity
Foresight	Service
Stewardship	Empowering
Commitment to the growth of people	Serve others' needs before their own
Building community	Collaboration
	Love
	Unconditional love and learning

1.1.3.4. Transformational leadership and servant leadership

According to Wart (2003), the first leading publication dedicated to ethical issues in the field of leadership was Greenleaf's *Servant Leadership*, but it did not join the mainstream. By stark contrast to servant leadership, *Leadership* (Burns, 1978), a book by James MacGregor Burns, came into the limelight (Wart, 2003). Although both authors emphasized the ethical dimension, Burns' theory became well-known as "Transformational Leadership" and became extremely popular because of its ideal of leadership for change. Bass (2008) explained that the transformational leaders as defined by Burns (1978) "motivate their followers by raising their followers' concerns from security and belonging to achievement and self-actualization, and by moving them beyond self-interest to concerns for their group, organization, or society" (Bass, 2008). The transformational theory has been well researched and further developed by many researchers since then (e.g. Avolio and Bass, 2002, Bass, 1985, Bass and Avolio, 1990, Kotter, 1999, Tichy, 1997, Yukl, 1998). Kotter conducted fourteen formal studies and more than a thousand interviews, directly observed dozens of executives in action, compiled innumerable surveys, and concluded that most organizations today lack the leadership they need and the shortfall is often large (Kotter, 1999). He established a model entitled "Eight Steps to Transforming Your Organization", to show how to transform an organization for success in projects/business, and presented eight complicated but necessary steps that leaders cannot skip to achieve real success. His model has been used not only by academics but also by practitioners. Servant leadership is considered similar to transformational leadership and Stone *et al*. (2004) identified the similarities and differences between the two leadership theories. They pointed out that "both transformational leadership and servant leadership emphasize the importance of appreciation and valuing people, listening, mentoring or teaching, and empowering followers." Nonetheless, the transformational leaders direct their focus on the organization and their behavior is motivated towards achieving the organizational goals. In comparison, the servant leaders direct their focus on the followers, with the accomplishment of organizational objectives being just a consequential result.

1.1.4. Methodology and general objectives

Gordon and Yukl (2004) pointed out that academic researchers long for a deeper understanding of leadership processes, but practitioners become frustrated with academic theories that fail to offer real solutions. In order to bridge such a gap, this study focused on some public energy and environmental projects in which I was involved directly (as a project manager) or indirectly. Gordon and Yukl (2004) recommended that academic researchers include methodologies such as comparative case studies to benefit from the richness of field data. This study was conducted using the participant observation method and interviews (e.g. Slack *et al*., 2020) in addition to a literature survey. The leaders observed and interviewed in this study were public leaders who held real power and were actively involved in the selected projects mentioned above. As public leadership remains an elusive concept in the academic field, I attempt to gain insights into the particularities of leadership in the public sector by qualitative case studies.

The general objective of this study is to investigate problems encountered and the solutions adopted from a perspective that highlights what were, in retrospect, missed opportunities in each project. A further goal is to look to the future and, from lessons learned, to determine primary leadership roles in energy and environmental projects.

1.1.5. Organization of the thesis

This thesis is divided into five chapters. Chapter 2 examines the history of HLW management in Japan through a literature review based on key papers and reports on HLW management and a book authored by the then mayor of Toyo town. Toyo town was the only local government that applied for a literature survey, the first step of a staged programmed for selecting a HLW disposal site before October 2020. This review was complemented by interviews with three key leaders of the Nuclear Waste Management Organization of Japan (NUMO) and the Agency for Natural Resources and Energy (ANRE) of the Ministry of Economy, Trade and Industry (METI), and investigated problems encountered and the solutions adopted from a perspective that highlights what were missed opportunities. A leadership role to allow HLW management to move forward to the next stage of selecting candidate sites is identified. Chapter 3 aims to identify why the then mayor of Toyo town failed and analyzes his behavior and leadership characteristics, including how he collaborated with NUMO and ANRE. To improve the future siting process, suitable leadership for HLW management based on leadership theories was identified. Chapter 4 focuses on the public project of the off-site environmental remediation in Fukushima. As the additional annual dose target was set to be 1 mSv or less as a long-term goal, the decision-making process by the then Minister of the Environment was examined through a literature review and interviews. How such a decision was made is defined based on the Role Theory of Kahn *et al.* (1964), the Cognitive Resource Theory of Fiedler (1986) and the findings of Berkowitz (1953) and Bass (2008). The Windscale (UK) accident, which is the closest analogue to the 1F accident, is introduced for scientific justification that should have been provided to the then Minister of the Environment before the remediation strategy was decided on. Chapter 5 summarizes the conclusions of these three studies and their future perspectives. Appendix focuses on two biomethane energy pilot projects carried out by Japanese, Indian and Thai officials, academics and private companies with the aim of technology transfer and practical realization in neighboring countries of technologies invented or developed by Japanese academics. For those projects, from the stage of research in the laboratory and planning in collaboration with central and/or local governments to completion, every possible leader of each level participating in the projects and others who followed the projects were monitored closely. The steps in each case were examined based on Kotter's model entitled "Eight Steps to Transforming Your Organization". Although the projects described in Appendix were led by academic leaders, there is a common difficult but important step to achieve for academic, political and administrative leaders. The contents of Chapters 1, 2, 3, 4 and Appendix have been extracted and organized from the three published papers (Takeuchi *et al*., 2016; Takeuchi *et al*., 2020a; Takeuchi *et al.*, 2020b), and one that is currently under review (Takeuchi *et al.*, in prep).

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Chapter 2

Leadership for Management of High-Level Radioactive Waste (HLW) in Japan

Keywords: Radioactive waste disposal; Nuclear power; Waste management & disposal

2.1. Introduction

In Japan, a range of different types of radioactive wastes are generated from nuclear power production and various other nuclear applications (e.g. in medicine, industry and research). In many countries around the world with advanced nuclear programmes, it is considered an ethical responsibility of the current generation (those that have benefited from the use of nuclear technologies) to prepare for, and ensure implementation of, safe disposal of this waste, without passing the burden on to future generations. HLW such as spent fuel from nuclear power plants or vitrified waste resulting from its reprocessing must be isolated from humans and the environment for extremely long periods, until it is no longer hazardous to life and the environment. Since the first discussions in the United States during the 1950s, geological disposal has been accepted worldwide as the most feasible option for the long-term management of HLW, regardless of the pros and cons of nuclear power generation (Tochiyama and Masuda, 2013). Finland is the first country in the world that selected a site for HLW repository due to their 'well-defined, sufficiently fair process, which the main stakeholders could accept and follow (Vira, 2006). Sweden has recently made great progress and some other countries (e.g. Switzerland, France) also have advanced programmes (NUMO, 2017d; SKB, 2017)

Currently, HLW management in Japan has stalled prior to selecting any candidate sites for a literature survey, the first step of a staged programme for selecting a disposal site, and those concerned therefore need to find a way to move forward. Despite suffering from atomic bombs during World War II, nuclear power was seen as a necessary requirement for meeting Japan's energy needs due to its limited domestic sources of alternative power. This situation of reluctant acceptance changed after the Fukushima Daiichi meltdown caused by the earthquake and tsunami in 2011, resulting in general public opposition to constructing and/or operating nuclear power stations (Gallardo *et al.*, 2014; Masaki, 2012). Regardless of the future of nuclear power in Japan, however, the fundamental requirement to dispose of current inventories of radioactive waste sometime in the future remains. Japan has already generated a lot of radioactive waste and may continue to generate more. In order to achieve the goal of safe disposal, created vision for sustainable strategy by leaders became more important after the Fukushima Daiichi accident. For implementation of geological disposal, we must examine, discuss and balance scientific aspects related to available technology, operational safety and possible risks in the far future with socio-political aspects related to established policies and, in particular, public and political acceptance. Over the last 3 decades, extensive work has been carried out to establish a strong scientific and technological basis for disposal in Japan, with addition of wider consideration of how to build technical and social confidence and promote public acceptance since the beginning of this century (Juraku, 2013; Kimura *et al.*, 2003; Komine, 2004; Tochiyama and Masuda, 2013; Wakasugi *et al.*, 2012; Yoshida *et al.*, 2014).

According to the original plan of the implementing organization for HLW management (NUMO, 2004a), field work should have started a decade ago and they should now be at the stage of repository licensing. Despite the general consensus on a need to move forward, even before the Fukushima Daiichi accident, the process for selecting candidate sites for a literature survey based on a call for volunteers failed as no communities came forward except Toyo Town in Kochi prefecture (See Figure 2.1). The closest case of a volunteer involved Toyo Town, although it eventually withdrew its application for a literature survey in 2007. Japanese researchers have analysed the political process and the decision-making process of the citizens of Toyo Town and investigated the causes of failure (Saigo *et al.*, 2010; Wada *et al.*, 2009). The importance of participation of various stakeholders and the miscommunication with non-expert stakeholders have been discussed so far. The development and implementation of a geological repository involves evolving multi-disciplinary projects running over a period of up to about 300 years (including possible monitoring and institutional control), for which there is internationally no precedent. This is coupled to the equally challenging job of building and maintaining acceptance by a wide range of stakeholders including, in particular, the host communities.

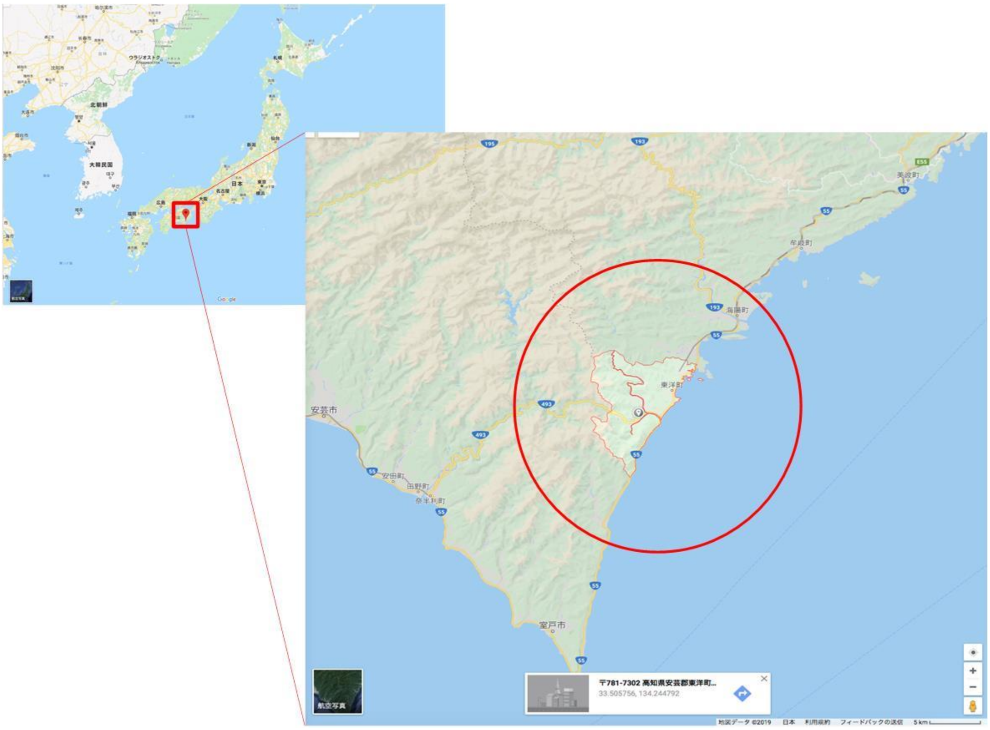

Figure 2.1. Diagram of Toyo Town that applied for literature survey for HLW disposal (Map data used by permission from Google, Maxar Technologies)

In this chapter, I first examine the history of HLW management in Japan, assess how leaders/decision-makers in different key organizations communicated with each other and identify the rationale for the resulting characteristics of the overall programme. The objective here is to investigate problems encountered and the solutions adopted from a perspective that highlights what were, in retrospect, missed opportunities. A further goal is to look to the future and, from lessons learned, to determine a leadership role to allow HLW management in Japan to move forward to the next stage of selecting candidate sites to be investigated as potential repository hosts.

2.2. History of HLW management in Japan

2.2.1 HLW management prior to 2000

The Power Reactor and Nuclear Fuel Development Corporation (PNC) was established in 1967 as the core organization for the nuclear fuel cycle, including R&D on HLW treatment and disposal. PNC ran under the supervision of the Science and Technology Agency (STA, now the Ministry of Education, Culture, Sports, Science and Technology). At that time, ANRE of METI was responsible for matters associated with the commercial nuclear power plants, while the STA covered other nuclear issues. Since HLW was managed outside the commercial nuclear power plants, STA was responsible for it.

PNC established the fundamental feasibility of HLW disposal in Japan in the seminal "H3" project, the documentation of which was also translated into English (PNC, 1992) and was, at the time, considered to represent the international state of the art in this field. PNC/the Japan Nuclear Cycle Development Institute (PNC was subsequently reorganised in 1998 as JNC) also developed extensive world-class R&D infrastructure to support the geological disposal project - in particular, including underground research laboratories (URLs) and the ENTRY and QUALITY facilities at Tokai. This was complemented by R&D carried out by a range of other Japanese organizations (e.g. Radioactive Waste Management Funding and Research Center (RWMC), Central Research Institute of Electric Power Industry, Japan Nuclear Energy Safety Organization…) and universities. Formally, some of this work could be considered as supporting either a future repository implementer or a regulator, but the distinctions were unclear as research topics tended to be defined in a bottom-up manner with little or no top-down technical coordination of this work.

Outside the geological disposal field, confidence in PNC suffered due to a series of accidents in their facilities, including a sodium leak accident and subsequent fire at the Monju prototype fast breeder reactor located in Fukui prefecture in 1995 and another accident at the Tokai nuclear fuel reprocessing plant located in Ibaraki prefecture in 1997. Here it should be noted that concerns arose not only from technical failings, but also a lack of openness and communication (Kondo, 2017; Mikami *et al.*, 1996).

Around this time, the governors of Fukushima, Niigata and Fukui prefectures, where key nuclear power plants are located (generating capacity of the nuclear power plants in these three prefectures was about 50% of the total capacity of the nuclear power plants in Japan), required the Japanese government to constitute a law for final disposal of radioactive waste. This involved interaction with the Federation of Electric Power Companies of Japan (FEPC), an organization of the electricity utilities in Japan established to smooth the operation of the plants and, especially, to promote nuclear power generation. STA did not feel capable of managing such interaction and thus requested the Director of ANRE to take over full responsibility for constituting this law. This resulted in drafting of the "Specified Radioactive Waste Final Disposal Act (hereafter the Final Disposal Act)" by ANRE (MIC, 2000).

2.2.2. H12 report

The Japanese R&D programme for geological disposal initially focused on vitrified HLW from reprocessing of spent fuel based on a national policy requiring recycling of all U and Pu for reuse in reactors. This was the waste "specified" in the Final Disposal Act and, to support this, progress since H3 was summarised in a Second Progress Report entitled "H12: Project to Establish the Scientific and Technical Basis for HLW Disposal in Japan" (JAEA, 1999). The objectives of the H12 study were to reconfirm the technical basis for assuring the reliability of geological disposal in Japan and to provide input to the siting and regulatory procedures following the initial R&D phase. This report was submitted to the Atomic Energy Commission of Japan (AEC) in 1999. H12 was also translated into English and an international peer review was carried out by the Nuclear Energy Agency (NEA) prior to its submission. The general conclusion of the review was that the generic technical basis for geological disposal in Japan had been comprehensively documented and convincingly assessed. This provided a sufficient level of confidence that the tools and system understanding had been developed to justify proceeding to the next phase of site selection and characterisation (NEA, 1999).

In parallel, R&D for transuranic (TRU) waste (a range of higher activity radioactive waste generated during reprocessing and MOX fuel fabrication) was summarised for a concept of geological disposal using the H12 knowledge base combined with experience in disposal of other types of lower activity waste at Rokkasho (JNC and FEPC, 2000).

2.2.3. Establishment of the Nuclear Waste Management Organization of Japan (NUMO)

NUMO was established in 2000, in accordance with the Final Disposal Act (authorised by METI) as the implementing organization for the geological disposal of specified radioactive waste (initially HLW, expanded to include TRU waste in 2008 (NUMO, 2008). Since NUMO has no research facilities, JNC (renamed JAEA in 2005), other R&D organizations and Japanese universities provide scientific support to NUMO. NUMO initiated invitation of applications for a literature survey for HLW disposal in 2002. The site selection procedure specified in the Final Disposal Act consists of three steps, namely a literature survey, preliminary investigations and detailed investigations. At each stage in the site selection process, NUMO will compile reports on the investigation results and will hold explanatory meetings. The opinions of local people expressed at these meetings will be made known to the relevant prefectures and municipalities together with NUMO's views and selection will proceed on the basis of respecting local opinions, obtaining stakeholder agreement and securing government approval. The government has stipulated that, when approving each stage of the site selection process, the opinions of the municipality mayors and the governors of the prefectures concerned must be listened to and respected. Selections that oppose these views will not take place (NUMO, 2002).

2.2.4. Rapid development guided by advisory committees and supported by bilateral agreements

NUMO established an International Technical Advisory Committee (ITAC) in June 2001, with the intention of transferring know-how from other national disposal programmes to the Japanese programme and also ensuring that NUMO's technical work is of an appropriate international standard. ITAC complemented NUMO's Domestic Technical Advisory Committee (DTAC) by providing input that contributed to the technical and scientific accuracy, openness, transparency and traceability in NUMO's technical programme (NUMO, 2001). NUMO also established bilateral links with some of the most advanced national waste management programmes (ANDRA, Nagra, Posiva, SKB, U.S. DOE and RWMC) and initiated several active collaboration projects with these partners, aimed at both knowledge transfer and staff training.

2.2.5. Innovative siting factors and repository concept catalogue

In TR-04-03 (NUMO, 2004a), NUMO developed and described a catalogue of "Repository Concepts" which illustrated the tailoring to potential volunteer sites of not only the design and layout of the disposal system, but also the associated evaluation of operational and long-term safety and assessment of socio-economic aspects. An associated study showed how the volunteering approach to siting should be constrained by the use of "Siting Factors" (NUMO, 2004b) which ensure that only locations which have sufficient geological stability are considered – an important factor in a country like Japan which lies in a tectonically active region (NUMO, 2004a). Both these English summary reports of larger Japanese studies were well received internationally and, indeed, served as models for other programmes that followed NUMO in the volunteering approach to siting. Despite rapidly establishing international technical recognition, the most difficult problem of communicating disposal safety to key stakeholders, in particular, non-technical decision-makers and the general public remained unsolved by NUMO.

2.2.6. Illustration of implementation problems: the Toyo Town case study

Stepwise siting in Japan is initiated by community acceptance of a literature survey to determine if there are any fundamental blocks on it being considered further, such as major active faults or evidence of Quaternary volcanism in the vicinity. Even if a volunteer clears this first hurdle, they cannot move on to the next stage of the preliminary investigation (including surface-based geophysics and drilling boreholes) if this is not accepted by citizens as represented by the mayor of the community or the governor of the prefecture.

Toyo is a small town in Kochi prefecture of Shikoku in Japan. The Town's population is only about 3,400 and the budget for fiscal year 2006 was around two billion Japanese yen (about $US 20M). The Town was in serious financial straits and the mayor of the Town applied for a literature survey for HLW disposal in March 2006 with the aim of benefitting from the associated subsidies: municipalities that accepted a literature survey would receive 210 million Japanese yen (raised to 1 billion Japanese yen from 2007) over two years. The mayor of Toyo Town hoped that the Town would develop support industries and employment with this large investment, leading to improvement of living standards. As the literature survey could be applied for based on the mayor's judgment, he submitted the application form to NUMO without discussion with the local council (his rash behaviour later incurred the distrust of local people and he regretted this). NUMO suggested he should apply after discussing the issue with the local council and organising some workshops for citizens. He asked NUMO to return the application form at the end of March. To gain the understanding of local people and communicate and share his vision with them, he organised the first workshop in August with all the members of the local council, some Town officials, the general manager of the public relations department of NUMO and others. During the following month, not only local people but also anti-nuclear groups from other prefectures mobilised to object to the literature survey with general support from the media. The anti-nuclear movement deliberately focused on building opposition to siting a repository in Toyo Town (not against the literature survey as such). In this regard, the local populace suffered from a lack of opportunity to develop an unbiased understanding of technical issues associated with siting and operating a repository and the arguments for its long-term safety. Finally, the mayor decided to apply based on his political judgment without further discussion with local people, submitting the application form to NUMO on 25th January 2007. This was the only local government application for a literature survey. The council of Toyo Town adopted a resolution to demand the mayor's resignation on the 9th February. He resigned on the 5th April and called a snap election. He suffered a crushing defeat on the 22nd April and the newly elected anti-nuclear mayor withdrew the application on 23rd of April 2007 (Saigo *et al.*, 2010; Tashima, 2008; Wada *et al.*, 2009).

In retrospect, Toyo Town's case can be seen to be similar to experience in other countries where, even at the very earliest stages of characterisation of potential sites, opponents immediately focus on concerns related to repository safety – regardless of how premature this may be. This has proven to be difficult for implementers to counter when disposal concepts are still at a very basic, generic stage. It is clear, however, that a much more active, comprehensive and user-friendly approach to communication is required, which needs concerted efforts from not only implementers, but also regulators (to establish their own credibility), the Government and the "nuclear community" within the utilities, R&D organizations and universities.

2.2.7. Developments since 2007

No volunteer communities have come forward since Toyo Town and the programme has been continually losing momentum, in particular since the Fukushima Daiichi accident in 2011 (Table 2.1). Negative opinions toward nuclear power generation in Japan supporting "abolition or reduction", which is used to be 20-30% over the past 30 years, increased to 70% from four to six months after the accident (Kitada, 2013).

Table 2.1. The chronological order of events in the establishment of HLW disposal in Japan

Years	Important Events
1967	PNC was established as the core organization for the nuclear fuel cycle, including R&D on HLW treatment and disposal.
1992	PNC established the fundamental feasibility of HLW disposal in Japan in the seminal "H3" project, the documentation of which was also translated into English.
1998	STA requested the Director of ANRE of METI to take over full responsibility for constituting the Final Disposal Act.
1999	"H12" report was submitted to AEC of Japan. "H12" was also translated into English and an international peer review was carried out by the NEA prior to its submission.
2000	NUMO was established, in accordance with the Final Disposal Act (authorised by METI) as the implementing organization for the geological disposal of specified radioactive waste.
2007	Toyo Town, the only local government that applied for a literature survey withdrew the application.
2011	Fukushima Daiichi accident happened.
2017	The Japanese Government published a "Nationwide Map of Scientific Features for Geological Disposal."

In an attempt to attract volunteers, the Japanese Government reviewed and improved the relevant policy in 2015 and published a "Nationwide Map of Scientific Features for Geological Disposal (Nationwide Map) (NUMO, 2017a)" on 28th July 2017, which divided all areas in Japan into four categories, i.e. (1) areas with unfavourable geological features that may damage the long-term stability of geological environment, (2) areas with natural resources, (3) areas with a good chance of being confirmed as having favourable characteristics and (4) areas within (3) which are also favourable from the viewpoint of waste transportation (NUMO, 2017b). NUMO started to organise events to exchange opinions about the publicised map for geological disposal with the general public in 46 prefectures in Japan. This initiative showed that it was recognised that the Government had to play a more active role and an international review by the NEA was included at an early stage.

2.3. Methodology

A literature review was undertaken based on key papers and reports on HLW management in Japan and the book written in Japanese "Nuclear Energy War in a tiny Town no one knew" (Tashima, 2008), authored by Mr. Yasuoki Tashima, the then mayor of Toyo Town who promoted acceptance of the literature survey. This review was complemented by interviews (conducted between March 2017 and May 2018) with three key persons: (1) the director of ANRE of METI who was requested to take over full responsibility for constitution by STA in 1998 and created the draft of the Final Disposal Act as the administrative leader (directors of the ministries hold real power in Japan), (2) the technical leader of Tokyo Electric Power Co., Inc. (TEPCO) for HLW management who had been developing new methods to ensure safety and introducing Japanese technological strategies to international experts (Ichikawa *et al.*, 1999a; Ichikawa *et al.*, 1999b; Kitayama *et al.*, 2007) between 1995 and 2000 (TEPCO was the lead company among electric power utilities in Japan before the Fukushima Daiichi accident); he was also the technical leader of NUMO between 2000 and 2008 and (3) the current key official of ANRE responsible for the management of HLW disposal, as well as discussions (conducted between May 2017 and May 2018) with a number of officials of METI, members of NUMO and international Technical Advisory Committee (TAC) members who have been transferring know-how from other national disposal programmes to the Japanese programme and also ensuring that NUMO's technical work is of an appropriate international standard (NUMO restarted their Technical Advisory Committee in 2015, which includes both Japanese and international experts).

Those interviewed were as follows:

1. Mr. Masanori Suzuki, Director of the Nuclear Industry Division of ANRE of METI between 1997 and 2000
2. Dr. Kazumi Kitayama, technical leader of TEPCO for HLW management between 1995 and 2000, then Director of the Science and Technology Department of NUMO between 2000 and 2008
3. Mr. Shinichi Kijima, Deputy Director of ANRE of METI who is currently responsible for the management of HLW disposal

2.4. Summary of the interviews

2.4.1. Director of ANRE of METI

As the Director of the Nuclear Industry Division of ANRE between 1997 and 2000, Mr. Suzuki points out that the hardest obstacle was to align personnel of FEPC to build consensus on their responsibility for HLW management because it was not the electric power companies but the Japanese Government that promoted nuclear fuel cycle policy (IAEA, 1993); the electric power companies therefore believed that the Japanese government was responsible for HLW management. Scientific input to confirm the technical basis for assuring the reliability of geological disposal in Japan was provided by staff of various organizations and opinions varied from person to person. He does not remember whether he had read JNC's H12 report or its draft or the NEA's international review before ANRE drafted the Final Disposal Act. He never met Dr. Kitayama, who had been technical leader for HLW management since 1995.

ANRE thought Japan was behind in scientific research for HLW management compared to leading countries such as Finland and Sweden. Due to a lack of data obtained through experiments using radioactive materials, reliability of safe disposal was considered to be low and ANRE was not able to include a regulation that ensures safe disposal in the Final Disposal Act. This was clearly a fundamental problem.

2.4.2. Technical leader of TEPCO/Director of NUMO

Dr Kitayama's direct involvement with HLW disposal started with his role supporting the establishment of an implementing organization while at TEPCO between 1995 and 2000 and, thereafter, serving as the head of the NUMO science and technology division between 2000 and 2008. His impression is that the Final Disposal Act was not formulated appropriately with regard to selection of Preliminary Investigation Areas based on literature surveys as it requires that the Minister of Economy, Trade and Industry should "listen to the opinions of the governor of the candidate prefecture and the mayor of the candidate municipality and respect them sufficiently" even before commencing the first step of a literature survey. He believes such surveys should be conducted without any formal consent since the literature involved is already openly published (Kitayama, 2013; Kitayama and Kikura, 2013). If this had been the case, first communication with local communities could be tailored to their particular boundary conditions and thus provide a sound basis for discussion of any of their concerns with regard to the following field investigations, site selection and eventual repository implementation.

The draft of the Act was created by ANRE officials without input from Dr. Kitayama. NUMO was the nominated implementing organization, but was expected to move forward with siting without direct support by the Government or any other organizations (e.g. regulators, local utilities, nuclear R&D agencies), which contrasts with the wider basis of siting in other successful national waste management programmes.

In addition, NUMO had difficulties in communicating with local people of Toyo Town because of the involvement of NUMO public relations staff with little understanding of geological disposal and the scientific basis of the safety case. Although Dr. Kitayama recognised this problem and the risk of losing public acceptance, his opinion was ignored. He regretted not having breathed life into his project.

2.4.3. Deputy Director of ANRE of METI

As the Deputy Director of ANRE (since 2017) who is currently responsible for the management of HLW disposal, Mr. Kijima claims that very low awareness of geological disposal of HLW is the biggest problem in Japan. He therefore thinks it was meaningful to publish the Nationwide Map by the Japanese Government to let people see the category in which his/her city/town/village is placed. He believes it is crucial to improve awareness amongst the general public first. He is willing to support NUMO and is positive about the activities to exchange opinions about the Nationwide Map with the general public.

2.5. Results and discussions

2.5.1. Lack of communication between leaders/decision-makers and alliance

Implementing geological disposal involves balancing a number of technical and socio-political requirements, thus it is important that all key actors – the Government (at all levels), implementers and regulators plus their supporting technical experts - are aware of the issues involved. According to the interviews, prior to drafting of the Final Disposal Act there was no communication between the Director of ANRE and the technical leader of TEPCO (who later became the technical leader of NUMO) who could have provided scientific context and justifications to assure any stakeholders of the fundamental safety of such disposal. There seemed to be no connection between ANRE and JNC, which was the key nuclear R&D organization that could also have provided scientific input.

Actual scientific input to confirm the technical basis for assuring the reliability of geological disposal in Japan was provided to ANRE by various organizations, but opinions varied from person to person and were considerably influenced by their understanding of progress in other advanced national programmes. Recognition of the importance of public acceptance based on international experience was captured and led to the policy of volunteering as a key to initiation of repository siting – a novel approach which was positively received and copied by other programmes (e.g. Canada, UK). However as seen from Mr. Suzuki's comments, there was a general lack of understanding of the different international boundary conditions and how these influenced programme implementation. The then leaders did not discuss thoroughly how safety could be demonstrated and how the volunteering process should be implemented prior to drafting of the Final Disposal Act. Dr. Kitayama claimed the Final Disposal Act drafted by ANRE alone became a very big obstacle to the initial literature survey for HLW disposal. One of the international TAC members pointed out that there is general agreement with Dr. Kitayama's points with regard to both the literature survey without a local permitting process (this is the norm internationally) and the fundamental basis of programmes with siting by nomination rather than volunteering, although with increasing involvement of local communities as site selection proceeds. Related technical communication is certainly more effective if supported by a site-specific knowledge base and must involve technical staff with wide backgrounds and required communication skills. Such messages were clear from a recent seminar run by NUMO that featured input from its international TAC members. (The record of the first meeting held in November 2015 was published (NUMO, 2015).

The international review of the NEA in 1999 reported that special complexities affected the H12 study because of its wide scope of diverse geological and surface environments, leading to very conservative assumptions about site conditions. Safety assessment could thus be more realistic for the lower uncertainties associated with site-specific databases. In order to narrow down suitable areas for disposal, it would have been prudent to discuss whether the Japanese implementing organization could conduct literature surveys based on published literature without a local permitting process before the Final Disposal Act was created. In fact, the reliability of safe disposal was considered to be low by ANRE and the Act stipulates that selection of Preliminary Investigation Areas based on literature surveys requires that the Minister of Economy, Trade and Industry should "listen to the opinions of the governor of the candidate prefecture and the mayor of the candidate municipality and respect them sufficiently". This results in a "Catch 22" situation where lack of understanding of the arguments for safety from generic assessments results in resistance to site-specific characterisation of the type that would allow safety margins to be realistically assessed and hence increase acceptance. As a result, no survey has yet been conducted and the HLW management programme has been on indefinite hold.

As Mr. Suzuki said, it was very hard for the Japanese government/ANRE to align FEPC to build consensus on their responsibility for HLW management because it was not the electric power companies but the Japanese Government that promoted nuclear fuel cycle policy and thus the electric power companies and FEPC believed the Japanese Government was fully responsible for this area. Here an important point is that no distinction was made between establishing policy and implementing it. Although it is clearly a role of the Government to set policy, it is evident that countries (e.g. Sweden) where major progress has been made have strong, relatively independent implementers and regulators together with committed support by the utilities (NEA, 2012a). Without such an alliance, they could not move forward.

Although both the Director of ANRE and the Technical Director of NUMO tried to push

HLW management forward, the required infrastructure was missing and implementation of possible improvements was blocked by lack of communication and alliance. This situation is evident in the case of Toyo Town. The mayor, who was trying to devote himself to the development of Toyo Town, submitted the first application to NUMO without discussion with the members of the local council. Local people including the decision-makers of the Town considered that the mayor and NUMO were "talking money" for siting without transparency and had doubts about their ethical responsibilities. In addition, there was no alliance and the mayor could not obtain strong support by the Government, NUMO, local utilities and nuclear R&D organizations, who could have helped to explain the strength of the safety case to local communities (Tashima, 2008). Indeed, how can the general public trust the safety of disposal before all leaders / decision-makers are clearly convinced of this?

2.5.2. Leaders' actions to win credibility and understanding for geological disposal

Even recent signs of Government support such as the Nationwide Map reflect a lack of understanding of the history of the Japanese programme (such a map was already developed by NUMO in 2004) and unpreparedness to commit to making major changes in the programme in order to break the present log-jam. NUMO recognised that an integration of additional, more refined techniques would be required to evaluate sites that pass the minimum site acceptance criteria (related to earthquake risk and active faults, igneous activity, uplift and erosion, unconsolidated Quaternary sediments and mineral resources). In particular, tools for quantitative assessment of the likelihood and potential impacts of tectonic events and processes at any site are required. A major project for developing such methodology for the specific conditions of Japan based on state-of-the-art approaches used internationally (eventually termed 'TOPAZ' - **T**ectonics **O**f **P**otential **A**ssessment **Z**ones) was thus initiated and has been described in both the open literature and in NUMO technical reports (Chapman *et al.*, 2012; NUMO, 2017c). Despite the consensus from both domestic and international experts that this formed a sound basis for assessing risks from 100,000 years out to one million years and illustration of its application to a number of regions in Japan, such output was not reflected in the Nationwide Map published in 2017 and is little known by non-technical stakeholders in “preferable” siting areas. Despite its technical content, it is clear that NUMO needs to communicate this work to ANRE to support selection of suitable areas and, together, ensure that key messages are understood by key decision-makers.

The bottom line is that effective communication of technical issues, in particular for decision-makers, is essential to make progress with such a technically complex and socio-politically sensitive project. Alliance with key organizations and commitment by the Government are also required, but the implementer (and regulator) require freedom to implement policy in a flexible manner: if this is not assured, regardless of communication, key decisions will be stalled by NIMTOO (Not in My Term of Office) considerations as seen in many other past cases around the world.

It was unfortunate that the NUMO programme was disrupted after the Fukushima Daiichi accident in 2011, with key technical staff moved to other organizations. NUMO suffered loss of national / international credibility of the geological disposal project, resulting from loss of confidence in the entire Japanese nuclear industry. NUMO needs to find a way to promote public acceptance and move forward. Tochiyama concludes that the politician’s role is the most critical for the solution of the HLW management issue (Tochiyama and Masuda, 2013) and Masuda points out the role of policy-makers as mediators between the implementing organization and the general public (Masuda, 2016). The need for leadership by NUMO was argued by the Advisory Committee on Radioactive Waste of the Japan Atomic Energy Commission (AEC, 2016) and is emphasised again in the master plan for R&D for geological disposal between 2018 and 2023 (METI, 2018). Many experts recognised of the need for leadership to move forward but no one has given shape to leadership for HLW management.

In the case of Toyo Town, local people considered that the leaders were talking money for siting without transparency and thus both NUMO and the mayor failed in winning credibility as discussed in the previous section (Tashima, 2008). Whenever some leaders in the Japanese nuclear industry tried to cover up the causes of the accidents, including Fukushima, the population criticised their secretive nature (Nikkei, 2017). They could not believe such leaders took ethical responsibilities towards society seriously.

To win credibility and understanding for geological disposal, ethical responsibilities should be borne in the first place by leaders / decision-makers of relevant organizations. How then can leaders take ethical responsibility?

In the report of the NEA, the importance of societal and ethical responsibilities taken by waste management organizations and safety authorities is emphasized. As behavioural features to be addressed, openness, transparency, honesty, consistency, willingness to be tested, freedom from arrogance, recognition of limits, commitment to a highly devoted and motivated staff, coherence with organizational goals, an active search for dialogue, and an alert listening stance and caring attitude are enumerated (NEA, 2012b).

A huge amount of studies on leadership, including in political and social movements and complex organizations, are introduced by Bass (2008) and there are numerous studies of public or public-sector leadership (e.g. Wart, 2003; Vogel and Masal, 2015).

Among the many theories, I direct my attention to servant leadership as formulated by Robert K. Greenleaf (1977), which embodies the above behavioural features and seems to be most applicable to Japan’s case. The major characteristic of the servant leadership theory is the emphasis on ethical responsibilities to followers, stakeholders, and society (Wart, 2003). According to Greenleaf, the servant-leader is servant first. It begins with the natural feelings that one wants to serve. The person who is leader first later serves out of promptings of conscience or in conformity with normative expectations. Greenleaf explains “Those who choose to follow this principle will not casually accept the authority of existing institutions. Rather, they will freely respond only to individuals who are chosen as leaders because they are proven and trusted as servants.” I assume that the quality of management in a public sector area such as HLW management could be enhanced by servant leadership. To servant leaders, both the means of siting and the goal of safe disposal are equally important. The ends do not justify the means. They do not manipulate information or people. The major problems of each key organization and their causes are summarised in Figure 2.2. To solve these problems, I will further discuss how to enhance the quality of management in the future based on leadership theories in the next chapter.

Key organisations	Major problems
ANRE	• Lack of understanding of scientific context and justifications to assure any organisations of the fundamental safety of disposal • Lack of understanding of the different international boundary conditions and how these influenced programme implementation
NUMO	• The Final Disposal Act enacted in 2000 became a very big obstacle to the initial literature surveys for HLW disposal • Had difficulties in communicating with local people of Toyo town and failed in winning credibility
Toyo town	• Lack of opportunity to develop an unbiased understanding of technical issues associated with siting and operating a repository and the arguments for its long-term safety and failed in winning credibility

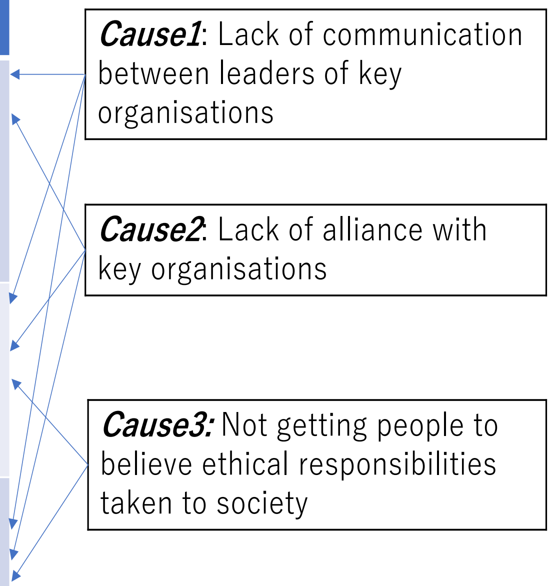

Figure 2.2. Summary of the problems in each key organization and the relationship to three main causes

2.6. Conclusions

I examined the history of HLW management in Japan and found five major problems with the key organizations. Their causes can be summarised as around three points which are all related to leadership: 1) lack of communication between leaders of key organizations, 2) lack of alliance with key organizations, 3) failing to convince people of the ethical responsibilities taken towards society. Effective communication for correct scientific input between leaders / decision-makers of relevant organizations is of critical importance. Alliance with key organizations and commitment by the Government are also required. To win credibility and understanding for geological disposal, ethical responsibilities should be borne in the first place by leaders/ decision-makers of those organizations. I assume that the quality of management in a public sector area such as HLW management could be enhanced by servant leadership.

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Chapter 3

What is Suitable Leadership for High-Level Radioactive Waste (HLW) Management?

Keywords: nuclear power; radioactive waste disposal; high-level radioactive waste management; siting; servant leadership

3.1. Introduction

In the light of growing concerns of the impacts of climate change, there is an increasing interest in expanding the role of nuclear power as a step to moving away from fossil fuels (Gospodarczyk and Fisher, 2019）. This general global trend towards more nuclear power is mainly driven by expansion in Asia. In Europe, moves towards phase outs in Germany and Switzerland are balanced by new build projects in the UK, Finland, and Russia (WNA, 2020). Although Japan has been reducing its nuclear power dependency since the Great East Japan Earthquake and Tsunami of 11 March 2011, it decided to pursue reactors with superior safety, economics, etc., and to develop technology aimed at the resolution of backend problems according to the latest strategic energy plan for 2050 (METI, 2018b).

A constraint here is the public concern about the management of radioactive wastes—resulting in this often being termed the Achilles' Heel of nuclear power. Due to the relatively large number of reactors in Japan, the management of radioactive waste is recognized as a key issue—leading to the establishment of NUMO in 2000 as the organization responsible for the deep geological disposal of the most radioactive wastes (termed "specified" wastes) as described in Chapter 2. NUMO has been tasked with implementing geological disposal of HLW since 2000 and low-level radioactive waste containing long-lived nuclides (TRU waste) since 2008 (NUMO, 2008). Although both waste types result from reprocessing of spent fuel, HLW is of greatest public concern. Hence, I focus on HLW management in this chapter again.

Geological disposal is a recognized solution for the management of more radiotoxic solid wastes, as recommended by the IAEA (2011). The site of a geological repository needs to be carefully selected to ensure that the risks due to natural or anthropogenic events, long-term radionuclide transport, and the thermo-chemical-mechanical integrity of the site (Bossart *et al.*, 2017; Tsang *et al.*, 2005) are minimal and contamination of the surrounding biosphere is precluded (Bossart *et al.*, 2017; NEA, 2016a). HLW management is a multi-dimensional issue that is impossible to reduce to a few simple aspects and planning for geological disposal, including siting and overseeing its implementation, requires more than just technical aspects (Tochiyama and Masuda, 2013).

In most democracies, the implementation of any geological repository requires the acceptance of local communities and this is established by law in Japan.

With the emphasis on public acceptance, the siting of a geological repository in Japan was initiated through an open call for volunteers to host the project (NUMO, 2002). At the time, this was a revolutionary approach, but it has since been taken over by other national waste management programs (most notably the UK and Canada). On the other hand, despite extensive efforts, siting in Japan has not progressed. In the past two decades, no volunteer communities have come forward with the exception of Toyo Town, which was the only municipality that applied for a literature survey for HLW repository siting but then withdrew the application in 2007. This is in large contrast to the progress towards the implementation of repositories in Finland (NEA, 2016b) and Sweden (NEA, 2013) and towards siting in France, Switzerland, and Canada (NUMO, 2019).

The entire concept of a volunteering approach to siting disposal facilities is based on the assumption that the general public in and around the host locations would be prepared to accept the responsibilities associated with a burden that is balanced by the benefits gained by society as a whole. In the past, Japanese culture, which stresses respect for those in authority, has allowed nuclear projects to develop without open debate, with local benefit packages being negotiated between implementing organizations and municipal/ prefectural governments. However, after a number of high-profile accidents, most notably at the Fukushima Daiichi Nuclear Power Station (termed “1F” in Japan), the acceptance of any type of nuclear infrastructure in Japan has declined markedly. To overcome the growing opposition and loss of public trust, it is now a requirement for the government leaders and key organizations to clearly communicate long-term safety, as well as the service which the host communities will provide, together with the appropriate corresponding compensation the communities will receive for their role. This is especially tricky due to the long-lived nature of the wastes, which requires a convincing demonstration of high safety levels for both present and future generations. Moreover, it is important that leaders clearly demonstrate social awareness and concerns, prioritizing the interests of stakeholders rather than their own goals. As Ohtomo *et al.* (2014) pointed out, the level of public acceptance for HLW disposal cannot be raised only by making an appeal of technological safety because people tend to consider this less as an issue of technological risk but more one of ethics after the 1F accident. Therefore, procedural fairness should be an integral part of HLW management to win public acceptance and consequently gain momentum towards repository siting.

Takeuchi *et al.* (2020) have examined the history of HLW management in Japan, and conducted interviews with the leaders who held real power and were actively involved in the HLW projects, (the director of NUMO who had been developing new methods to ensure safety, and the director of ANRE who drafted the “Specified Radioactive Waste Final Disposal Act”) and assessed problems encountered from the viewpoint of leadership. Takeuchi *et al*. (2020) found five major problems with two key organizations, NUMO and ANRE, and Toyo Town. The major role of NUMO was to implement the projects for geological disposal and they thus invited applications for a literature survey for HLW disposal from municipalities in Japan. The major roles of ANRE were to constitute the “Specified Radioactive Waste Final Disposal Act” and to supervise NUMO and their project implementation. Toyo Town studied the NUMO’s siting program towards and applied for a literature survey for HLW disposal as a candidate host community. The causes of the five problems with the three entities investigated by Takeuchi *et al*. (2020) could be summarized as centering around three points. They were all related to failures of leadership as shown in Chapter 2. Needless to say, not all problems in the world are caused by leaders; however, leaders are the actors who are identified as responsible for these issues and they are often the focus for blame by the general public as in the case of Toyo Town or the Fukushima case (Tashima, 2008; Anon, 2017). Therefore, this chapter focuses not on organizational problems or a culture peculiar to Japan but on leaders' behavior and leadership characteristics. Two of the three causes of the identified leadership problems were already discussed in the previous chapter, but cause 3, "not getting people to believe the ethical responsibilities taken by society", is taken up for further discussion in this chapter as public acceptance for the successful siting of a geological repository can be influenced by the trust of the general public in leaders who are involved in project implementation. Public perception of how the leaders are putting forth ethical responsibilities towards society is a crucial factor (Agarwal *et al.,* 2019; Malik *et al.,* 2014). Regardless of role, ethical responsibilities are required of leaders of NUMO, ANRE, and any candidate municipalities.

Although public engagement has been tackled (NEA, 2012b) and the need for leadership of NUMO was recognized (AEC, 2016; METI, 2018a), leaders' behavior for successful HLW management has not yet been discussed. In fact, leaders' behavior has been questioned for a long time and it is not something limited to HLW management in Japan. In order to clarify a promising alternative leadership to the past leadership in the field of nuclear power and how such suitable leadership can contribute to getting people to believe in ethical responsibilities as a society and to win their trust, I will analyze the behavior and leadership characteristics of the then mayor of Toyo Town and will study how the mayor collaborated with NUMO and ANRE. Based on his leadership shortcomings which led to the withdrawal of Toyo Town's application, I will define the ideal behavior of a leader for HLW management by using the leadership characteristics I have found through a systematic literature review of leadership theories. (In this study, conceptual behavior which has the characteristics of servant leadership emphasized by Greenleaf is assumed as "Ideal behavior".) Finally, I will describe how leaders of NUMO, ANRE, and candidate municipalities can exhibit the characteristics of suitable leadership for successful HLW management in Japan by modifying the functions of ideal leaders identified by the systematic literature review as well as taking into account the results of the study of Takeuchi *et al*. (2020).

3.2. The major problems of HLW management in Japan

In this section, I review the results of the study of Takeuchi *et al*. (2020) before analyzing the behavior and characteristics of leadership of the then mayor of Toyo Town.

There were five major problems with HLW management involving the most important organizations in Japan, namely NUMO and ANRE in addition to Toyo Town (Takeuchi *et al*., 2020). According to Takeuchi *et al*. (2020), (1) ANRE lacked an "understanding of scientific context and justifications to assure any organizations of the fundamental safety of disposal" and (2) an "understanding of different international boundary conditions and how these influenced program implementations." It was also mentioned that (3) the Final Disposal Act enacted in 2000 (drafted by ANRE) "hindered NUMO in starting literature surveys for HLW disposal", (4) NUMO had a "problem communicating with local people of Toyo Town and could not win credibility", and (5) Toyo Town lacked the "opportunity to develop an unbiased understanding of technical issues associated with siting and operating a repository and argue for its long-term safety, thereby failing to win credibility."

The causes of these five problems were all related to failures of leadership as previously identified by Takeuchi *et al*. (2020): (1) lack of communication between leaders of key organizations, (2) lack of alliance with key organizations, and (3) not getting people to believe ethical responsibilities taken to society, and cause 3 is further discussed in this chapter.

In order to clarify leaders' behavior and leadership characteristics for successful HLW management, I first focus on Toyo Town's case. The then mayor used his power to submit the application form for a literature survey to NUMO twice. The first time, he did not communicate with the decision-makers of the local council, the governor of Kochi Prefecture where Toyo Town was located, nor the leaders of neighboring municipalities. The second time, he submitted the application based only on his political judgment. His application ran into strong opposition from not only the local council but also the governor of Kochi Prefecture and the residents in the neighboring municipalities (Tashima, 2008; Saigo *et al.,* 2010; Wada, *et al.,* 2009). As seen elsewhere (e.g., the municipality of Wellenberg, Switzerland), even if there is some local acceptance, if neighboring municipalities feel that they are impacted but do not receive the benefits of the host, they often apply pressure to decrease acceptance (Swissinfo, 2019).

It is crucial for a leader (mayor) of a candidate municipality to communicate transparently with the governor of the prefecture where the candidate municipality is located and leaders (mayors) of neighboring municipalities in addition to the decision-makers of the local council in order to inform them of the reasons for the application, share the vision, and align them all. Since the then mayor acted according to his arbitrary judgement to obtain the subsidies, the local people, the governor of Kochi Prefecture and residents of neighboring municipalities considered him and the Japanese government as making money talk for siting without transparency (Tashima, 2008). The general public did not clearly distinguish the Japanese government from NUMO and/or ANRE. The then mayor's behavior discussed below is based on the facts described in his book (Tashima, 2008) and two studies which were based on the same mayor's book and the newspaper articles (Saigo *et al.*, 2010; Wada, *et al.*, 2009). By examining the behavior of the mayor based on the leadership theories I reviewed in Chapter 1, I found that his leadership was Machiavellian. Therefore, I further analyzed which behavior of the mayor of Toyo Town closely follows a typical Machiavellian leader (Machiavelli, 1961).

3.2.1. What did the mayor of Toyo Town do?

(a) *Used his power to submit the application form for a literature survey to NUMO twice, first without communications with the decision-makers of the local council, the governor of Kochi Prefecture, and the leaders of the neighboring municipalities, later based on his political judgment.*

(b) *Tried to benefit from the subsidies of the Japanese government (municipalities that accepted a literature survey could receive 210 million Japanese yen in order to develop and support industries and increase employment opportunities).*

(c) *Did not mean to manipulate or deceive local people on purpose but believed that getting the associated subsidies would justify his means of submission without transparency.*

Each behavior of the mayor of Toyo Town corresponds with the characteristics of

Machiavellian leaders below.

3.2.2. What do typical Machiavellian leaders do?

(a) *Try to obtain power and use it skillfully.*

(b) *Try to maximize their self-interests.*

(c) *Manipulate or deceive others since the ends justify the means.*

There was no evidence that the then leaders (not only the two directors mentioned above but also any other leaders) of NUMO or ANRE were Machiavellian or that they had concluded a secret agreement with the mayor before his submission of the application form for a literature survey to NUMO; however, the general public in Japan tended to doubt any leaders of NUMO and ANRE. This is due to the known association of NUMO and ANRE as part of the Japanese "Nuclear Power Village." The Japanese "Nuclear Power Village" is a closed and exclusive community of legislators, regulators, manufactures, and researchers who are involved in the promotion of nuclear power and recognized to act in a secretive way for a long time (Anon, 2017; TEPCO, 2016).

Due to the lack of procedural fairness, NUMO as well as ANRE failed to win credibility along with the mayor even before technical issues and safety protocols were properly communicated to the local residents. The mayor later complained in his book that NUMO and ANRE failed to take the lead in denying false rumors. He claimed that he was forced to fight alone while ANRE took too much time (two months) until his application was approved (Tashima, 2008). In fact, Machiavellian leadership is not something limited to the case of Toyo Town or HLW issues. According to the official report of The Fukushima Nuclear Accident Independent Investigation Commission by the National Diet of Japan (Kurokawa *et al.*, 2012) while TEPCO "strongly influenced energy policy and nuclear regulations", they abandoned their responsibilities to METI. Also, TEPCO "manipulated the cozy relationship with the regulators", the Nuclear and Industrial Safety Agency (NISA), and the Nuclear Safety Commission (NSC), "to take the teeth out of rules and regulations". TEPCO, NISA, and NSC "either intentionally postponed putting safety measures in place or made decisions based on their organization's self-interest." They prioritized their own institutional well-being over public safety, thereby compromising the safety of the public (Kurokawa *et al.,* 2012). When the then president of TEPCO covered up the fact of meltdown at 1F, the general public criticized their secretive nature (TEPCO, 2016).

When I compared the characteristics of the past leadership of the mayor of Toyo Town and the leaders of TEPCO, NISA, and NSC, I observed the pattern of their leadership as Machiavellian. As these organizations are known to be part of the Japanese "Nuclear Power Village", the general public distrusted their past and present leadership. Although the mayor was not a member of the "Nuclear Power Village", his leadership followed the Machiavellian pattern and, due to HLW being associated with the "Nuclear Power Village", it was easy for the general public to group their leadership characteristics all together. In order to get rid of deep-rooted distrust and start anew, leaders of NUMO and ANRE together with the leaders of candidate municipalities should take ethical responsibility towards their society by sound leadership that prioritizes public safety and the well-being of the nation, not their own profit or institutional well-being.

3.3. What is suitable leadership for HLW management for the future?

The pattern of behavior and characteristics of a Machiavellian leader were exhibited by the then mayor of Toyo Town, which led to the loss of his credibility along with that of NUMO and ANRE. I tried to find leadership theories which prioritize ethical responsibility towards society and well-being of the general public by literature review. As introduced in 1.1.2.2**.**, the major characteristic of the servant leadership theory is the emphasis on the ethical responsibilities to followers, stakeholders, and society (Wart, 2003). Servant leadership is considered remarkably similar to transformational leadership. While transformational leadership also places emphasis on ethics and valuing people as described in 1.1.2.4., the transformational leaders direct their focus towards the organization, and their behavior builds follower commitment towards organizational objectives (Stone *et al.,* 2004). If transformational leadership is adopted for HLW management in Japan, the leaders' focus will be directed toward NUMO and/or ANRE, and their behavior builds the general public's commitment towards final disposal. On the other hand, if servant leadership is adopted, servant leaders of NUMO and ANRE will focus on both their employees and the general public, including local people of any candidate municipalities.

After the 1F accident, the Japanese government and the nuclear industry severely lost national and international credibility. If NUMO and ANRE's behavior builds the general public's commitment towards final disposal now, the public will probably feel a strong antipathy against such leadership. Hence, it is prudent for leaders of NUMO and ANRE to serve first for the well-being of the whole nation and then think that the achievement of final disposal is a subordinate outcome.

In addition, Sendjaya and Cooper (2011) pointed out that Machiavellian behavior squarely contradicts the behavior of servant leader as described in 1.1.2.1.

Moreover, the report of the Nuclear Energy Agency (NEA) (2012b) described how waste management organizations and safety authorities can effectively fulfil their societal and ethical responsibilities. They enumerated the behavioral features necessary for such organizations and authorities as having "openness, transparency, honesty, consistency, willingness to be tested, freedom from arrogance, recognition of limits, commitment to a highly devoted and motivated staff, coherence with organizational goals, an active search for dialogue, and alert listening stance and caring attitude" (NEA, 2012b). These behavioral features closely overlap with the characteristics of a servant leader, which further emphasizes the suitability of servant leadership in HLW management. Hence, among many leadership theories, servant leadership was found to be the most suitable for HLW management.

Needless to say, there have been other problems besides the leadership problem. According to an interview with the technical leader of NUMO between 2000 and 2008 from the study of Takeuchi *et al*. (Takeuchi *et al*., 2020), he emphasized that it was too difficult to convince the general public of safety. The current director of NUMO explains three frequent comments on fear from the participants in "Dialogue-Based Meetings on Final Disposal of High-Level Radioactive Waste" (NUMO, 2020) that have been held by NUMO at more than 100 venues all over Japan to enhance understanding among the general public about the geological disposal project since the Nationwide Map of Scientific Features for Geological Disposal (NUMO, 2017) was published by the Japanese government in July 2017. Their comments are (Takahashi, 2020): "(1) fear and distrust towards the Japanese government's nuclear power policy, the electric power companies and nuclear power/nuclear power industry due to the 1F accident etc., (2) fear of the geological features of Japan (e.g., groundwater and earthquake risk, igneous activity), and (3) fear of long-term safety". Although confidence-building and risk communication on how to ensure safe HLW disposal have been done (NEA, 2012b; West and McKinley,2007; Osawa *et al.,* 2019; Saegusa, 2018), NUMO has had the same communication problem since it was established. We must remember that leaders are the actors who decide what to disclose and how to communicate their visions to others. They also decide whether or not to empower the general public including the locals of candidate municipalities to engage in important communications for decision-making during the siting process in order to achieve the envisioned goal. Leadership is reflected in all strategies and tactics to solve any problems and/or move forward, as Machiavellian leadership was reflected in the case of Toyo Town. Hence, it is crucial to adopt an appropriate leaderships strategy before developing communication skills or tools.

Therefore, I conceptually define the ideal behavior of a leader for HLW management by using the characteristics of a servant leader identified by Spears (2010) and Focht and Ponton (2015) as well as the interpretation of servant leadership theory by Stone *et al*. (2004) as shown in Table 3.1. I focus on behavior which Machiavellian leaders lacked in the past, but which is required by the general public. I believe servant leadership can be functional through the practice of the ideal behavior I have defined in Table 3.1. In the next section, I will describe how leaders of NUMO, ANRE and candidate municipalities can exhibit the characteristics of a servant leader through the practice of the ideal behavior in Table 3.1.

Table 3.1. The ideal behavior of a leader for HLW management based on the characteristics of a servant leader identified by Spears (2010) and Focht and Ponton (2015) and the interpretation of servant leadership theory by Stone *et al*. (Stone *et al.* 2004).

Characteristics of a Servant Leader		**Ideal Behavior of a Leader for HLW Management**
Identified by Spears (2010)	Identified by Focht and Ponton (2015)	
Awareness, stewardship	Caring, serving others' needs before their own	Serve first for the well-being of the whole nation and think that the achievement of final disposal is a subordinate outcome.
Listening, empathy, healing	Value people, listening, humility, trust, love	Value the general public and listen to their opinions with humility, empathy and an altruistic mind.
-	Unconditional love and learning, collaboration, empowering	Learn from the general public, collaborate with them, and empower them to engage in decision-making during the siting process.
Persuasion, conceptualization	Integrity	Persuade the general public with integrity and clear vision through meetings such as "Dialogue-Based Meetings on Final Disposal of High-Level Radioactive Waste."
Foresight, commitment to the growth of people, building community	Service	Not only secure procedural fairness and safe disposal, but also commit themselves to the growth of people and development of a unique community.

3.4. The functions of servant leaders for HLW management in Japan

According to Greenleaf (1977), the person who is leader first chooses to serve later—after leadership is established. On the other hand, the servant leader is a servant first and tries to benefit the least privileged in society or at least not to further deprive (Greenleaf, 1977). Who will be the least privileged in society when the final disposal of HLW is proceeding? Many people may insist that the local people of the host municipality where the HLW repository is constructed will be the least privileged. If so, how will the servant leaders for HLW management in Japan function to benefit the least privileged?

Coetzer *et al*. (2017) pointed out that although servant leadership had been studied quite well in the literature, practical recommendations for how to successfully implement servant leadership within organizations has yet not been properly conceptualized. Through a systematic literature review, Coetzer *et al*. (2017) identified and grouped the main functions of a servant leader into strategic and operational servant leaderships using the characteristics and competencies of servant leadership. Since their study was basically on servant leadership within organizations, I take account of the results of the study of Takeuchi *et al*. (2020) and modify their results to define the functions of servant leaders that will be suitable for HLW management in Japan as indicated below.

3.4.1. Strategic Servant Leadership

Function 1

A technical leader of NUMO communicates with a leader (a director) of ANRE for correct scientific input and confidence-building before communicating with their employees or the general public (here general public includes leaders and local people of municipalities), and sets, translates, and executes a higher purpose vision, namely: (1) devoting themselves to the nation and not to pass on the burden to future generations; (2) isolating HLW from humans and the environment to ensure safety; (3) establishing a unique local community such as the Östhammar municipality of Sweden is aiming for (NEA, 2012a).

Function 2

Each leader's own behavior is aligned so that he/she becomes a role model and ambassador to others in line with a higher purpose vision described above. By exhibiting the characteristics of servant leadership not only to the employees of NUMO and ANRE but also to the general public, leaders will demonstrate why they love to serve the nation. Some people served by servant leaders will become followers, even "grow as persons", and "become more autonomous" and more likely themselves to become servant leaders as Greenleaf (1977) states.

3.4.2. Operational servant leadership

Function 1

The leaders of NUMO and ANRE align themselves first and thereafter their followers. Leaders care and grow the talent of the followers so that they can become servant leaders themselves and achieve the visionary goal for the well-being of the whole nation. Since a servant leader can help followers to mature emotionally, intellectually, and ethically (Sendjaya and Cooper, 2011), the general public may be able to transcend personal emotions. It is desirable that NUMO and ANRE should raise both the capacity to serve and the level of performance as servants for a better society using new regenerative forces operating within their organizations. If their servant leadership is functional at this stage, the leaders of some municipalities may become followers and join the alliance with NUMO and ANRE.

Function 2

The leaders of NUMO, ANRE, and candidate municipalities empower followers to achieve the higher purpose vision, but leaders need to continuously monitor progress and improve policies, processes, systems, products, and services for safe disposal. When the general public is convinced of the higher purpose, vision, and safety, they will become followers or even become servant leaders to achieve the vision by themselves. Leaders of NUMO, ANRE, and candidate municipalities need to value the autonomy of their followers and let them act by themselves.

Although I have theoretically defined the functions of servant leaders for HLW management, people may question its validity and may doubt if there are servant leaders who can work like this in Japan. I have met a number of potential servant leaders who were involved in HLW management in Japan before.

Greenleaf (1977) pointed out that even intelligent leaders often fail in leading and in following servants as leaders due to fuzzy thinking. Too many leaders tend to settle for being critics and experts and there is too much intellectual wheel spinning, too much retreating into "research" (Greenleaf, 1977). Such leaders do not undertake the tough and high-risk tasks of building a better society. It is prudent for the current leaders of NUMO and ANRE to "offer explicit preparation for leadership" to potential servant leaders so that they can realize the supreme functions described above. Even if the current leaders are not servant leaders themselves, they can lead potential servant leaders to the strategic stage of servant leadership and decide to follow the potential servant leaders.

If the servant leaders of NUMO, ANRE, and candidate municipalities could follow what I have suggested, the general public will grow according to Greenleaf's test of servant leadership. Moreover, some of them may subsequently become servant leaders who can devote themselves to the nation and ultimately avoid passing the burden of the present to future generations. Needless to say, servant leadership is not a panacea for all the problems. For example, NUMO needs to develop a safety case to ensure safe disposal and their latest report will be published soon. Nonetheless, leaders of not only NUMO but also ANRE must place their ethical responsibilities towards their society first to win credibility. Otherwise, the general public cannot accept any offers related to HLW disposal.

All over the world, there are many elected officials who postpone projects that are unpopular among the general public like HLW disposal. Such a habit is referred to as "Not in My Term of Office (NIMTOO)". NIMTOO has been a key driver of resistance to repository siting at local, regional, and national levels around the world. If leaders of ANRE are servant leaders, they will not postpone their project on purpose; instead, they will tackle the tough project and avoid passing the burden on to future generations. In this way, the higher purpose vision can be achieved for the well-being of the nation. Even if most elected officials involved are not servant leaders at the starting point of the project, some of them who are served by a servant leader may grow as persons according to Greenleaf's test of servant leadership, and consequently may become servant leaders themselves during the project period.

Finally, I believe servant leadership will break the ice for winning credibility. If leaders pretend to be servant leaders with modest behavior or words, the general public will sense such acts. A genuine servant leader is able to find a solution based on scientific justifications under the given constraints and assess the gain by the public using a smoothing approach based on ethics. As Greenleaf (1977) believed, the most open course to carry out a project for a better society must be to develop the capacity to serve and improve the level of performance as servant of existing organizations such as NUMO and ANRE by employing new regenerative forces operating within them. If servant leadership is proved as such a leadership, people will grow and our society will develop while producing more servant leaders who will be willing to serve together for the well-being of the public.

3.5. Conclusions

The pattern of behavior and characteristics of a Machiavellian leader were exhibited by the then mayor of Toyo Town, which led to the loss of his credibility along with NUMO and ANRE. In common with some other leaders in the Japanese "Nuclear Power Village" whose behavior had been questioned by the general public for a long time, the then mayor could not get people to believe that he took his ethical responsibilities toward society seriously and consequently halted the progress towards siting. To get rid of deep-rooted distrust and improve the future siting process, this study suggests that servant leadership is the suitable leadership for HLW management because servant leaders direct their focus on the followers, with the achievement of organizational objectives a subordinate outcome; this will increase the positive perception of the general public by involving them in the decision-making process. Leaders of NUMO and ANRE together with leaders of candidate municipalities can break the ice in terms of winning credibility with servant leadership that prioritizes public safety or well-being of the nation instead of their own profit or institutional well-being. By exhibiting the characteristics of servant leadership, some of those who are served by a servant leader will grow and evolve as persons according to Greenleaf's test of servant leadership. Consequently, followers of servant leaders would become servant leaders themselves who will be willing to devote themselves to the nation and prioritize proper implementation of difficult and controversial, but necessary, projects to ultimately avoid passing the burden of the present on to future generations. If servant leadership were to be adopted for the management of HLW in Japan, further research based on feedback from followers and the general public may be required. Such research can be meaningful both to researchers and those who are engaged in HLW management worldwide.

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Chapter 4

Scientific Justifications for the Political Decision-making on Environmental Remediation Carried out after the Fukushima Nuclear Accident

Keywords: environmental remediation; nuclear power; nuclear accidents; waste management; decision-making; leadership

4.1. Introduction

Following the Great East Japan Earthquake and Tsunami on 11th March 2011 and the subsequent reactor meltdowns at the Fukushima Daiichi (termed "1F" in Japan) Nuclear Power Plant (NPP), the Japanese Government was directly responsible for making key decisions in terms of both immediate responses and long-term recovery of the devastated coastal area on the northeast of the main island of Japan (Honshu). After stabilization of the 1F site, the Japanese Government believed environmental remediation was crucial and decided to implement a program to classify and remediate the evacuated areas. They conducted clean-up work to remove radioactive materials in Special Decontamination Areas (SDA) where the fallout of radionuclides was higher under the direct control of the Japanese Government. The SDA included the Evacuation Zone (20 km from the Nuclear

Power Plant) and the Planned Evacuation Zone (annual cumulative dose of > 20 mSv). Municipalities in the Intensive Contamination Survey Areas (ICSA) also conducted such clean-up based on radiation surveys with technical and financial support from the Japanese Government. The areas where an additional exposure dose (over and above natural background radiation) of over 1 mSv/year was observed were designated as ICSA. The Japanese Government invested huge financial and human resources in order to enable the fastest possible return of evacuees.

Immediately after the 1F accident, comparisons were made with the Chernobyl accident and the Chernobyl exclusion zone (CEZ) by the media, even though many technical experts were fully aware of the differences between these two accidents, as has previously been pointed out by Hardie and McKinley (2014). On the basis of the scientific facts, the fallout from the 1F accident was recognized to be more akin to either the fallout from Windscale or the distant Chernobyl fallout deposited in Fenno-Scandinavia and parts of the United Kingdom than that in the Chernobyl exclusion zone (Hardie and McKinley, 2014, Table 4.1).

Table 4.1. Three reactor accidents

Chernobyl (1986, Ukraine of USSR)	• Criticality excursion during tests • Explosive release of core contents • Long-term releases during / after responses to control fire / criticality
Windscale (1957, Cumbria of UK)	• Core fire during secret production of polonium • Extensive releases of volatile components and water used for fire-fighting
Fukushima (2011, Fukushima of Japan)	• Core melt due to decay heat and fuel pond damage after loss of power following the tsunami

The accident at the Chernobyl NPP reactor number 4 was caused by overheating during a safety test which led to a vapor explosion in the reactor core and subsequent fire. This resulted in the explosive dispersion of a large quantities of both volatile and non-volatile radioactive materials in the form of gases, fine aerosol mists and pieces of reactor core into the surrounding environment. The 1F accident, on the other hand, was triggered by hydrogen explosions in all three of the on-line reactors at the 1F plant. Just after the earthquake and subsequent tsunami, all three online reactors (units 1, 2 and 3) automatically shut down (scrammed) as they were designed to do and many of the very short-half-life radionuclides therefore decayed before core meltdown. The World Nuclear Association summarized the radioactive release from the Fukushima Daiichi reactors as "Major fuel melting occurred early on in all three units, though the fuel remains essentially contained except for some volatile fission products vented early on… (World Nuclear Association, 2021)."

Radioactive gases such as the noble gases and radioiodine and lower boiling point radioactive metals such as cesium were dispersed into the environment after the accident.

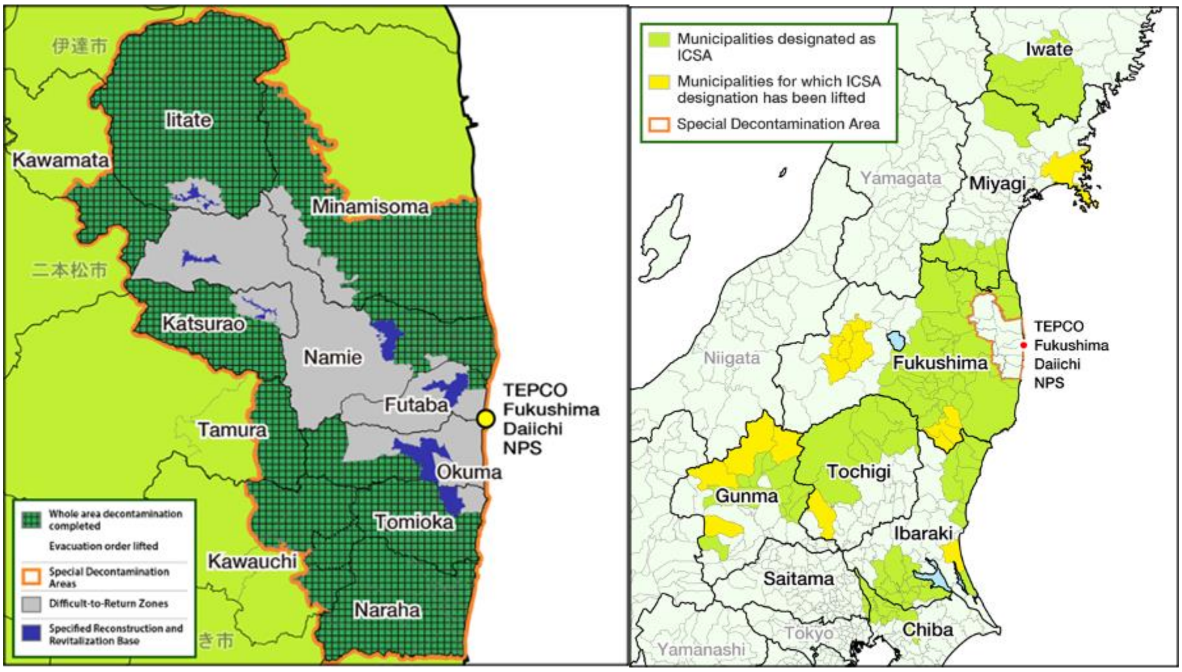
Otosaka *et al.* (2017) concluded that most cesium was dispersed into the environment within one month after the accident. The focus of radiological assessment was mostly on ^{131}I (half-life 8 days), ^{137}Cs (half-life approximately 30 years) and ^{134}Cs (half-life 2.1 years) due to environmental or human concentration mechanisms (Hardie and McKinley, 2014). Miyahara and Ohara (2017) concluded that radionuclides released from 1F were about 10% of the release during the Chernobyl accident, with the exception of the noble gases, and 80% of the radionuclides released from 1F went into the sea (including via aerial deposition).

The initial health focus was on radioiodine, particularly ^{131}I due to its short half-life and potential to concentrate in both foodstuffs and the human thyroid. However, ^{131}I decayed to insignificance within 3 months (Hardie and McKinley, 2014), after which the measured doses were mainly due to radioactive isotopes of cesium (specifically ^{134}Cs, due to its much shorter 2-year half-life) according to field investigations carried out in June 2011 (Saito *et al.*, 2017). Koizumi *et al.* (2012) pointed out that the rapid decay of the most hazardous short-lived isotopes and "natural cleaning" of longer-lived contaminants (e.g. ^{137}Cs) reduced radiological health hazards considerably. It should be noted that although (radio-)cesium is strongly adsorbed by clay minerals and is not easily removed due to the strong affinity of clays for cesium (Iijima *et al.*, 2017), these clays can be mobilized in the environment, e.g. as suspended sediments in rivers.

Although it has been argued that there were many opportunities for the Japanese Government, the regulators and the Tokyo Electric Power Co., Inc. (TEPCO) to strengthen measures that could have prevented the accident prior to 11th March (Kurokawa *et al.*, 2012), this paper focuses on the situation that the Government was then faced with: a globally unprecedented disaster in the absence of any kind of guidelines on which to base responses. Here, consideration is confined to actions off-site – which were decoupled from decision-making associated with management of the evolving situation at the 1F nuclear power plants.

In May 2011, the headquarters of the Fukushima Partnership Operations of JAEA were established to coordinate environmental remediation within Fukushima Prefecture and provide technical support to the MOE. Two model projects for environmental remediation were started outside the evacuated zone, in Minamisoma City and Date City (but still within Fukushima Prefecture) in August 2011. The guidelines subsequently produced for further clean-up were developed from the experience gained and lessons learned during the execution of these model projects (JAEA, 2012).

In order to develop and test tools and methodologies for decontamination, a further eleven demonstration model projects commenced in September 2011, this time within the evacuated zone. These demonstration model projects were carried out by three consortia, including major civil engineering contractors (Nakayama *et al.*, 2014), after which region-wide remediation followed. Eleven Fukushima Prefecture municipalities in the SDA (basically the “Planned Evacuation Zone” where the annual cumulative dose was more than 20 mSv and the “Evacuation Zone”, which is the 20 km zone around the 1F nuclear power plants) were chosen for clean-up by the Japanese Government. Also, a number of municipalities in eight prefectures in the ICSA, namely Chiba, Gunma, Ibaraki, Iwate, Miyagi, Saitama and Tochigi Prefectures in addition to Fukushima Prefecture, were chosen for conducting surveys in order to determine if clean-up was also necessary in these areas (MOE, n.d.). Details on the municipalities which conducted clean-up based on surveys performed have been published by the MOE (2018a). The SDA and ICSA are shown in Figures 4.1.a and 4.1.b, respectively.



(a) (b)

Figure 4.1. The areas in northeastern Japan showing the progress of decontamination **(a)** among eleven municipalities under the designation of the Special Decontamination Areas (SDA) and **(b)** within the Intensive Contamination Survey Areas (ICSA) as of March 19, 2018. Maps reproduced with permission of the Ministry of the Environment (MOE), Japan (MOE, 2018b).

The Japanese Government announced in October 2011 that they would aim to reduce additional annual doses (over and above natural background radiation) to 1 mSv or less as a long-term goal (MOE, 2012a). As a consequence of this decision, the areas for clean-up were vast and the Japanese Government subsequently had to manage huge volumes of soil and waste generated during the remediation activities (Fujita *et al.*, 2020).

Although at the time (October 2011) there were arguments over the decision that a lower reference level should be selected from the additional dose range of 1-20 mSv/year (and the long-term goal for residents of an additional dose of no more than 1 mSv/year), it was not changed and consequently it took the Japanese Government until the 1st of April 2017 to complete all the planned clean-up (MOE, 2018b). By March 2018, the total volume of removed contaminated soil generated by off-site clean-up inside and outside of Fukushima Prefecture reached 17,000,000 m^3, and over 2.9 trillion Japanese Yen had been allocated as the budget (Fujita *et al.*, 2020).

The next big problem faced by the Japanese Government was attempting to reduce the volume of removed soil and other wastes that would go for disposal. Thus, methods on how to recycle waste materials and where to use these recycled materials should have been considered carefully. According to the MOE, 14,000,000 m^3 of removed soil and waste, including specified waste (> 100,000 Bq/kg), is to be stored for a maximum of 30 years (Fujita *et al.*, 2020) at the Interim Storage Facility (ISF) built in Okuma Town and Futaba Town of Fukushima Prefecture. After storage at the ISF, it is intended that waste will be removed from the facility and taken to an as yet unspecified final disposal facility, outside Fukushima Prefecture (MOE, 2019). It was not easy to acquire land to construct the ISF (it took many years to obtain permission from landowners) and, to date, the strategy for final disposal of this waste has not yet been defined.

Based on scientific justification (e.g. Waddington *et al*., 2017), leaders of the Japanese Government who were responsible for environmental remediation should have defined the level of clean-up. Hence, I directed my attention to the decision-making process of the then responsible leaders. Specifically, this study investigates whether or not technically based assessment of dose targets, health effects and risk-based approaches were communicated to the Ministry of the Environment (MOE) which was responsible for the decision-making before the remediation strategy was decided upon by the Japanese Government. Further goals are to clarify the roles of academic leaders and define how such decisions were made based on some leadership theories and findings so that future leaders can avoid the same pitfalls encountered during similar events.

4.2. Methodology

The assessment is based on key papers, reports and records of environmental remediation in Fukushima and related issues, in addition to the Role Theory of Kahn *et al.* (1964), the Cognitive Resources Theory of Fiedler (1986) and the findings of Berkowitz (1953) and Bass (2008). In the field of leadership, there are many findings from different approaches such as the trait approach, the behavioral approach and the situational approach as described in section 1.1.1. Due to the globally unprecedented disaster and the Fukushima Daiichi accident, the Japanese Government was placed in a critical situation and the behavior, including decision-making, of the then Minister of MOE must have been strongly influenced by the situation. Hence, I focus on the situational approach and use some findings by leadership researchers in addition to situational theories in order to define how the decision to establish the 1 mSv/year dose target was made. According to Yukl (1989), "the situational approach emphasizes the importance of contextual factors such as the nature of the work performed by the leader's unit and the nature of the external environment." My assessment is complemented by interviews (between 26th of June 2017 and 7th of November 2017) with a number of experts from both governmental and research organizations:

1. The Director General (technical leader) of the Japan Atomic Energy Agency (JAEA) who was responsible for coordinating environmental remediation in Fukushima prefecture and providing technical support to the MOE (the implementing body)
2. A number of technical experts within JAEA
3. The official of the Fukushima Prefectural Government who was in charge of the environmental remediation
4. Dr. Irena Mele, Head of the Waste Technology Section in the Division of Nuclear Fuel Cycle and Waste Technology of the Department of Nuclear Energy of the International Atomic Energy Agency (IAEA) in 2011
5. International technical experts who were involved in various Fukushima remediation projects
6. Mr. Tomohiro Kondo, the Councilor of the Environmental Regeneration and Materials Cycle Bureau of the MOE
7. Mr. Goshi Hosono, Minister of the MOE between September 2011 and October 2012
8. Mr. Takashi Ohmura, Chief of the Secretariat of the Task Force for Decontamination of the MOE (this job title was translated by Takeuchi because no English title existed just after the accident) since June 2011 and Director, Fukushima Office for Environmental Restoration of the MOE between April 2012 and June 2013.

4.3. Results of the investigation

4.3.1. The Japanese Government's decision

According to the interview with the then Minister and officials of the MOE on 10th November 2017 and the additional interview with the then Chief of Secretariat of the Task Force for Decontamination of the MOE on 14th November 2017, the governor and mayors of the municipalities in Fukushima Prefecture demanded an exhaustive clean-up just after the 1F accident and the Japanese Government responded to their demand even before the "Act on Special Measures concerning the Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District" came into force (MOE, 2012b). This act was intended to clarify the responsibilities of national and local governments, the nuclear power producers and citizens in handling the environmental pollution by radioactive materials discharged during the accident, as well as to promptly reduce the impacts of the pollution from radioactive fallout on human health and the living environment by instituting the measures that should be taken by the national and local governments and the relevant nuclear power producers, etc. (MOE, 2012b); the act came into force from 1st of January 2012.

The Nuclear Safety Commission (NSC) stated the basic view that a lower reference level should be selected from the additional dose range of 1-20 mSv/year and the long-term goal for residents of an additional dose of no more than 1 mSv/year should be achieved based on ICRP Publication 103 (ICRP, 2007) of 19th of July 2011 (NSC, 2011). The average natural radiation background of Japan is 2.1 mSv/year and the average natural radiation background worldwide is 2.4 mSv/year (MOE, 2015). If the medical exposure in Japan is included, the average dose that the Japanese population receives is around 6 mSv/year (MOE, 2015). If the long-term goal for residents of an additional dose of no more than 1 mSv/year is set, the exposure dose/year should be reduced to less than the natural radiation background of each area + 1 mSv/year after clean-up. On 26th August 2011, the Nuclear Emergency Response Headquarters decided the fundamental policy on urgent implementation of environmental remediation based on ICRP Publication 103 and the basic view stated by the NSC (Prime Minister of Japan and His Cabinet, 2011). Since the then Minister and officials of the MOE did not join the discussions held by the NSC and the Nuclear Emergency Response Headquarters, they did not know details of the discussions when the fundamental policy was being decided. The Minister and officials of the MOE only joined meetings held by the Environmental Remediation Investigation Committee at a later stage, when environmental remediation was carefully discussed (MOE, 2011a; MOE, 2011b). However, the decision that a lower reference level should be selected from the additional dose range of 1-20 mSv/year and the long-term goal for residents of an additional dose of no more than 1 mSv/year was not changed. When I asked during the interview about how to handle the large volumes of contaminated soil, vegetation and other generated wastes, as well as the huge cost of managing the collected radioactive wastes, and whether or not international experts had suggested any different dose targets or strategies, the Minister of the MOE answered, "I visited Fukushima many times and was considerate of the feelings of mothers who had young children and understood their fears of radiation because I also had an elementary school child. The dose target issue was discussed in depth by excellent technical experts such as university professors. I also met international experts from the IAEA and so on. All of them supported our decision. If the same accident occurs again, I will set the final dose target of no more than 1 mSv/year again. I'm sure any country would set the same target as ours if a similar accident occurs."

4.3.2. Recommendations of international and Japanese experts

All the international and Japanese experts who were interviewed suggested that the dose target of 1 mSv/year was too low and a dose of 5 mSv/year would have been more reasonable, even taking into account young children. All the technical experts interviewed were also worried about the management of the much larger volumes of generated waste which resulted from the lower dose target. They recommended that the budget allocated for remediation should have been spent for some other purpose. Ahn (2012) also questioned "How clean is clean enough?" and argued about the total volume of waste material, the associated cost and the insignificant health risks in areas of low contamination were factors that should have been considered.

According to Kurokawa's report (Kurokawa *et al.*, 2012), some residents wanted to remain in their homes and actively support clean-up, but others wanted to move away and requested compensation to support their relocation. Many people thought it would be impossible to resume their normal lives and hoped the government would spend the allocated budget to support evacuees in starting new lives outside Fukushima Prefecture. Some also hoped that the Japanese Government would re-examine the dose target of 1 mSv/year (Ishii, 2013a; Ishii, 2013b). When members of the IAEA visited Fukushima in 2011, they also suggested not to be overly sensitive to safety and pointed out that the dose target of 1 mSv/year was inappropriate. The Minister of the MOE also recognized the IAEA's advice, but he answered at the press conference held on 18th October 2011 that he would follow the wishes of municipalities in Fukushima Prefecture (MOE, 2011c). On 4th March 2013, he objected to the article published in Yomiuri Shimbun (a Japanese newspaper) that his decision of 1 mSv/year hindered evacuees' return to their homes (Yomiuri Shinbun, 2013). He explained in his blog that, although he pointed out repeatedly that 1 mSv/year was not the standard for health or evacuees' return, the target of 1 mSv/year was set according to the demands of the mayors and the governor of Fukushima Prefecture (Hosono, 2013).

Fears were also generated by the media. Exaggerated news reports provoked suspicion and resentment not only towards TEPCO and the Japanese Government but also scientific experts in nuclear technology from any of the involved organizations. According to interviews with JAEA staff and international experts, they had a strong impression that public opinion was created and controlled by the media. The interviewees from JAEA said mothers who had young children were frightened of the radiation and cried a lot and emphasized that the media created an atmosphere of fear. As the then Minister of the MOE said, those frightened mothers, in addition to the governor and the mayors of the municipalities in Fukushima Prefecture, played a major role in leading to his decision of implementing exhaustive clean-up and the subsequent setting of the long-term dose goal of no more than 1 mSv/year for the residents. Although the Minister of the MOE insisted that all technical experts supported the Japanese Government's decision, I could not find any technical experts who supported the target of 1 mSv/year above background.

4.3.3. How was the decision to establish the 1 mSv/year dose target made by the Minister of the MOE?

Yukl (1989) described one of the situational theories, the Role Theory of Kahn *et al.* (1964), as that "the role expectations from superiors, peers, subordinates, and outsiders are major influence on a leader's behavior and leaders adapt their behavior to role requirements, constraints, and demands of the leadership situation." For the environmental remediation in Fukushima, the role expectations from the governor and mayors of municipalities in Fukushima Prefecture and many frightened mothers with children must have been the major influence on the Minister and officials of the MOE who were responsible for the decision-making. They adapted their behavior to role requirements, constraints, and demands of the leadership situation, namely an exhaustive clean-up without thought of cost, time and environmental impacts.

Yukl (1989) explained that situational variables such as interpersonal stress determine whether a leader's intelligence and experience enhance group performance. According to the Cognitive Resources Theory of Fiedler (1986), leaders use their intelligence when stress is low, but their experience when stress is high. The experience of a leader is related to group performance under high stress but not under low stress because an experienced leader most likely relies mainly on experience to solve problems when under high stress, not on intelligence (Yukl, 1989). When the then Minister and officials of the MOE had to set the long-term additional dose target for residents, stress was very high, which likely interfered with the use of intelligence (rationality) to solve problems and make decisions. Needless to say, these leaders did not have any prior experience in the clean-up of radioactive materials.

Bass (2008) explained that "the leadership that succeeds in influencing followers may not be most effective in stressful situations, particularly in the long run". The leadership by the then Minister of the MOE succeeded in influencing people, but it resulted in a "faulty decision made too hastily" (Bass, 2008) and "a defensive reaction" (Bass, 2008) to set the target of 1 mSv/year, even if his leadership was likely to "contribute to escape from panic situations" (Bass, 2008), in particular for frightened mothers with young children. His leadership decision on the exhaustive clean-up must have eased the concerns of such mothers and the mayors of the municipalities in Fukushima at least in the interim.

Berkowitz (1953) pointed out that when groups are confronted with urgent problems, the group motivation to reach a solution as quickly as possible appears to be stronger than their motivation regarding the expectations concerning role differentiation (expectation that a leader should be functionally differentiated from the others in the group). There is also a tendency for these groups to have greater interdependence among the members (Berkowitz, 1953). Bass explained that Berkowitz found that "both governmental and industrial groups were more likely to accept leadership when the problem was urgent" (Bass, 2008). Since the radiation problem was urgent and officials, politicians and the general public, including residents in Fukushima, were under high stress just after the 1F accident, they were likely to accept the leadership of the then Minister of the MOE despite the content of his decision. Understanding the decision-making process as shown in Figure 4.2 can help future leaders to avoid the same pitfalls encountered under similar events.

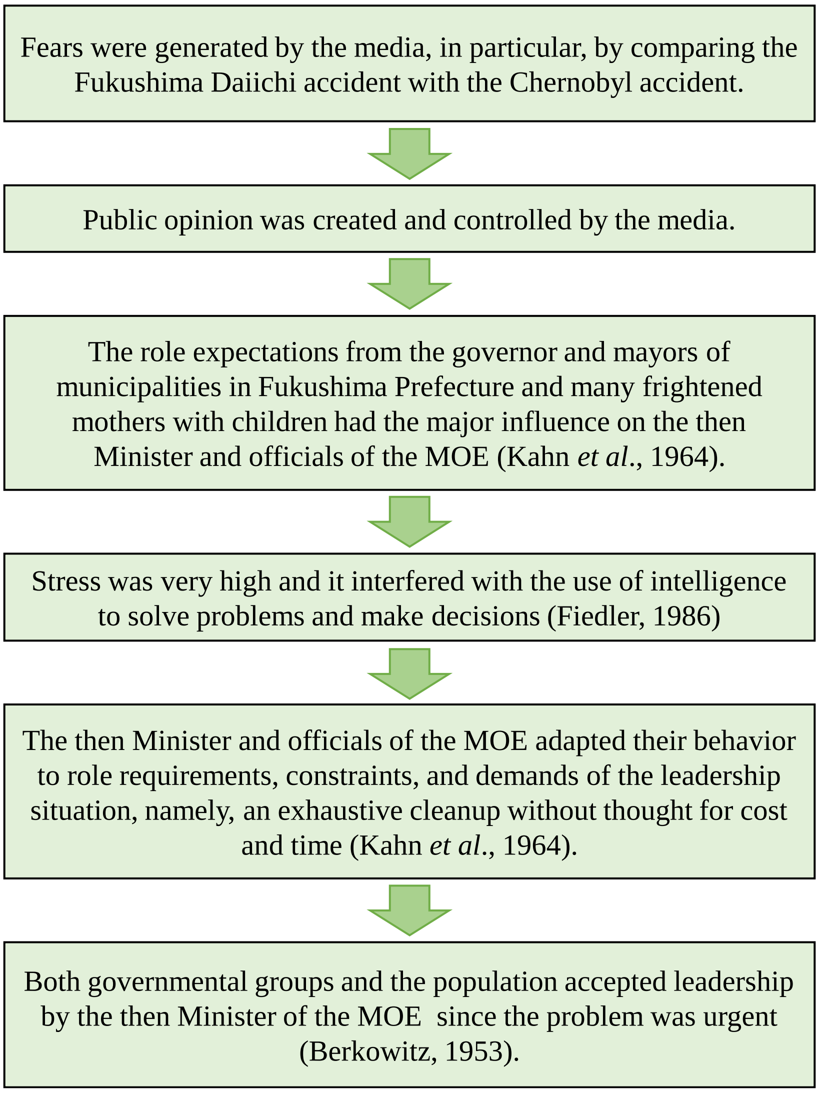


Figure 4.2. Diagram showing how the decision of establishing the dose target of 1 mSv/year was made by the then Minister of the Ministry of the Environment (MOE) and accepted by governmental groups and the Japanese public.

4.4. The leadership role of academics

4.4.1. What should have been done by Japanese academic leaders?

Fukushima cannot be rejuvenated by environmental remediation alone. Although it is important, political and administrative leaders should also create a clear vison and strategy for rejuvenation at the earliest stages, so that they can allocate their limited finances and human resources appropriately towards an integrated plan for reconstruction, which includes environmental remediation. For example, it was necessary to sustain local infrastructure such as roads and water supply facilities. Although finances were allocated for that purpose by both the Japanese Government and the local government (Fukushima Prefecture), they were insufficient and, according to officials of Fukushima Prefecture, the infrastructure in the Prefecture requires further improvement. The Japanese Government became too sensitive to the feelings of the residents of Fukushima and focused only on environmental remediation immediately after the accident. It took too much time to complete environmental remediation due to the dose target of no more than 1 mSv/year being set.

Nine years have passed since the 1F accident but only 28% of the registered residents of the municipalities where evacuation orders have been lifted have returned to their homes according to a 2020 survey (Jiji.com, 2020; Reconstruction Agency, 2020). About 70% of the residents who were evacuated from Fukushima municipalities settled in different municipalities outside Fukushima Prefecture. For a better decision-making on environmental remediation, a technically based assessment of dose targets, health effects and risk-based approaches should have been logically communicated by Japanese scientific leaders (usually most scientific leaders are academic leaders in Japan) before the dose target was set, not only to the then Minister and officials of the MOE but also to the governor and the mayors of the municipalities in Fukushima Prefecture.

The Minister and officials of the MOE should have consulted international technical experts who had experience or knowledge in environmental remediation at the earliest stage, not after the decision was made. International technical experts can suggest reasonable dose targets, but ultimately, they cannot object to a target decided by the Japanese Government. Such experts should have been a part of a team to help explain what would have been realistically achievable and why. Furthermore, it would have been desirable for Japanese academic leaders to provide the appropriate information on environmental remediation and reconstruction for Fukushima to the then Minister and officials of the MOE. In collaboration with Japanese academic leaders and international technical experts, the Minister and officials of the MOE could also have developed a communication program to alleviate residents' fears and expedite reconstruction for the affected Fukushima municipalities.

4.4.2. The Windscale accident

By examining experience in recovery from nuclear accidents that took place in the past, academic leaders could have provided information that was directly relevant for the Fukushima case. Based on this case, environmental remediation could have been planned and implemented more effectively whilst maintaining the highest possible safety standards and balancing the economic burden (both of which impact the Japanese public). For example, academic leaders could have examined the case of Cumbria in NW England. The region of Cumbria, a popular tourist destination in the United Kingdom, has twice been contaminated with radiocesium released from nuclear reactor accidents; once in 1957 after the Windscale fire and again in 1986 after the catastrophic explosion at the Chernobyl NPP. Research into both of these cases could have informed and helped guide the development of appropriate and practical measures to be implemented after the 1F accident.

In the case of Cumbria, no remediation was performed after either accident, although some restrictions were placed on foodstuffs such as milk after the Windscale accident (Hardie and McKinley, 2014; McKinley *et al.*, 2011; Miyahara and Ohara, 2017). Similarly, no extensive off-site remediation was performed at Chernobyl; however public access to highly contaminated regions was restricted (Hardie and McKinley, 2014; McKinley *et al.*, 2011). Although the Windscale accident was not well known even among technical experts in Japan, it was perhaps the most analogous to Fukushima's case (Figure 4.3, Table 4.2). Taking a closer look, the Windscale nuclear reactors were built on the coast of Cumberland (now part of Cumbria), Northwest England to produce plutonium and other nuclear materials for the UK nuclear weapons program between the years 1947 and 1951. The two reactor piles at Windscale used graphite as a neutron moderator which allows a combination of natural and (from late 1953) slightly enriched uranium metal to be used as fuel (Garland and Wakeford, 2007) and for Wigner energy accumulation and release (Arnold, 1957). On the 10th of October 1957, the release of Wigner energy at Windscale Pile Number 1 through a standard annealing operation was not properly controlled. This resulted in the overheating of the core and subsequent burning of fuel and graphite in the air coolant (Garland and Wakeford, 2007). As the fire took place, radioactive materials such as fission and activation products from a small percentage of the core were released into the atmosphere. This nuclear disaster is the largest recorded release of radioactive material in the history of the nuclear industry in the UK (Garland and Wakeford, 2007). Despite this, the British Government did not conduct any clean-up, even though the radioactive cloud travelled southeast across most of England and then further eastwards over northern and western Europe (Figure 4.3).

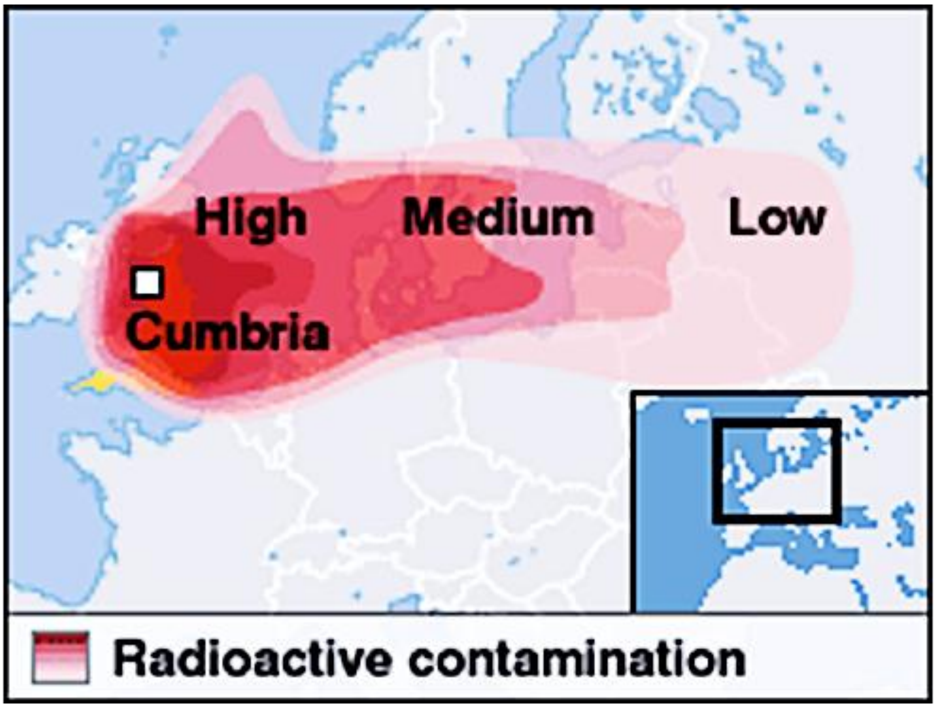


Figure 4.3. Map showing the spread of the radioactive cloud during the Windscale nuclear reactor fire, Cumbria, England on the 10^{th} of October 1957. Map reproduced from Morelle (2007).

Table 4.2. Inventory of radionuclides released during the Fukushima and Windscale nuclear accidents in 2011 and 1957, respectively.

Nuclear Accidents	Oceanic Release (Bq)				Atmospheric Release (Bq)			
	^{134}Cs	^{137}Cs	^{131}I	^{210}Po	^{134}Cs	^{137}Cs	^{131}I	^{210}Po
Fukushima (TEPCO, 2012)	3.5×10^{15}	3.6×10^{15}	1.1×10^{16}	-	1×10^{16}	1×10^{16}	5×10^{17}	-
Windscale (Garland and Wakeford, 2007)	-	1.8×10^{13}[a]	1.8×10^{14}[a]	4.2×10^{12}[a]	-	1.6×10^{14}[b]	1.6×10^{15}[b]	3.8×10^{13}[b]

[a]Taking into account that oceanic release from Windscale was limited by 10% of total radioactive material.
[b]Taking into account that atmospheric release from Windscale was limited by 90% of total radioactive material.

Nonetheless, Cumbria is now one of the most popular places for sightseeing in the UK. Fukushima used to be known as a beautiful place for sightseeing before the accident but has suffered reputational damage, in stark contrast to Cumbria. If political and administrative leaders and residents of Fukushima had learned lessons from the Cumbrian case, they could have devised a more effective and less damaging program for the reconstruction of Fukushima, without undertaking unnecessary clean-up that resulted in significant quantities of radioactive waste having to be managed.

4.4.3. Leadership to counter COVID-19

The world is now facing a pandemic, in the absence of any kind of guidelines on which to base national and international responses. To counter COVID-19, political leaders from different countries have been choosing different interactions or measures. At the beginning of 2020, the concerns of political leaders and people in most countries, except Sweden, were only how to minimize the number of confirmed cases and deaths, similar to the concerns of the Japanese political leaders and people after the 1F accident.

The Swedish government successfully implemented their controversial COVID-19 strategy without inciting strong public opposition. By looking closely at the situation in Sweden and comparing it to what happened during the 1F accident, the same strategy could be explored by the Japanese Government for future consideration. The strategy of the Swedish government in facing COVID-19 was more relaxed compared to other western countries. The government chose to adopt COVID-19 safety measures whilst also minimizing the impact on their domestic economy (Government Offices of Sweden, n.d.), thus making them the only European country which implemented a more sustainable strategy.

Although the number of deaths in Sweden is higher than the other countries in Fenno-Scandinavia (as of 29th of October 2020, Sweden: 5929, Denmark: 716, Finland: 354, Norway: 281) (Worldometer, 2020), more than 80% of Sweden's residents think their country's approach was the right one (Anderson, 2020). In Sweden, the Public Health Agency, an independent organization of experts, is responsible for public health issues. The government and the parliament of Sweden respect the autonomy of the Public Health Agency and their strategies in response to COVID-19, which were planned and recommended by the Public Health Agency, can be implemented smoothly. Sweden's residents trust their government and/or the Public Health Agency because of their transparency, resulting in high public acceptance of the COVID-19 strategies recommended by the Public Health Agency.

If, during the 1F accident, there had been such a reliable organization which consisted of Japanese experts, perhaps these experts could have recommended a much better clean-up strategy to the then Minister of the MOE, and, as a result, Japan would not have wasted so much time and money on inappropriate clean-up. Although the MOE was the responsible organization for the clean-up in Japan, they did not have any prior experience or knowledge in this area and relied on an expert (usually most experts are academics in Japan) committee for advice.

To complicate matters, Japan has a peculiar organizational culture in which political and/or administrative and/or academic leaders do not clarify who is responsible for each decision and most of the important decisions are made without open debate. Hence, after the 1F accident, the pros and cons of setting the dose target of no more than 1 mSv/year was not communicated clearly to the general public. With regard to the current global pandemic, the Japanese government did not disclose most of the minutes of the COVID-19 expert meeting (established on 14th February and abolished on 3rd July 2020) (NCDC, 2020) where the national response was discussed, and there is criticism here as well concerning the secretive nature (Shinya, 2020).

Leadership for reconstruction/rejuvenation of the affected areas of Fukushima Prefecture, including clean-up, cannot be practical or effective without sound scientific justification. Appropriate scientific input should have been provided by academic leaders to the responsible political and administrative leaders and such scientific justification should have been disclosed (in an easily understandable manner) to the general public, including the residents of Fukushima Prefecture, so that the general public could develop trust in their leaders and more readily understand and accept their decisions. Needless to say, ethical responsibilities should be borne by leaders in order to win public trust as discussed in Chapter 2 and 3. Leadership that prioritizes the well-being of the general public is required to implement public projects.

Finally, the leadership role of academics in Japan needs to be examined radically in the future. Furthermore, political, administrative and academic leaders are the main actors who can change the peculiar organizational culture in Japan. It is high time for such leaders to reconsider and change this situation in order to make better decisions and to create a better nation in the future.

4.5. Conclusions

Technically based assessments of dose targets, health effects and risk-based approaches of experts who had experience or the necessary knowledge were not communicated to the then Minister and officials of the MOE before the remediation strategy was decided upon. This is the main reason why the Minister of the MOE announced the long-term goal for residents of reducing the additional radiation dose to no more than 1 mSv/year.

The expectations from the Governor and the Mayors of the municipalities in Fukushima

Prefecture, and from many frightened people, in particular mothers with young children, were the major influence on the then Minister and officials of the MOE. When they set the long-term dose target, stress levels were very high and interfered with the use of intelligence (rationality) to solve problems and make decisions. They adapted their behavior to role requirements, constraints, and demands of the leadership situation, namely an exhaustive clean-up without due consideration of the resulting environmental impacts, costs and time required. Since the radiation problem was urgent and officials, politicians and the general public, including residents in Fukushima Prefecture, were under high stress just after the 1F accident, they were likely to accept the leadership of the Minister of the MOE.

Academic leaders could have examined the Windscale accident which can be considered to be much more analogous to the 1F accident than the accident that took place at Chernobyl. Environmental remediation could have been planned and implemented more effectively, while still maintaining the highest possible safety standards and balancing the economic burden, both of which impact the Japanese public. Appropriate scientific input should have been provided based on this type of experience and presented to the political and administrative leaders. In addition, such scientific justification should have been presented (in an easily understandable manner) to the general public, including the residents of Fukushima Prefecture, so that the general public could have developed more trust in their leaders and more readily accept their decisions.

Japan has a peculiar organizational culture in which political and/or administrative and/or academic leaders do not clarify who is responsible for each decision and most of the important decisions are made without open debate. How to change such a working culture should be an important research theme for the future. As we are currently facing a pandemic, now is a key opportunity to discuss leadership roles of academics and how to change the culture of Japan.

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Chapter 5

General Conclusions and Future Work

5.1. Summary of the thesis and general conclusions

This study first examined the history of HLW management in Japan, including Toyo Town's case, based on a literature review. This review was complemented by interviews with three key leaders of NUMO and ANRE and investigated problems encountered and the solutions adopted from a perspective that highlights what opportunities were missed in Chapter 2. Secondly, this study identified why the then mayor of Toyo Town failed and analyzed his behavior and leadership characteristics, including how he collaborated with NUMO and ANRE. In addition, suitable leadership for HLW management based on leadership theories was determined in Chapter 3. Finally, this study focused on the public project of the off-site environmental remediation in Fukushima, and the decision-making process for setting the dose target by the then Minister of the MOE was examined through a literature review and interviews with the Minister and other responsible officials of the MOE and Japanese and international scientific experts. How such a decision was made was defined based on leadership theories and findings from the situational approach. The Windscale (UK) accident, which was the closest analogue to the 1F accident, was introduced for scientific justification that should have been provided to the Minister of the MOE before the remediation strategy was decided on in Chapter 4.

Below are the general conclusions of this study.

- HLW management in Japan reached a deadlock due to lack of communication between leaders of key organizations, lack of sharing of scientific context between leaders of key organizations and justifications to assure stakeholders of the fundamental safety of disposal, and lack of alliance between key organizations.

- If projects require public acceptance, ethical responsibility toward the general public must be assumed by public leaders in order to win credibility. Hence, Machiavellian leadership is not suitable for HLW management.
- Servant leadership is suitable for HLW management because of its characteristics and focus on the followers, with the achievement of organizational objectives being a subordinate outcome.
- The leadership by the then Minister of the MOE succeeded in influencing people, but it resulted in a "faulty decision made too hastily" and "a defensive reaction" to set the target of 1 mSv/year, even if his leadership was likely to "contribute to escaping from panic situations".
- When groups are confronted with urgent problems, the group motivation to reach a solution as quickly as possible appears to be stronger than their motivation regarding the expectations concerning role differentiation. There is also a tendency for these groups to have greater interdependence among the members and "both governmental and industrial groups were more likely to accept leadership when the problem was urgent".
- Japan has a peculiar organizational culture in which political and/or administrative and/or academic leaders do not clarify who is responsible for each decision and most of the important decisions are made without open debate. Hence, after the 1F accident, the pros and cons of setting the dose target of no more than 1 mSv/year was not communicated clearly to the general public.
- Appropriate scientific input should be provided by academic leaders to political and administrative leaders for their decision-making and such scientific justification

should be disclosed to the general public so that they can develop trust in their leaders and more readily accept the decisions made.

Although the causes of the problems are not necessarily the same in all the cases, building consensus among various stakeholders is the common objective (step to achieve) of critical importance. I concluded from the results of this study that the most important leadership roles in energy and environmental projects involve finding solutions based on scientific justifications under the given constraints, assessing the gain by the public using a smoothing approach based on ethics, and encouraging all stakeholders to change existing values to achieve such solutions, thus serving the well-being of the public.

5.2. Recommendations for future work

Although this study presented primary leadership roles in their energy and environmental projects, more research could be done to further understand the roles of public and scientific leaders for similar projects.

5.2.1. Comparing leaders' behavior

For high-level radioactive waste management, it might be meaningful to compare leadership in Japan with that in Finland or Sweden. Furthermore, Suttu Town in Hokkaido, which is the northernmost island in Japan, applied for a literature survey, the first stage of the site investigation process for HLW disposal. NUMO received their application on October 9th 2020.

Kamoenai Village in Hokkaido also announced acceptance of the proposal by the Japanese government for a literature survey on the same day. It might be interesting if these two cases can be investigated and compared with Toyo Town's case from the viewpoint of leadership, in particular by observing the behavior of the leaders of these towns, NUMO and ANRE.

5.2.2. How to change the peculiar working culture of Japan

How to change the peculiar working culture of Japan, in which political and/or administrative and/or academic leaders do not clarify who is responsible for each decision and most of the important decisions are made without open debate, should be an important research theme for the future.

Appendix

"Leadership Engine" of Academics for Biomethane Energy Projects in Asia

Keywords: leadership engine; academics; biomethane energy projects; practical success

A.1. Introduction

The success of technology transfer and practical realization of commercial deployment abroad depends on human factors rather than technological development due to many obstacles such as language and culture barriers. The way to success is usually very long. Adam (1990) pointed out a delay of roughly 20 years between the appearance of research in the academic community and its effect on productivity in the form of knowledge absorbed by an industry. Once research in laboratories and surveys is completed, pilot projects for future implementation are often launched in developing countries by Japanese academics and industry to accelerate commercialization. The Japanese government sometimes supports such pilot projects. When a team for a pilot project consists of members from more than one organization, its implementation will be complex due to the differences in their perception of objectives and roles in the project. In addition, each organization has its own leader but more than one leader from different organizations have to work together on one project. Such leaders from different organizations are not authorized to work for their project as a sole leader even though one of them is chosen as a "project leader" in name only. When a key technology has been invented or developed by an academic, he/she is often chosen as a project leader of a pilot project for practical realization of commercial deployment (from basic research in his/her lab to pilot scale application and finally commercialization). However, such a chosen academic leader for a pilot project cannot act as a sole leader, unlike the president of a private company. Although an academic leader in Japan can choose researchers in his/her university and spend the allocated budget from the funding ministry or funding agency, he/she does not have real power of personnel assignment and budget allocation for his/her pilot project; and yet he/she has an obligation to lead his/her project to success with other organizations even if he/she does not have such power.

Various leadership theories have been discussed around the world. However, almost all of these theories are based on the assumption that a leader belongs to a specific organization such as a private company and is authorized to work for a specific operation or a project as a leader with his/her staff to contribute to his/her organization. When a project leader is not authorized to work for his/her project as a sole leader but is responsible for the project, its implementation becomes much harder and sound leadership is required to unite people from different organizations.

Turner (2005) said that the 1980s was a period of intense research into project success factors, with many authors producing lists of project success factors. Morris identified success and failure factors, with various factors being identified at successive stages of the project management life cycle (Turner 2005). He mentioned poor leadership as a failure factor during formation, build-up and close-out, but not during execution.

Tichy (1997), whose eyes and heart were opened to transformational leadership by Burn's book "Leadership (Burns, 1978)", pointed out that winning companies have developed into organizations with "Leadership Engines" (Tichy, 1997) in which leaders exist at all levels and actively develop the next generation of leaders. He believed that winners, whether they are organizations or individuals, consider leading and teaching as essential to success.

Thus, the key to success for private companies has been discussed extensively and teaching has been considered to be important as a leadership role of leaders in private companies or religious organizations worldwide.

However, the leadership role of academics in pilot projects with industry and government for commercialization has not been discussed, even if such technology has been invented or developed by academics.

Furthermore, both leadership and management are important for the success of any projects/business, but leaders are different from managers as Zaleznik (1992) said. People often focus on management, such as "planning" and "organizing people" (Kotter, 1999), and not on leadership, such as "setting a direction" and "aligning people" (Kotter, 1999), during the project period, but criticize the lack of leadership when they fail in the project. Needless to say, there are many management problems and one of them is that an academic leader does not have the power of personnel assignment and budget allocation for his/her pilot project. Even if there are management problems, a project leader has to implement his/her project and achieve his/her goal.

To identify leadership roles of academics in pilot projects, this paper focuses on biomethane energy projects carried out by Japanese, Indian and Thai officials, academics and commercial enterprises/private companies with the aim of transferring technology and realizing commercial deployment for the well-being of poor people in Asia. Kotter's model (1999) "Eight Steps to Transforming Your Organization" was previously applied to such projects (biomethane energy projects in Japan, Thailand and Bangladesh) and the data obtained was analyzed based on his model (Takeuchi, 2016). If each member from various organizations maintains his/her current system of the organization that he/she is working for, a newly formed organization for a project (or a project team) cannot be functional with various systems of various organizations. Furthermore, some of the project members may create a short-term win in the project and move forward to carry out another project. If they succeed in one project and move forward, they may work under the command of another newly formed organization (or another newly formed project team) again. A project leader needs to align stakeholders from various organizations with different cultures, viewpoints, etc. so that a newly formed organization for the project (or a project team) can be functional in terms of moving in the same direction.

To examine the implementation of the pilot projects from the viewpoint of leadership, the Eight Step Change Model (Kotter, 1999) is selected for this study. As the Eight Step Change Model is used to analyze the process when a leader wants to change his/her current system, organization and so on, progress towards commercialization can be analyzed using the same model.

The objective of this study is to identify the leadership role of academics in pilot projects carried out with industry and government for technology transfer and deployment of fruitful realization of invented or developed technologies or know-how by academics into practical success.

A.2. Methodology

Gordon and Yukl (2004) recommended that academic researchers include more alternative methodologies such as experiments and comparative case studies to benefit from the wealth of field data. In order to obtain such data, two cases which include pilot projects carried out by academics, commercial enterprises/private companies and government in India and Thailand were selected and compared in this paper. Every possible leader at every level participating in the following projects and others who followed the projects were monitored closely by taking part in these projects as a project manager. The data obtained during the projects were analyzed based on Kotter's model "Eight Steps to Transforming Your Organization (Kotter, 1999)". This model was originally created to transform a commercial enterprise/private company for achieving success in their project/business, but it can be applicable to a project team that consists of members from various organizations because such members have to work together for success under the command of a newly formed organization (or a project team) during the project period.

A.3. Results

The followings are the description of each case. There is more than one stage/project in each case.

A.3.1. Case 1: Projects in India

Some academics of a Japanese university (hereafter University N) hoped to conserve the environment and support the poorest villagers in India. Villagers cut down trees and burnt them in traditional cooking stoves. Since some women and children were suffering from asthma, biogas production from cow dung was welcomed. The Indian government funded people and several million small biogas plants were installed all over India (MNRE, 2011). However, most of the plants did not work. From time to time, such funds were embezzled. The biogas plants were poorly constructed with a low budget and biogas leaked from the defective plants. Some academics of an Indian university (hereafter University I) agreed with the concept of the Japanese academics. A local NGO in India also joined them and they were willing to educate villagers using Indian academics. The Japanese academics gathered money to manufacture small biogas plants (see Figure 1) in 2009 and the Indian academics installed them in one of the poorest villages in Madhya Pradesh in 2010.

Figure A.1. Small biogas plant in a village

Their project was welcomed by the leader of the village (the mayor) and many villagers. The Indian Minister for rural development also agreed to the Japanese concept and informed the ministry about the new renewable energy (hereafter Ministry N) to support their project. The Minister for rural development and the director of Ministry N had a meeting with the academics of University N and University I to develop their project on 18th October 2011. The objectives of the project were to introduce environmentally benign technologies to rural areas and to encourage villagers to increase their income through new business. The academics of University N and University I drew up a plan to establish a biomethane energy system (efficient biogas production, biogas collection while cleaning/upgrading on a truck and storing biomethane with adsorbent under 1 MPa, selling biomethane for automobiles and generating electricity at a biomethane station). Some Japanese private companies were ready to join the project and discussed the design of the biomethane energy system with University N. Ministry N changed its directors and University I started to work with a newly appointed director of Ministry N. Both universities applied for funds supported by two Japanese government agencies (hereafter Agency Js and Agency Ji) and their proposal was selected by Agency Js and Agency Ji in 2012.

However, there was a conflict between Agency Js and Agency Ji. Their points of view about practical realization of the technologies invented/developed by academics to contribute to society were completely different. Agency Js was willing to support the project since they hoped that University N would develop new technologies during the project period but Agency Ji attempted to cancel the project from the beginning, even just after the project was selected, because they were not interested in developing technologies or commercialization. Agency Ji told University N not to conduct most of the proposed research and activities.

As for the budget to carry out the project, Agency Js was to fund the Japanese side and Agency Ji was only to provide equipment to the Indian side. The budget was controlled by Agency Js and Agency Ji, and not by University N. University I needed to find additional funds to hire Indian researchers and engineers from Ministry N. Such conditions and rules for the project had been explained repeatedly to the leader of University I by the leader of University N before the project was selected in Japan, and the leader of University I had agreed to all the conditions and rules. However, when an important meeting with University N, Agency Js, Agency Ji and Ministry N was held at University I, a retired academic whom Japanese academics had never met before and some old academics of University I appeared suddenly and insisted emotionally that University I had a patent and should be funded directly by the Japanese agency to build the biogas plant according to the patent in India.

The negotiations broke down. The leader and the project manager of University N warned the leader of University I that their project would be canceled if University I could not agree to all the conditions and submit relevant documents to Agency Ji in time. To make matters worse, the new director of Ministry N in India did not support the project. He seldom attended the meetings with the academics of University N and University I and the academics could not discuss any details with him. He did not prepare any important letters and documents to be submitted to Agency Js and Agency Ji. Finally, the project manager of University N met his boss, the Joint Secretary of his ministry, to explain the critical situation and ask for his support. The Joint Secretary visited University N with the director three months later to declare financial support and signed the formal letter at University N. This letter was submitted to Agency Js and Agency Ji by University N but it was ignored by Agency Ji. All the academics, both in Japan and India, believed that the implementation of their project would be too difficult due to the weak coalition. Their project was canceled in September 2013. The Japanese academics realized that leadership at every level in each organization was crucial for the project.

These are the analyses of the progress after the proposal for the pilot project was selected by Agency Js and Agency Ji in 2012 based on Kotter's model.

Step 1: Establishing a Sense of Urgency

The leader and the manager of University N identified the obstacles and discussed the crisis in their *project with Agency Js that was willing to support the project. However, the Japanese academics could not discuss the crisis with Agency Ji due to lack of mutual trust.*

Step 2: Forming a Powerful Guiding Coalition

Although the leader of University N was the leader of the project as written in the proposal, he was not authorized to act as a sole leader for the project. Therefore, he could not choose members from different organizations such as Agency Ji or University I or Ministry N, nor could he change members to make the guiding coalition more powerful in a critical situation.

The leader of University N could not encourage all the members from different organizations to *work together on the same vision as one team because there was a conflict between Agency Js and Agency Ji and some academics of University I did not understand the rules for funding the project. The leader of University I could not persuade those academics in his university to understand and follow the rules.*

Step 3: Creating a Vision

The leader of University N created a vision and tried to share this with all the members from different organizations to introduce environmentally benign technologies such as biomethane energy systems to rural areas and to encourage villagers to increase their income through new business.

Step 4: Communicating the Vision

The leader of University N could not communicate the new vision and strategies due to the weak coalition both in India and Japan. Any opportunities and vehicles to communicate the created vision and strategies were ruined by some members who acted based on their own desires or interests.

Step 5: Empowering Others to Act on the Vision

The leader of University N could not remove the obstacles to change. As he was not authorized to act as a sole leader for the project, he could not choose members from different organizations nor change members even when the project was disturbed and ruined on purpose by some members from different organizations. To remove obstacles and to empower members to act on the vision created for success, a leader needs to have the power of personnel assignment.

Step 6: Planning for and Creating Short-Term Wins

The leader of University N could not plan for visible performance improvements and create these improvements. The project was disturbed in the early stages.

Step 7: Consolidating Improvements and Producing Still More Change
The leader of University N could not reinvigorate the process with a new project and theme due to the weak coalition.

Step 8: Institutionalizing New Approaches
The leader of University N could not articulate the connections between the new behavior and project success due to the weak coalition.

The result of the above analyses shows that it was very hard for an academic leader to form a powerful guiding coalition when an international project team consisted of members from various organizations. In particular, when a counterpart university lacked leadership and a ministry and/or a government agency became an obstacle, the academic leader could not communicate his created vision and strategies with the members from various organizations and thus could no longer move forward.

A.3.2. Case 2: Projects in Thailand

The former governor of NakhonNayok Province (hereafter the Province) of Thailand hoped to create a smart country that could serve the happiness of its citizens. (He later became the Permanent Secretary of the Ministry of Information and Communication Technology to establish smart system.) The Province is located 110 km northeast of Bangkok with a population of 250,000 and hosts Khao Yai National Park. The governor decided to introduce environmentally benign technologies to the Province to conserve its great natural assets. The Province was chosen as the first smart city in Thailand by the Thai government and hoped to obtain technological support from Japan and introduce advanced Japanese technologies in the Province. A smart energy system to conserve the environment (the same biomethane energy system that had been introduced in India above) was suggested by Japanese academics of the same University N as in the project in India in 2012 and it was accepted in 2013 as the project "Biomethane Energy System to realize the Smart City Concept in NakhonNayok Province, Thailand (METI, 2013)[)]".

An important meeting was held in the Province on 10th July 2013. The Prime Minister and some ministers of Thailand visited the Province to recognize the smart city. At the meeting, the Prime Minister expressed that smart technologies for waste disposal and wastewater treatment would be necessary for the smart city. The Province was interested in producing biogas using food waste and utilizing cleaned biogas (biomethane) for poor villagers. The Province intended to educate their citizens to separate garbage and leave the work of selling biomethane to a village cooperative association. One dumping site was chosen as the place for installation of the biogas plant and they hoped to construct a recycling center and an incinerator next to the biogas plant. They drew up the blueprint and decided to spend four million baht to provide a prefabricated building to house the biogas plant (see Figure 2) and a 2 t commercial car that would be converted as an Adsorbed Natural Gas (ANG) car to collect food waste. They had a plan to utilize liquid fertilizer produced from the biogas plant in an organic garden (see Figure 3). They were willing to promote the biomethane system with the Japanese government not only in Thailand but also in the ASEAN area. Thailand was ready to become a leader of the ASEAN Economic Community (hereafter AEC) and the project team was invited with the governor of the Province to an event of AEC organized by Channel 3 in Bangkok. Discussions with the advisor to the former Prime Minister (the advisor used to be the Minister of Energy and the Vice Prime Minister.) were held by the project manager of University N to promote the biomethane energy system. The Ministry of Energy, Thailand, and a Thai university (hereafter University S) also joined the project. The whole plan for the project including the promotion of the biomethane system was drawn up by the project manager of University N and the proposal of a "Biomethane Energy System to realize the Smart City Concept in NakhonNayok Province, Thailand" was submitted to the Ministry of Economy, Trade and Industry of Japan (METI). It was selected to be supported by METI at the end of July 2013. The Director General, director, deputy director and young officials of METI greatly encouraged both Japanese and Thai members regarding this project to promote invented or developed technologies by Japanese academics of University N for commercialization.

A small Japanese private company (hereafter Company S) concluded a contract with METI and Company S manufactured the biogas plant (see Figure 2) and installed it in the Province according to the instruction of University N. It was a promising but risky project, as Company S had to borrow money for the project. METI could not reimburse the money to Company S until all the work specified in the contract was completed on time. Three months later, a large demonstration against Thaksin Shinawatra and the Thai government started (CNN, 2013). Company S was on the verge of non-fulfillment of the contract and bankruptcy during the project period between September 2013 and March 2014.

The demonstration started just before the project team shipped their biogas plant from Japan. A lot of bombs were set off in congested areas of Bangkok and many people were killed by the explosions. The budget implementation by the Province was canceled but the technical leader of University S persuaded the administrative leader of his university to support the project. As a consequence, University S offered to finance the project and the location for installation was changed from the public dumping site to University S.

Despite the demonstration against Thaksin Shinawatra and the Thai government, the Japanese academics were able to ship, install and start operation of the biogas plant in time.

However, during the operation period a Japanese researcher of University N who was working at the installed plant reported to the leader and the manager of University N that Thai researchers had embezzled the Japanese budget. After the investigation, his report was proved to be a lie. When he was asked why he had told such a lie, he protested vehemently and insisted that he had not reported anything to the leader and the manager of University N.

There was a further problem just after all the experiments were completed at the beginning of March, 2014. Company S selected and installed a transformer with a capacity that was too small. The wires burned and the biogas plant was shut down suddenly, but the president of Company S blamed Thai engineers for the fire. Even after the investigation of the accident, the president of Company S did not apologize to the technical leader of University S nor did he change the transformer. The project manager of University N apologized to the technical leader of University S and offered to buy a large replacement transformer, but the technical leader of University S bought a new transformer on his own budget and did not blame any Japanese members.

The leaders of University N and University S not only developed technologies but also other young leaders. They were encouraged to lead their staff and to complete all the experiments and obtain the necessary data in time.

University S continued to operate the biogas plant for three years so that both universities could share the outcome and educate young researchers and engineers. In addition, University S installed other systems near the biogas plant and conducted more research in various fields together with another university in Thailand to establish an environmental training center.

The Japanese academics introduced their know-how and technologies to some commercial enterprises/private companies and installed pilot or working biogas plants in India, China and Bangladesh.

Figure A.2. Biogas plant installed in NakhonNayok Province.

Figure A.3. Spraying liquid fertilizer from the biogas plant in the organic garden.

The following are the analyses of the progress after the project was selected by METI in 2013 based on Kotter's model.

Step 1: Establishing a Sense of Urgency

The leader and the project manager of University N identified and discussed the crisis of the financial situation of Company S and the political situation in Thailand with all the organizations involved.

On the other hand, ASEAN represented a large market and many good opportunities for promoting the established energy system were expected.

Step 2: Forming a Powerful Guiding Coalition

The leader of University N could form a powerful guiding coalition with METI and all the organizations in Thailand to work together as one team with the same vision but could not form a powerful guiding coalition with Company S and one researcher of University N. There was no leadership in Company S and it made the guiding coalition weaker at *the site. When a coalition is not powerful enough, leadership at every level in each organization is all the more necessary. Leaders of University N and University S tried to develop other leaders at every level of each organization by teaching and trusting them.*

Step 3: Creating a Vision

The leader and the project manager of University N and the leader of the Province (the Governor) created a vision to establish an ideal smart energy system and to educate engineers for the first smart city in Thailand.

Step 4: Communicating the Vision

The leader and the project manager of University N and the leader of the Province (the Governor) used every opportunity and vehicle possible to communicate the new vision and strategies in Thailand. Despite language and culture barriers, the leader and the project manager of University N were able to communicate the created vision and strategies with all the members in Thailand. The Director General and the Deputy Director of METI also shared the vision with the members from different organizations of both countries.

Step 5: Empowering Others to Act on the Vision

The leader of University N empowered the project manager of University N and removed obstacles to change and encouraged risk taking and non-traditional ideas, activities and actions together thanks to the leadership at every level in Thailand. Despite the demonstration against Thaksin Shinawatra and the Thai government, the Japanese academics could ship, install and start to operate the biogas plant in time.

Step 6: Planning for and Creating Short-Term Wins

METI explained how to manage their funds to the Japanese members but never controlled the members or the project. The leaders of METI, at all levels, encouraged the members to complete all the proposed demonstrations. In collaboration with METI and all the Thai members, University N was able to plan for visible performance improvements and implement these improvements. The leaders of University N and University S developed not only technologies but also other leaders. Success was achieved by young educated leaders and researchers during the project.

Step 7: Consolidating Improvements and Producing Still More Change

After the project supported by METI was completed, the leader of University N fired or changed some Japanese members for future projects and was able to reinvigorate the process with new projects in collaboration with other private companies for practical success.

Step 8: Institutionalizing New Approaches

The leaders of University N and University S developed the means to ensure leadership development and succession. The Japanese academics introduced their know-how and technologies to commercial enterprises/private companies and installed pilot or working biogas plants in India, China (See Figure 4) and Bangladesh.

The result of the above analyses shows that when a coalition is not powerful enough but academic leaders can develop other leaders at every level of each organization (e.g. the administrative leader of a university, technological leader of a university, younger leader responsible for the plant demonstration in the university), they can remove obstacles, complete all the work and create a short-term win during the project period. The strong support from a ministry was also a crucial factor for a successful pilot project.

Figure A.4. Working biogas plant in China

A.4. Discussions

Leadership is considered to be important for all projects. According to Tichy, one reason leadership takes precedence is that leaders are the persons who decide what needs to be done and the ones who make things happen (Tichy, 1997). In both Case 1 and Case 2, academic leaders were the persons who fully understood the adopted technologies for their projects, decided what needed to be done and who made things happen. Hence leadership by academic leaders should take precedence for their projects.

From the analyses of two cases above, “Forming a Powerful Guiding Coalition (Step 2)” is the hardest among the eight steps for an international team that consists of members from industry, university and government. For domestic cases in Japan analyzed in previous work (Takeuchi, 2016), to form a powerful guiding coalition is also found to be the most difficult step to achieve.

In fact, to unite people from various organizations and make a powerful guiding coalition is very difficult for any leaders. What happened to the European Union (e.g. UK)? How will political leaders from many countries overcome various obstacles without a powerful guiding coalition? To unite people from various organizations and form a powerful guiding coalition is the hardest subject that is tackled in many countries.

A weak coalition ruins a mission/ project and the team cannot move forward smoothly from one step to another, as Kotter points out (Kotter, 1999). A weak coalition also disturbs any actions or changes for success.

In Case 2, the academic leaders tried to develop other leaders at every level of each organization so that they could remove obstacles to change. In addition, leadership at all levels existed within the ministry (METI) which supported the project and the academic leaders could work together as one team on the same vision in Case 2, while leadership was lacking or existed only at the top level in each organization in Case 1.

Even when a formed coalition is not powerful enough, leadership at every level in the different organizations can result in project members acting according to the same vision. It is desirable that an academic who is a project leader should encourage the other leaders from various organizations to create leaders at every level.

University S continued to operate the biogas plant for three years and educated young leaders, researchers and engineers. In addition, University S installed other systems near the biogas plant and conducted more research in various fields with another university in Thailand to establish an environmental training center.

University N introduced their know-how and technologies to some commercial private companies and installed pilot or actual biogas plants in India, China and Bangladesh.

Leadership at every level in each organization for just one project created a "Leadership Engine" of academics for future projects. The project team in Case 2 developed into an organization with a "Leadership Engine" of academics, where leaders existed at all levels. The academic leaders developed the next generation of leaders for sustained success as educators of technologies and leadership.

In this paper, I examined only two cases and compared them. It is necessary to examine more cases in order to clarify the leadership role of academics in similar projects for commercialization.

A.5. Conclusions

In this paper, two selected cases of biomethane energy pilot projects carried out in two countries were analyzed using Kotter's Eight Step Change Model. The following is highlighted.

"Forming a Powerful Guiding Coalition (Step 2)" is the hardest step among the eight steps of Kotter's model for an international team that consists of members from industry, university and government. A weak coalition ruins a pilot project and its team cannot move forward smoothly from one step to another. Leadership role by an academic who is a project leader is to develop other leaders at every level of each organization.

Leadership at every level in each organization for just one project can create a "Leadership Engine" of academics for future projects. Not only winning companies but also winning projects carried out by academics in collaboration with other organizations may have a "Leadership Engine" to achieve their goals.

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