Commentary

The Disaster by the Fukushima Nuclear Power Plants and the Risk Science

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The author is a researcher in social psychology, having a long association with the world of nuclear power; however, his knowledge does not go beyond hearsay, and he has little expertise in the field. Thus, many of the following opinions may sound irrelevant to the nuclear energy experts. Bearing the above in mind, the author will discuss the problems of this accident from the perspectives of social psychology and risk studies.

I. Nuclear Power Plant Accident that the World is Watching

The Fukushima Nuclear Power Plant Accident caused by the Great East Japan Earthquake had a tremendous impact on the world. Because Japanese nuclear power plants were highly trusted so far, the public's reactions were also strong. At the citizen level, this shock mainly manifested itself in the form of panic toward radiation, reputational damage, the advancement of anti-nuclear organizations, and the general skepticism toward science and technology.

However, more serious issues are the national-level impacts such as the effect on the nuclear industry of the world, the resulting pressure on the energy demand and supply, and its impact on the world economy. If wrong responses are delivered regarding these issues, there is a possibility that the world will fall into confusion around energy security; moreover, the decline in Japan's power could trigger a major loss of balance in the world order.

Furthermore, major countries of the world are seriously observing this accident not only from such resource-based/economic perspectives but also from the perspective of government's comprehensive risk management abilities, field simulation of response to nuclear war, response to nuclear terrorism, review of emergency deployment capability of military forces and specialized equipment, and the reaction to emergency among their citizens. The world is observing because the state and potential of a nation becomes apparent in a big emergency.

While such cold logic of statecraft exists behind the warm support offered by other countries of the world, who in Japan is responsible for national security, which comprises advanced risk management that is beyond the problems of the earthquake and the nuclear power plants? To begin with, is the Japanese government capable of such risk management?

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II. The Impact of the Nuclear Power Plant Accident on Japan

Public opinion will undoubtedly be stricter against nuclear energy. Not only will the construction of new nuclear power plants be more difficult, there may also be demands for decommissioning existing nuclear reactors. Until now, the majority of the public opinion agreed that "although nuclear power plants are dangerous, their operation should continue as nuclear energy is useful" [1]; however, this risk/benefit trade-off relationship may be affected by this accident. Based on a recent opinion poll, the percentage of "people who promote nuclear power plants and people who support the status quo" was 56% [2]. Although this is 10% lower than the 2007 poll, its decrease was not as large as expected. If the accident resolves without any more deterioration, public opinion may not conclude that "nuclear power stations are dangerous and unnecessary, and therefore should be discontinued." However, public opinion may change quickly, depending on further developments of the situation.

In any case, the issue of energy security as the national policy is highly likely of triggering a major debate that will polarize the public opinion in future. There will be opinions to review the current basic energy plan, and the prospect of the so-called Nuclear Renaissance will be more distant for the near future. Most immediately, a reexamination of the safety of the FBR sodium-cooling system (which is considered a potential successor to the light water reactor) when it is damaged will be demanded.

The author believes it is imperative to remember that the energy security problem including the nuclear energy policy must be discussed from the global perspective of international strategy instead of the local Japanese perspective. What must be avoided is a debate that is driven by temporary emotional excitement and political speculation.

Finally, the most important concerns are the large number of nuclear energy researchers and engineers who are despondent and have lost confidence. Even though it might be a reversal of their previous overconfidence, this despondence is problematic for the Japanese people. Soul-searching is necessary after this accident, but the knowledge of these people is still indispensable for the maintenance of existing nuclear power plants and future development of safe nuclear power plants.

III. Hardware Problems from the Risk Studies Perspective

The accident has not yet been resolved (this paper was written in late April 2011), and the official work of elucidating the cause has not yet been conducted. Thus, it appears premature to discuss the cause of the accident. For this reason, it is possible that the following opinions are incorrect as they are based on predictions. Even if the opinions are correct, they may be criticized to be mere "afterthoughts." Nevertheless, the author will highlight some of the risk studies problems that have already become obvious without waiting for the official report.

1. Station Blackout

The loss of emergency power sources due to the tsunami is often deemed the cause of this accident. However, the author is more concerned about why the external main power source collapsed so easily, and why its recovery took so long. It is understandable to automatically shut down the circuit when a major earthquake hits to protect related equipment such as the generator. However, this external power supply's loss was beyond that level, including the collapse of transmission towers coupled with the absence of the supplementary circuit.

Meanwhile, from the perspective of the risk theory, it appears that the emergency power supply's preparation was insufficient despite being "for emergencies." As it will be discussed later, the reason for this is that the "defense in depth" arrangement that was required for emergency preparation was not implemented for some reason. Moreover, it is common in risk studies to always prepare machine or manual operation systems that do not require electricity for emergencies. Then, in the case of nuclear power plants, is it difficult to implement such an idea? [3]. For instance, the emergency condenser or the isolation cooling (IC) system is present to realize such systems. So why did they not function during this accident? In any case, from the perspective of non-experts, it is too embarrassing for an electricity company to have suffered a total power loss. The author would like to know the type of unexpected events that led to such a situation.

2. How Much Preparation Was Made in Advance Against the Shortcomings of the Reactor

If the author is not mistaken, all reactors that caused this accident were BWR/Mark 1 type designed by General Electric (GE) (though the installer was different for each reactor and some had mediating consultants). The weakness of this reactor includes the possibility of the primary containment vessel (PCV) being overloaded more than the assumed pressure when the cooling function is lost, resulting in rupture. In addition, the PCV is too small and can easily cause problems during an accident; furthermore, the spent-fuel pool is positioned too high and thus cannot be appropriately managed. According to the report from the public hearing at the U.S. Congress, these shortcomings were found during the designing of Mark 2 and 3.

These are all important problems that were also revealed during this accident, and in fact, the issues thus highlighted were resolved in the reactors constructed after Mark 2. Although GE informed all the owners of Mark 1 at that time and requested them to take measures against these weaknesses, judging from the result of this accident, it appears that Japanese electric companies did not take enough measures. For an outsider, it is not possible to know the reason behind this lapse.

3. Disasters Attack the Weakest Point of a System

From the perspective of risk theory, it is quite common that a system is fragile as a whole even if the individual machines that constitute the system are robust. This is because the weakness is often hidden in the interface connecting these machines, and the strength of the overall system is often determined by the strength of the weakest factor instead of the average strength of all factors constituting the system or the strength of the strongest part.

Importantly, disasters are known to precisely target the weakest point of a system. In other words, a disaster "bullies the weak". Therefore, risk management of a system requires deep knowledge of this characteristic of disasters [3].

This issue was in fact already highlighted at the time of the Great Hanshin Earthquake. For instance, the emergency information system normally comprises primary equipment such as a radio transceiver and a generator. However, many components of this system did not function. The reason was not the damage on the main equipment such as the transceiver or generator. Instead, it was the damage on the function of the peripheral equipment such as the damage to the water tank used for cooling the generator or the cutting of the pipe that connects them. Also in this case, the earthquake attacked the weakest point of the system.

To give an example from daily life, the same can be said about the members of a hiking trip. If one plans to go hiking in a group, one must plan his schedule while considering the member with the least physical strength. If the plan is made based on the average of the strengths of all participants, someone may drop out of the plan.

The malfunctioning of a transceiver or a hiking group is far less significant compared to the nuclear power plant disaster. However, when studied from the perspective of functionality, there are many similarities between them: a nuclear power plant is also a typical system, and while the main body of the reactor is extremely robust, other minor equipment and the interface connecting them (e.g., piping, connecting or welded parts of the equipment) are relatively weak[4)]. It is common for a slight damage to these parts to stop the entire system. There are major concerns of non-experts regarding how many measures were taken against this risk in nuclear power plants, which are for such complex piping that they are called “piping monsters”.

4. Was the Defense in Depth Truly Multilayered?

Thus far, technical explanations claimed that protection against radiation of a nuclear reactor is tightly conducted with a 5-layered “wall”, and the probability of its safety is extremely high. However, this belief was easily broken by this disaster. The reason for this was the fact that each of the 5-layered walls was not independent. Moreover, the walls of the emergency power source or the spent-fuel pool were not multilayered to begin with.

Needless to say, to improve the probability of safety with defense in depth, the necessary precondition is that the individual protection system must be entirely independent[3)]. Regardless of the number of multiplexed walls, unless each wall is independent, the safety of the whole system cannot be obtained as the product of probability. This is why the brake system of an automobile is designed with entirely independent systems, namely, the hydraulic system and the wire system. This “entirely independent system” is literally independent from the beginning to the end. A famous example of failure is the 1985 Japan Airline accident.

As many people already know, there were several control systems in the tail of the crashed Japan Airline aircraft, and each of them was independent. However, these circuits were at the end gathered in one spot at the bulkhead of the tail. And when this bulkhead was damaged, the circuits for several systems fractured at once. Hence, the multiple systems in the circuit appeared independent, but in fact they comprised a single system at one point in the aircraft’s tail. This nuclear power plant accident appears to be similar to this lesson from the Japan Airline aircraft’s accident.

As can be observed, the 5-layered protection against radiation walls appear to be designed as independent, similar to the tail control circuit of the Japan Airline aircraft. However, similar to the way the circuit of the airline was gathered at one spot in the partition of the tail and lost independence, the walls of the nuclear plant also lost their independence when the assumption that the cooling function of the fuel rods is continuing collapsed.

Another point of concern regarding the independence is the location of the emergency generator. Here, emergency must include not only tsunamis such as this, but also many other cases such as fire or explosion. And when primary equipment is damaged during such emergencies, it implies a high possibility of the emergency generator installed nearby being damaged as well. Thus, to avoid such a risk, it is necessary to install at least one emergency generator at a safe location that is separated from the main equipment. For the same reason, a bank stores its client data, which is its lifeline, in a region far from the head office as a backup. It is difficult to understand why this design philosophy of risk distribution, which is the most basic logic in risk management, was not applied to the design of the nuclear power plant.

5. Meaning of "Unexpected"

The word unexpected is frequently used for this nuclear power plant accident: An earthquake of an unexpected M9.0 scale and the unexpected scale of the 15m-high major tsunami. Moreover, there are opinions that certain assumptions must be made to design equipment. However, from the perspective of the risk theory, this word unexpected is misunderstood because there are several levels in this assumption[4].

The types of unexpected situations include: (1) an unexpected event whose probability of occurrence is objectively so low that it was removed from the list of expected events (e.g., the falling of a meteorite). (2) Events where there were people who brought the possibility to attention, but theirs were minority opinions, and because the consensus of the academic field exhibited low probability, such events were removed from the list of expected events (limit of academic standard or the issue of considering minority opinions). (3) Events whose probabilities are shown to some extent, yet removed from the list of expected events owing to subjective judgment that they are unlikely to occur (e.g., from misguided belief or overconfidence or the inability to face a difficult situation resulting in pushing the thought out of one's mind). These problems are faced in engineering ethics as well[5]. (4) Events whose probabilities of occurrence are understood, yet removed from the list of expected events owing to trade-offs with external factors (e.g., the cost was too high or political consideration). (5) Events where despite being present, the possibilities of occurrence were not considered due to lack of imagination or information, leading to an unexpected result (the sin of ignorance, lack of study, or poor imagination). As can be seen, there are many types of unexpected events.

Moreover, in terms of the quality of prediction, there is not only the issue of the comprehensiveness of the assumed scope of risk of the probable events and the prediction of the risk's probability, but there is also the issue of total risk assessment in terms of how much consideration was given to the size of the damage when such events occurred. Regarding the quality of this risk prediction, the basic rule outside Japan is to begin with the "worst case scenario." However, for some reason, the Japanese do not wish to assume the worst case. The prediction-makers claim that this reluctance is because they do not wish to cause excessive concern. But that is a lie. Instead, it shows the mental weakness and inability to face the necessity of "thinking of the worst case."

In any case, only the first case among the 5 cases of "unexpected" discussed above is legitimate. All other unexpected events, especially the 3rd and the 5th cases must not be allowed to occur. In the case of this disaster, were there such unexpected events? Although there are many media reports swirling around this issue, the author cannot verify the fact and this issue will be the focus of legal disputes. Therefore, no further comments regarding this will be given in this paper.

However, from the perspective of risk studies, the 4th case, the case where events were removed from the list of expected issues owing to the concern for cost, is problematic. In general, it is natural to consider the cost during design, and there is no objection to this point. The problem, however, is what standards and sense of values were used to evaluate the risk and cost trade-off. Cost includes not only the initial cost, but also the running cost, disaster cost during an emergency, and the disposal cost. Moreover, there are political, social, or psychological costs in addition to the economic cost. The author wonders whether much consideration was given to these other costs. Especially the disaster cost during an emergency tends to be given low priority because of its infrequency. However, there are countless examples of being stingy with this initial cost and ending up paying a lot more after a major disaster struck. Perhaps the same mistake was made during this accident? As it will be discussed later, such a misjudgment is known to happen often when the evaluation is performed with only an insular sense of value within an organization.

Furthermore, regarding this cost, there is a big difference between the cost for proceeding to the design of the actual facility/equipment and the monetary cost of conducting only thought simulation and thinking about the preparation of procedures in advance. Were the relevant people aware of this difference? For instance, the author does not insist that the abovementioned risk of a meteorite hitting the power plant should be considered when the real machine is designed. But it may be preferable to at least conduct a low cost thought simulation and be prepared. This logic is applicable to the unexpected events of case 2 as well.

Finally, there is the issue of whether the station blackout during this disaster was within the assumption or was unexpected. The possibility of power loss was brought to attention by some members of the administrative committee. Moreover, the scenario for preparing for it was at least discussed. Thus, it can be said that it was at least formally assumed. However, the real response was so inadequate that one cannot say that the administration was prepared. In that case, what was the content and scenario they assumed?

For instance, were they optimistically expecting some of the emergency power source to be functional even when the main power source is lost? Were they thinking that even if there is a station blackout, it will only be temporary and will recover quickly? Surely, the knowledge that the time until a core meltdown is short following total power loss was shared among them. So was there any special measure to ensure that the emergency power source will be available for a long time to prepare for such a situation? Regarding the three rules of “stop”, “cool”, “confine”, there may be an optimistic thought that if the first step “stop” goes well, the following cooling process including ECCS will proceed smoothly. In any case, the author believes that the most important point in future examinations of the accident will be the issue of this assumption level and the number of measures taken in advance based on it.

IV. Problem of Software from the Risk Studies Perspective

1. Problem of Layout of the Structure

In addition to the safety of the structure itself, the issue of the layout, in which how the structure as a whole is positioned, is involved in the safety of the structural system. The concern regarding the installation position of the emergency generator was already discussed in section III-4. Regarding Mark 1, the same could be said about the over-packed layout of the pipes and various equipment inside the PCV as well as about the layout of the spent-fuel pool, which was positioned high in the nuclear reactor building. However, this is a design-based issue for GE, and it will not be discussed further in this paper because these issues were improved in the reactors following Mark 2.

A more pressing issue is the fact that the four reactor buildings and turbine buildings are too close. Naturally, in normal times, it is more efficient for these buildings to be close to each other. However, this could worsen the damage during an emergency. For instance, when one reactor has an accident and generates abnormally strong radiation, there is a concern that the reactor next to it will be affected, and it will not be possible to even go close to the reactor, let alone repair it. This issue of "concentration and dispersion" has historically been discussed frequently in both risk studies and engineering fields. Was this issue sufficiently considered? However, there is no simple answer to this issue when one thinks of the trouble people have in working within many constraints attached to a site in a small country like Japan.

In addition, many nuclear reactors in Japan are built by the sea. For tsunami countermeasures, it appears that instead of building embankments more than 10 m high, building the reactor on land that is 10 m higher would be more effective. Why was there no design that considered layouts that utilized the topography? Furthermore, there are many pumps by the sea that did not have a building and were simply exposed. Why were buildings not built for them?

2. Absence of Professionals Who Know the Whole System

The response to this accident projects the impression that there was no professional who understood the system of the nuclear power plant as a whole down to the small details. Although there are many professionals for each component of the system, it appears that there is a serious shortage of professionals who have an overview of the entire system.

However, this issue did not become apparent only by this accident; rather, it has been discussed on the site for more than a decade. In fact, whenever a discussion was held with people responsible during a visit to the nuclear power plant, this issue was almost always raised. According to the people in charge, it sometimes happens that an experienced engineer who has been staring at a large design drawing for a long time points to somewhere in the drawing and says "I am not comfortable with this part," or "this part feels scary for some reason." Even though there is no real data, a problem was discovered when such a part was inspected just in case, allowing them to take measures in advance and avoid accidents. This is not simple "intuition." Instead it is "professional sense" acquired after long years of experience. These people intuitively know the basic fact that in a system, the simple sum of "parts" is not the "whole." Such extraordinary professionals have been the backbone of Japanese nuclear power plants.

However, when studying the response to this accident, one gets an idea of how the consequence of one measure leading to a certain type of chain reaction, especially during the early stage of the accident, was not sufficiently considered. If this lack of consideration was due to a decrease in the number of professionals capable of grasping the overall picture of the entire system, then what are the implications for future maintenance systems? Such staff cannot be trained in a short period of time.

3. First-Rate Design and Third-Rate Construction?

It has often been pointed out that while the design of Japanese nuclear reactors is first-rate, both the construction and the inspectors are third-rate [6)]. As the author has no experience in this issue and consequently may have misunderstood something, the writing of Mr. Hirai, who does not support the anti-nuclear stand and has detailed field knowledge of the reactors, has some degree of persuasiveness. His writing also echoes the abovementioned lamentation of the people who are in charge of nuclear power plant sites that expert skills are not being passed on.

According to Mr. Hirai's opinions, the work at the frontline is facing the following problems: There are less "craftsmen" among the workers at nuclear reactors, and the number of workers who are not so different from amateurs is increasing. Even if one tries to train them, it is difficult to train the successors due to the issue of exposure. And many of the specialized operation management officers sent from the relevant ministries are also complete amateurs, and there is a shortage of people who can impart correct instructions. These anecdotes are not necessarily exaggerated. When talking to the technicians working at reactors, one often hears the same stories.

Regarding the specialized operation management officer, the necessity of establishing a third party organization that has solid specialized knowledge and skill, and can objectively and fairly conduct evaluations has been pointed out for some time, prior to the comment by Mr. Hirai. However, there are several variations of the function of a third party organization including giving advice, making inquiries, monitoring, evaluating, and providing information [4, 7]. Although what is required here is to mainly focus on monitoring and evaluation, which will not be discussed further in this paper because this issue also involves the issue of governmental administration reform.

4. The Gap Between the Verification on Paper and the Real Situation on Site

For the first step of a safety audit related to the abovementioned problems, it is common for the audit to be conducted through the inspection checklist supplied by the administration in advance and the papers the company prepared in response to the checklist. This checklist includes questions such as whether there is an emergency generator, a vehicle with a generator, and whether routine inspections are being conducted. Other such questions include, in case the telephone stops working, whether an alternative communication system is prepared; how many staff members are allocated for fire prevention, and whether training for emergencies is being conducted. On the whole, the checklist includes numerous questions.

This type of paper examination is not entirely meaningless, and not all its aspects are bad. The problem is the extent to which the numbers on the paper reflect reality. Even if every question in the checklist was answered as “yes,” it does not necessarily reflect the reality because this practice is simply “matching the numbers,” if stated negatively.

For instance, regarding the abovementioned generator vehicle, the problem is not whether they exist in number, but whether they are “active” and are maintained in a condition to be used at any time. To achieve this, every possible obstacle must be considered including whether the vehicle is always stored in a safe place, whether it is inspected daily, is its fuel secured, how long can it run continuously, whether an alternative vehicle is prepared when the primary vehicle is under inspection or in repair, if a driver is secured, and what are the measures when the road is blocked by debris. Such a consideration for complex and diverse risks is not possible unless one works at the site. It must be constantly repeated that risk management cannot be conducted only on paper. However, to begin with, is there a risk manager who can consider all these risks stationed at the site?

5. Necessity of Accident Simulation Experiment

It goes without saying that daily training is necessary to prepare for an accident (however, training that only follows the manual is not sufficient). What is equally important is a prior simulation of an accident. And it is desirable for this simulation to not only be a virtual simulation using a computer, but also an experimental simulation using real equipment, even if it is on a small scale. According to Dr. Itsuro Kimura of Kyoto University, such an experiment is already conducted in the U.S.

However, the author must admit that doing this is extremely difficult in reality, partly because of the issue of cost. Yet, the knowledge obtained from such an experiment will be much more realistic than that obtained from trainings, and it will be very advantageous to obtain such precious real data.

6. Nuclear Energy Industry As a Closed System and Its Safety Culture

The nuclear energy industry has been metaphorically compared to a “village” for a long time. That is because this industry is insular, and it does not often share or accept information from the outside. As this view is often voiced even by the staff or other departments of the electric company, who are colleagues of the nuclear energy staff, other related companies, government officials, and the staff of research institutes, the author believes that this impression of insularity is not merely a personal impression.

The possible reasons for the insularity of the industry is include how private use of nuclear energy rapidly progressed about 50 years ago, and nuclear energy was praised as the “dream energy” by the industry, government, academia, and public opinion, causing elites to enter this industry. Another reason is how the industry became inaccessible to outsiders because it is a technology that requires state-of-the-art and advanced specialization, and consequently, the internal group became united and lost the sense of necessity to absorb or share information with the outside world. There is a fierce criticism that says its insularity became an indirect cause to this accident.

To avoid misunderstanding, the author would like to clarify that the author is not claiming that nuclear specialists have been ignoring safety. They have been pursuing safety in their own ways. For instance, some intellectuals criticized the nuclear industry after this accident by saying that “the nuclear industry misled the people by propagating the safety myth.” However, this comment is not necessarily correct. After the 1991 accident at the Mihama Nuclear Power Plant of the Kansai Electric Power Company, the company responded to the triggering of ECCS by significantly altering the claim in nuclear energy public relations (PR) magazines that said “accidents will never happen.” Moreover, the content of the “White Papers on Nuclear Safety” published by the Nuclear Safety Commission in 2000 clearly suggests a “departure from the safety myth.” This was also widely reported in newspapers at the time [8].

This indicates the presence of the perspective that understands that there is no certainty in the safety of science and technology existing in the nuclear industry, at least on a philosophical level. The author also believes that this perspective was widely shared throughout the industry after 2000. However, upon studying this accident, it appears that this perspective did not lead to concrete and functioning actions. Why was that?

It may be due to a discrepancy between the standard for safety and that of the specialists outside the nuclear village. It is possible to wonder whether this discrepancy originated from the experts’ overconfidence in their specialization, and whether the inability to notice the discrepancy or the overconfidence was due to the insularity of the village.

In short, even though they understood the concept of safety in theory, their response as an institution suddenly became an insular judgment, and they made an indulgent estimation or rejected external minority opinions and made themselves absolute. In other words, consciousness in terms of safety was not internalized by the organization. Such a negative aspect of organizational code has been one of the main research subjects of social psychology for a long time. The author hopes that the nuclear industry will consider such social psychological knowledge in their future organizational reviews, because wonderful knowledge also exists among the “outsiders” who are not part of the village.

In addition, the media is reporting several other problems around the insularity of the nuclear industry such as its collusion with politicians or the administration and the vested interest structure[9]. The author will not discuss this issue further owing to a lack of material or knowledge to discuss the validity of these reports. However, the author would like to highlight once more that generally, a system that cuts off its energy metabolism with the outside world always collapses. This is both a law of physics and a law of social science.

V. Problem of Command/PR System from the Perspective of Risk Studies

This nuclear power plant accident raised questions, beyond engineering problems such as how to handle the reactor, what type of team should be made to effectively cope with the major accident that occurred, what type of leadership is required in such circumstances, and what type of PR is required to explain the situation to the concerned people. Therefore, a major suggestion was made on the issues of social psychology. These questions will be discussed as follows.

1. Problem of the Chain of Command

There were many players who were involved in the response to this accident including the Tokyo Electric Power Company, the Nuclear Safety Commission, the Nuclear and Industrial Safety Agency of the Ministry of Economy, Trade and Industry, Toshiba, and Hitachi. However, what type of joint team was formed and who played the central role in leading the team is still unclear.

The author believes that when the JCO Accident occurred, the Nuclear Safety Commission played a central role in terms of implementing countermeasures and resolved the issue relatively smoothly. However, they did not play many visible roles this time. Was there a special reason for it?

What is more important than such an inquiry is the fact that what type of organization should take a leading role in the response to such a major accident was not clarified beforehand in normal times. It is commonly known that setting up an organization in haste after the occurrence of an event will not result in a functional organization.

Moreover, many other countries naturally have such an organization. Although Japan also has what is called the Government Nuclear Emergency Response Headquarters, its technical leadership was not very visible during this accident. There are many other similar organizations being established. However, they are not unified, and it is difficult not to form an impression of “too many cooks spoil the broth.” What creates the most confusion in an organization is a person who only has “enthusiasm” without specialized knowledge tries to lead the organization.

According to the knowledge of social psychology, it is known that the ideal style of an organization or a group is strongly dependent on the task environment they are in. In a highly specialized task environment with significant urgency such as the situation of this accident, it is imperative to create a task-oriented organization. It can also be described as a type of task force.

To achieve this, it is important to unify the very best professionals of each specialized field, create a headquarters with a small group that controls the whole including support groups (the type of staff discussed in Section IV-2 is needed for precisely this type of task), select a leader who can see the big picture and make judgments accordingly, unify the group under strong leadership, provide that leader with sufficient authority (some countries grant the leader authority equal to the prime minister under certain conditions), and above all value decisiveness and speed. A good example of such a task force is the “Hayabusa” Asteroid Probe mission that returned safely despite many unexpected dangers [10].

Note that, for such task force members who are requested to possess highly professional knowledge, it is unacceptable for politicians with poor knowledge to interfere in the process or technical discussions. However, this does not mean that politicians must be ignored. Broadly speaking, they have two roles. One is to instruct the direction of problem solving, and the other is to make the final decision.

The first case is when the progress of the occurred situation includes socially complex factors, and the staff on site is not sure where to begin; it is the role of politicians to instruct the directions to proceed and the priority of tasks. However, to perform this role, it is a prerequisite for the politician to possess high-level judgment that can view the bigger picture in such a situation.

The second case is of taking responsibility and making decisions as the situation progresses, facing a difficult scenario where every option will likely lead to a negative consequence. That is because these two cases are highly political decisions rather than technical decisions.

2. The Issue of PR System

At the beginning of this accident, PR was handled by the Chief Cabinet Secretary and the staff of the Safety Agency. Later, TEPCO joined, and PR is currently handled by these three parties. What is hard to understand is why PR is not being unified. In risk studies, it is common sense to unify the PR system during such an emergency, similar to the abovementioned chain of command. Indeed, the existence of three information sources leads to the repetition of information or discrepancies between the claims of the three sources, causing misunderstanding and confusion.

There is of course the advantage of increased information when there are three sources. However, instead of conducting press conferences separately, the three parties should join in support, convert the information of all three sources into one, and then speak at any time depending on the topics. This may be a normal arrangement, but the problem in PR is not related to only its system but also to its contents.

First, there is a problem in the level of information disclosure. Information disclosure has generally been too passive or too careful. The reason for that is because relevant people may claim that “disclosing uncertain information will cause unnecessary concern to the people.” However, this is an amateur’s view with no knowledge of the communication theory of social psychology. If an uncertain piece of information is disclosed with careful explanation, the people will accept it without misunderstanding. Withheld information will lead to speculations that important information is hidden from the people, which will in turn cause more concerns [8, 11, 12]. PR does not demand strict accuracy in terms of presentation in an academic society. And it must be understood that the people are not as ignorant as the persons involved believe they are.

Another misconception of the persons involved is that they seem to think “Correct PR is to ease the concern of the people”. However, this is wrong. While it is good to correct the people when they are concerned about something that is objectively safe, it is in fact more dangerous to convince them that something dangerous is safe. They must understand what is required is to help the people to adapt the attitude to “fear what is dangerous, but fear it correctly” [13].

It is also important to know that there is no experiential data of panic occurring after a natural disaster, including earthquakes. This is common knowledge among sociologists and psychologists around the world. The term earthquake panic is merely a word coined by the media. However, in the case of this nuclear power plant disaster caused by an earthquake, there is a possibility of panic caused by distorted information.

Another problem the author would like to discuss is the quality of provided information. Seen from the perspective of social psychology, the current spokesperson unfortunately does not have basic academic knowledge of PR techniques toward the general public. The author can understand that the spokesperson is attempting to speak as simply as possible, but the problem is that the explanation is not in accordance with the recognition structure of the citizens.

Take the example of the radiation exposure problem, which the citizen is highly interested in. The average thinking pattern of the citizens is probably at the level of radiation = atomic bomb = Chernobyl = scary, and they hardly have knowledge in radiobiology or radiation protection science related to the danger of exposure. Although it is understandable that they do not know units such as Sv or Bq, it can be speculated that the number of citizens who have basic knowledge on radiation, such as how the dose-response relation of radiation is studied, the difference between risk measurement and risk assessment, the transition of the temporal and spatial distribution of radiation, the meaning of stochastic effect, the meaning of tolerable risk or regulation value, or the meaning of precautionary principle, is extremely small.

And without some of this basic knowledge, it is not possible to understand why the radius of evacuation area was different between Japan and the U.S., why spinach was the first to be restricted, and why vague expressions such as do not go outside “for the time being” were used.

It is however wrong to criticize the citizens for being ignorant of these concepts, because they do not need this knowledge in daily life, and the citizens are too busy to study unnecessary subjects.

If that is the case, the persons involved must approach the citizens and make an effort to reconstruct the concept to suit the recognition level of the citizens and communicate them. Without such an effort, the meaning of radiation risk will be difficult to convey. To achieve this, a cooperation of professionals in both communication and radiation seems indispensable. However, there is no sign of such considerations being taken. The author believes this is due to the insular nature of the nuclear village discussed in Section IV-6 that neglects sharing information with the outside world.

There are many possible methods for improving PR. The first step would be a collaboration between the professionals of communication and radiation as discussed above to devise logic and expressions that are easy for the citizens to understand. Following this, is it necessary to print an explanatory article based on these expressions as a preserved version and distribute it among the people of affected areas who are concerned about the radiation exposure? (Newspapers are already trying similar PR techniques). Furthermore, establishing a fair third party organization focused on PR, as discussed earlier, would also be effective. References that will be useful for learning the points to be careful and useful examples are abundant, including the ones by us. The author hopes they will be utilized by the relevant parties [7, 8, 11, 14–18].

In addition, a related problem that is being discussed is the so-called reputational damage. The term reputational damage is a neologism by the media, and is a concept without any academic ground. Socio-psychologically, reputational damage is close to gossip or rumor. And it is impossible in principle to stop the emergence of gossip or rumor, including the reputation. However, there are many techniques to reduce its scale, and there have been several studies on this issue [12, 19]. The author omits a detailed discussion due to space limitations.

VI. Conclusions

Even though the Atomic Energy Society of Japan invited the author to contribute to their journal, the author is aware that it was highly presumptuous of a non-specialist to present an opinion about this Fukushima Nuclear Plant Accident. Although the author discussed how things appear from the outside perspectives of risk studies or social psychology, there may have been some misunderstandings or prejudices originating from a lack of knowledge. The author would like to apologize to the concerned people in advance.

However, if the author may offer an opinion, while many vague expressions such as “safety myth” or “unexpected” were used liberally around this accident, this in fact points to the possibility that the discussions based on the concepts of “safe/secure” are problematic to begin with because “safe/secure” are problematic concepts that sound pleasant but cannot be defined operationally [13]. The author omits the details of the debate around them, but what is required in the future is “risk”, which is a logical expansion seen from the perspective of science. As Sugawara [20] suggested, the author believes that it is necessary to “stop being emotionally satisfied with words such as safe or secure; instead recognize that risks exist in every product and technology, and think of appropriate measures against these risks.”

Finally, the author would like to conclude this paper by dedicating the utmost respect and gratitude to the technicians and workers who are still risking their lives in the fight against the accident at the site of the Fukushima Nuclear Power Plant.

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