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

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Abstract: 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 the initial literature survey, but then withdrew the application due to strong opposition in 2007. To identify why the then mayor of Toyo Town failed, we analyzed his behavior and leadership characteristics, including how he collaborated with NUMO and the Agency for Natural Resources and Energy (ANRE). We 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, we identified suitable leadership for high-level radioactive waste (HLW) management based on leadership theories. We 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.

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

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 [1]. 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 [2]. 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 [3].

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 the Nuclear Waste Management Organization of Japan (NUMO) in 2000 as the organization responsible for the deep geological disposal of the most radioactive wastes (termed “specified” wastes). NUMO has been tasked with implementing geological disposal of HLW since 2000 and low-level radioactive waste containing long-lived nuclides [transuranic (TRU) waste] since 2008 [4]. Although both waste types result from reprocessing of spent fuel, HLW is of greatest public concern. Hence, we focus on HLW management in this paper.

Geological disposal is a recognized solution for the management of more radiotoxic solid wastes, as recommended by the IAEA [5]. 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 [6,7] are minimal and contamination of the surrounding biosphere is precluded [6,8]. 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 [9].

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 [10]. 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 [11] and Sweden [12] and towards siting in France, Switzerland, and Canada [13].

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. [14] 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. [15] 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 Agency for Natural Resources and Energy (ANRE) who drafted the “Specified Radioactive Waste Final Disposal Act”] and assessed problems encountered from the viewpoint of leadership. Takeuchi et al. [15] found five major problems with two key organizations, NUMO, the organization

responsible for deep geological disposal and ANRE, one of the sections of the Ministry of Economy, Trade and Industry (METI) responsible for the energy and natural resources policies of Japan, and a candidate municipality, 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. [15] could be summarized as centering around three points. They were all related to failures of leadership, namely: (1) the lack of communication between leaders of key organizations; (2) the lack of alliance with key organizations; and (3) not getting people to believe in the ethical responsibilities of a society. 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 [16,17]. Therefore, this study 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 [15], but cause 3, “not getting people to believe the ethical responsibilities taken by society”, is taken up for further discussion in this study 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 [18,19]. Regardless of role, ethical responsibilities are required of leaders of NUMO, ANRE, and any candidate municipalities.

Although public engagement has been tackled [20] and the need for leadership of NUMO was recognized [21,22], 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, we will analyze the behavior and leadership characteristics of the then mayor of Toyo Town, who applied for a literature survey, 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, we will define the ideal behavior of a leader for HLW management by using the leadership characteristics we have found through a systematic literature review of leadership theories. Finally, we 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. [15].

2. Leadership Theories

In order to analyze the behavior and leadership characteristics of past leaders and determine suitable leadership for HLW management for the future based on leadership theories, we first review the history of leadership theories, then Machiavellian leadership theory, because we observe the pattern of leadership by past leaders as Machiavellian, and finally, servant leadership because it emphasizes ethical responsibility and the overriding focus of a servant leader is to serve his/her followers [23].

2.1. Changes in Leadership Theories

A range of leadership theories have been produced 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 [24]. 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 [25]. However, a leader's behavior is not the only factor that influences effectiveness. Although traits of leaders influence their behavior, the behavioral approach seldom took up the traits of the leaders [25].

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.

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 [25], 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" [26] 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 [25]. According to Burns [27] 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" [26]. Transformational leadership theory became well-known in the world. It 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.

Although primarily mainstream theories were introduced, we have focused on the Machiavellian leadership theory because of the behavior and characteristics of the leaders involved in HLW management in Japan as identified in Section 3, and on the servant leadership theory among a huge number of theories in the literature because of the characteristics which Machiavellian leaders lacked in the past but which are required by the general public.

2.2. *The Characteristics of 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 [28]. Bass [26] explained that highly Machiavellian presidents, as measured on the Mach Scale developed by Christie and Geis [29], 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 a lot of heated debates about Machiavellian leadership (e.g., President Trump [30,31]).

Sendjaya and Cooper [32] surveyed two for-profit and two not-for-profit organizations in Australia to examine the dimensionality and construct the validity of the Servant Leadership Behavior Scale (SLBS). They measured "Machiavellian leadership orientation" and "Servant leadership behavior" using the Machiavellianism scale (Mach IV) [33] and SLBS, respectively (They also measured other factors such as social desirability, but we excluded the measurements because they are irrelevant to our 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 5-point

scale, ranging from 1 (“strongly disagree”) to 5 (“strongly agree”) [32]. 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 [32].

2.3. Brief Review of Servant Leadership Theory and Related Research

According to Wart [34], the major characteristic of the servant leadership theory is the emphasis on the ethical responsibilities to followers, stakeholders, and society. Bass [26] described servant leaders as those who are especially concerned about their constituencies with less power or at a disadvantage. Robert K. Greenleaf, who is the founder of 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 dispute in the late 1960s and early 1970s. According to Greenleaf [35], “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 being 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. Covey in the foreword to Greenleaf’s book *Servant Leadership*. This means that a servant leader believes that the ends and means cannot be separable from all 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 [35]. Although Greenleaf first coined his philosophy of servant leadership in the 1970s, its academic progress is still at its earliest stage [23]. Parris and Peachey [36] 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 to model it or development of measurement tools to empirically test it [36].

In order to determine how current and future leaders should accept their ethical responsibility for HLW management, we have examined the details of the characteristics and the definitions of servant leadership through a literature review.

2.4. The Characteristics of Servant Leadership

In this study, we introduce “Ten Characteristics of a Servant Leader” identified by Spears [37] and “Primary Characteristics” identified by Focht and Ponton [38] through a Delphi study (Table 1). Parris and Peachey [36] 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 [38] conducted a Delphi study [39,40] 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 [32]. These 12 primary characteristics of servant leadership were identified as the most essential characteristics that should be exhibited by a servant leader.

Table 1. The ten characteristics of a servant leader as identified by Spears [37] and twelve primary characteristics of servant leadership as identified by Focht and Ponton [38].

Characteristics of a Servant Leader	
Identified by Spears [37]	Identified by Focht and Ponton [38]
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

Although Coetzer et al. [41] 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 if we consider the history of HLW management and the leadership in Japan as discussed in the previous study [15]. We introduce a similar leadership theory to servant leadership next and summarize the results of the previous study and describe the past leadership in Section 3.

2.5. Similar Leadership to Servant Leadership

According to Wart [34], 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* [27], a book by James MacGregor Burns came into the limelight [34]. Although both authors emphasized the ethical dimension, Burns' theory became well-known as "Transformational Leadership" and became extremely popular because of its ideal leadership for change. Bass [26] explained that the transformational leaders defined by Burns [27] "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" [26]. Transformational theory has been well researched and further developed by many researchers since then [42–47]. Servant leadership is considered similar to transformational leadership and Stone et al. [23] 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 while their behavior is motivated to achieve the organizational goals. In comparison, the servant leaders direct their focus on the followers, with the accomplishment of organizational objectives just a consequential result.

3. The Major Problems of HLW Management in Japan

In this section, we review the results of the study of Takeuchi et al. [15] 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 [15]. According to Takeuchi et al. [15], (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. [15]: (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. Causes 1 and 2 were previously discussed in detail [15], but cause 3 is taken up for further discussion in this study as the trust of the general public in the implementing leaders can be influenced by how the leaders put social responsibilities into practice.

In order to clarify leaders’ behavior and leadership characteristics for successful HLW management, we 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 [16,48,49]. 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 [50].

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 [16]. 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 [16] and two studies which were based on the same mayor’s book and the newspaper articles [48,49]. By examining the behavior of the mayor based on the leadership theories we reviewed in the previous section, we found that his leadership was Machiavellian. Therefore, we further analyzed which behavior of the mayor of Toyo Town closely follows a typical Machiavellian leader [28].

3.1. 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. 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 [17,51].

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 [16]. 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 [52], while Tokyo Electric Power Company Holdings (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 [52]. When the then president of TEPCO covered up the fact of meltdown at 1F, the general public criticized their secretive nature [51].

When we compared the characteristics of the past leadership of the mayor of Toyo Town and the leaders of TEPCO, NISA, and NSC, we 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.

4. 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. We tried to find leadership theories which prioritize ethical responsibility towards society and well-being of the general public by literature review. As introduced in Section 2.3, the major characteristic of the servant leadership theory is the emphasis on the ethical responsibilities to followers, stakeholders, and society [34]. Servant leadership is considered remarkably similar to transformational leadership. While transformational leadership also places emphasis on ethics and valuing people as described in Section 2.5, the transformational leaders direct their focus towards the organization, and their behavior builds follower commitment towards organizational objectives [23]. 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 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 [32] pointed out that Machiavellian behavior squarely contradicts the behavior of servant leader as described in Section 2.2.

Moreover, the report of the Nuclear Energy Agency (NEA) [20] 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" [20]. 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. [15], 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" [13] 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 [53] was published by the Japanese government in July 2017. Their comments are [54]: "(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 [20,55–57], 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, we conceptually define the ideal behavior of a leader for HLW management by using the characteristics of a servant leader identified by Spears [37] and Focht and Ponton [38] as well as the interpretation of servant leadership theory by Stone et al. [23] as shown in Table 2. We focus on behavior which Machiavellian leaders lacked in the past, but which is required by the general public. We believe servant leadership can be functional through the practice of the ideal behavior we have defined in Table 2. In Section 5, we 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 2.

Table 2. The ideal behavior of a leader for high-level radioactive waste (HLW) management based on the characteristics of a servant leader identified by Spears [37] and Focht and Ponton [38] and the interpretation of servant leadership theory by Stone et al. [23].

Characteristics of a Servant Leader		Ideal Behavior of a Leader for HLW Management
Identified by Spears [37]	Identified by Focht and Ponton [38]	-
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.

5. The Functions of Servant Leaders for HLW Management in Japan

According to Greenleaf [35], 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 [35]. 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. [41] 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. [41] 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, we take account of the results of the study of Takeuchi et al. [15] and modify their results to define the functions of servant leaders that will be suitable for HLW management in Japan as indicated below.

5.1. Strategic Servant Leadership

5.1.1. 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 [58].

5.1.2. 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 states [35].

5.2. Operational Servant Leadership

5.2.1. 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 [32], 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.

5.2.2. 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 we 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. We have met a number of potential servant leaders who were involved in HLW management in Japan before.

Greenleaf [35] 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” [35] (p. 58). 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 we 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, we 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. As Greenleaf [35] 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.

6. 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 style 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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Abbreviations

ANRE	Agency for Natural Resources and Energy
METI	Ministry of Economy, Trade and Industry
NEA	Nuclear Energy Agency
NISA	Nuclear and Industrial Safety Agency
NSC	Nuclear Safety Commission
NUMO	Nuclear Waste Management Organization of Japan
TEPCO	Tokyo Electric Power Company Holdings

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