Imperial Journal of Interdisciplinary Research (IJIR)
Vol-2, Issue-11, 2016
ISSN: 2454-1362, http://www.onlinejournal.in

Criticality of Communication on Nuclear Risk and Safety in Nuclear Energy Sector

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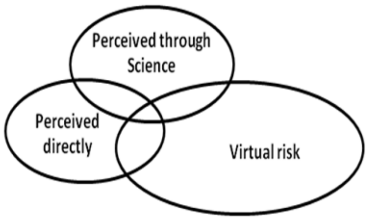
Abstract: *Scientific and technological development has long been considered in the context of its associated risk to people and environment. Advancements in nuclear technology and continued expansion of its application in all major spheres of life such as health, agriculture, energy, industry, military and the outer space over more than half a century has tremendous effect on public life and raised questions about risk and safety concerns. This paper addresses the responsibility of key stakeholders in the nuclear energy business -the government authorities, corporate power sector/energy companies, atomic energy agencies and the scientific community, to clearly and unambiguously communicate to public risks associated with nuclear power plant operation, particularly in the case of an accident and measures taken/to be taken for public safety. Apropos to the 5th anniversary of Fukushima Daiichi Power Plant accident (11 March 2011), the author conducted a short survey and text analysis of a newspaper article using Critical Discourse Analysis to understand the flow of information on potential risk from key stakeholders (as mentioned above) to general public. The paper is an effort to add to the on-going discourse on the issue.*

1. Introduction and Definitions

Before opening the discussion on nuclear risk communication as a core responsibility of stakeholders for creating awareness, building risk perception among the members of the public and enhancing safety culture in the energy sector, it is important to define several important terms and relationship dynamics among them that will make the core of the arguments in the forthcoming text.

Firstly, let us take the term 'risk' and what it entails. According to Breakwell, "risk is the probability of a particular adverse event occurring during a stated period of time".[1] The term 'risk' is also used in parallel to 'hazard' which refers to something that could result in causing harm to people and the environment. [2] Nuclear risk turns into nuclear hazard when an accident takes place.

According to John Adams, "Risk is a word that refers to the future. It has no objective existence. The future exists only in the imagination". His conceptual model, given below, uses the Venn diagram to describe the various ways and means that play a role in developing public understanding of risk. [3]



Hence, people perceive risk both directly and effectively by the power of imagination as well as what comes to their knowledge through science. Not only that people experience and observe risks at various stages and situations in life, but scientific discoveries also continuously bring out new information that authenticate or reject earlier facts causing people to seek clarification and / or change views about risk. As described by John H. Marburger III, "(t)he mix of certainty and uncertainty in science is a source of confusion to a public whose view of science is idealized."[4]

The risk perceived generally differs from the specific risk associated with technology or technological development. "Experts use the words risk, safety and security in ways that diverge from the everyday understandings of these terms by non-experts, audiences and interlocutors, there is always potential for misunderstanding".[5] Therefore in the context of this paper, specific definitions are provided to distinguish the word 'risk' from 'nuclear risk' in this case.

The International Atomic Energy Agency (IAEA) Glossary provides definitions of 'nuclear risk' and related terms. Accordingly, the term, 'Nuclear' strictly means relating to a nucleus or relating to or using energy released in nuclear fission or fusion and the term 'Nuclear Risk' refers to the risk of exposure to radiation under normal circumstances and as a consequence of incidents, as well as other possible direct consequences of a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source. 'Safety' is the achievement of proper operating

conditions, prevention of accidents and mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards. 'Nuclear security' is the prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities. [6]

Scientific and technological development is considered by experts in the context of its associated risk to people, their livelihood and environment. Two main aspects of risk are 'probability' and 'consequences' which are further assessed in terms of frequency and intensity of the event. Risk analysis, therefore, includes 'risk assessment, risk characterization, risk communication, risk management, and policy relating to risk' as defined within the practice of Society for Risk Analysis (SRA). [7]

2. Scientific Communication and Perceived Obstacles

The reluctance of authorities to communicate to the public details of the extent and severity of nuclear risk leads to negative public reaction or confusion. The Government's argument is based on the fear that it (sharing information with the public) would cause panic and disturb public peace due to the "very nature of nuclear physics and its apparent complexity". [8]

The changing social trends captured by various independent surveys show that the immediate reaction in the aftermath of an accident progressively becomes weaker [9], therefore, the above argument does not exonerate the authorities from their responsibility to communicate.

Discourse on technological risk of nuclear energy is inviolable at social forums because of the dual use of reactor technology that invariably turns the conversation from civil use and social benefits to the threat of nuclear proliferation. Besides, there is not sufficient technical knowledge available to people in non-technical genre to describe their views clearly on such issues. One of the limitations is that "people are not scientifically literate enough to understand the information they do have". [10] There is a disconnect between the debate represented in media on the issue of nuclear risk and the scholastic pursuits and "(m)uch of it has to do with the way scientists communicate their work to the public, a public that does not understand how science progresses, journalists who believe every story has two sides, and outright propaganda for political gain."[11]

If we move away from this confusion and look at the use of nuclear technology in our daily life such as in energy and health sectors that concern people's life at social level, it would create more congenial environment to discuss pros and cons of nuclear technology, its risks and safety needs at the individual, institutional and societal level more realistically.

As far as the vast use of nuclear technology in the energy sector is concerned, there are experts' opinions for and against it with valid arguments, but the people may have their own reasons to feel anxious about it. The key argument in favour of the use of nuclear energy is its being clean in nature compared to fossil fuels in terms of carbon emissions. Besides, it could be produced at a mass scale to overcome power shortages in a number of developing countries in many regions of the world. The argument against it refers to the huge and potentially harmful waste produced as a result which the world community has to deal with for generations to come. So far no environmentally sustainable, socially acceptable and economically affordable solution has been found to the problem of nuclear waste to do justice to the present and future generations.

An earlier study focused on risk perception of large scale application of nuclear energy and coal, conducted in 1995, found that (at that time), France had the highest density of nuclear power plants and the Netherlands the lowest, whereas the public perception of risk in both countries was equally negative. [12] To date, France heavily relies on nuclear energy as 74% of its needs are met through nuclear power plants. [13]

Whereas the environmentalists constantly call upon masses to consider damage already done to natural resources and environment due to fossil fuel carbon emissions, and exert pressure on policy makers to start acting responsibly, there is not sufficient discourse and lobby on the topic of nuclear risk to people and their sustainable livelihood and no collective global opinion is being evolved to influence the policy makers. Like Jim Collins puts it, "people are fearful of penalty and criticism for shining light on the harsh realities" [14] with regard to nuclear risk.

What we are observing now is the "revival of nuclear energy as UK, USA, France, Finland" [15] and China are pursuing ambitious nuclear energy policies. In their quest to achieve low carbon targets, most advance countries, as a quick fix, are opting for nuclear power instead of looking for means to invest in and build renewable energy options with the exception of Germany. The UK government has recently approved the nuclear power plant at Hinkley Point in Somerset, UK, with a financial outlay of £18bn including investment by the French and Chinese governments. [16]

The reason for this deliberate policy approach is deep-rooted in the fact that the social development and humanitarian groups (except economists and financiers) are not part of the inner circle where debates on various energy options take place and political, economic and technological decision are made that often serve the corporate global agenda for maximizing profit and minimizing cost and not maximizing social and humanitarian benefits and minimizing risk to people and environment. [17]

This being said let us look at 'who is who' in the energy sector. The key stakeholders in the energy sector are the state government that "partially or wholly" owns the nuclear technology facilities "even though they are generally thoroughly commercial in outlook,"[18] and regulates the power sector, the nuclear industry that further develops "reactor designs... originated in state-led research institutes"[19] and its vendors, the private sector energy producers, suppliers and distributors, scientific community - the brain behind research, development, innovation and knowledge building, technical and non-technical power industry and power plant staff, and lastly the ILO, representing employers and workers associations and the government. Consumers (general public) and consumer bodies are at the receiving end of the rope.

From the perspective of communication, it does not include broader participation from consumers as well as other social groups except economists/financiers or to a smaller extent the environmentalists at the early stages of planning in the process of building a nuclear power plant (NPP). The role of other social and professional groups, media (except for political reasons) and non-profit humanitarian and human rights groups is almost non-existent.

There is an invisible code governing the flow of scientific and technological information to the public. The 'safety' of people and building people's capacity to understanding the nuclear risk and finding ways to protect themselves, their families, livelihood and environments gets far less attention in the official circles than the normative aspects of safety regulations. Events with negative consequences such as the nuclear power plant fall out receive limited public exposure on the pretext of avoiding unnecessary panic. It is in total disregard of the fact that 'safety' is not a stand-alone notion. It is measured vis-à-vis a perceived risk, a hazard or an actual threat. Higher the risk, higher the need for public information on risk and safety!

Article 12 of International Covenant on Economic, Social and Cultural Rights (ICESCR) aspires that "The State Parties to the present Covenant recognize the right of everyone to the enjoyment of the highest attainable standard of physical and mental health", whereas Article 7 (b) of the same Covenant puts emphasis on "Safe and healthy working conditions".[20]

The Universal Declaration of Human Rights in its Article 19 upholds the right of every human being "to seek, receive and impart information and ideas through any media and regardless of frontiers". [21]

The 'right to information' has been upheld in many international conventions such as the "Aarhus Convention on Information, public Participation in Decision Making and Access to Justice in Environmental Matters". [22]

There exist many autonomous international legal frameworks and protocols on nuclear energy, environmental protection and protection of human health against radiation exposure, however, "a number of treaties adopted in the nuclear field endorse a kind of a health protection/environmental protection dichotomy. Among the nuclear law instruments there are those that merely make a passing, declarative reference to environmental protection and those that lay down concrete substantive rules and/or obligations thereto". [23]

The European Union's institutional framework on nuclear energy is called EURATOM. EURATOM Treaty Article 30 "lay(s) down the basic standards within the Community for the protection of health workers and the general public against the dangers arising from ionizing radiation". [24] Violations to the treaty are addressed by the European Court of Human Rights (ECtHR).

Besides, the ILO and IAEA have a host of protocols and conventions to ensure occupational health and safety of workers against radiation as is referred later in this paper.

In order to translate these rights into good governance practices, countries promulgate laws and regulations to ensure that workers not only receive information with regard to occupational hazards, but also being assured of their health and safety. The US State Department, for example, through its Occupational Safety and Health Act of 1970 "gives workers and their representatives the right to see information that employers collect on hazards in the workplace. Workers have the right to know what hazards are present in the workplace and how to protect themselves."[25]

3. Real-life Situations

Three global examples of nuclear accidents have shaken the confidence of people in the safety claims of the respective state authorities. These are: Three Mile Island (TMI), Chernobyl and Fukushima accidents. All three exposed a variety of patterns of releasing information to public on nuclear disaster. "Information about the accident at TMI was available in greater quantity in a shorter time and with fewer restrictions than at Chernobyl". [26]

The discourse on nuclear risk and public safety that was revisited by the shocked world community at Chernobyl incidence in 1986 and post-handling of the situation was further intensified after the recent experience of Fukushima double disaster of tsunami and earthquake in 2011 that caused tremendous damage to and failure of power reactors. Fukushima proved to be a "turning point for Japan overall and for nuclear energy in a number of countries."[27]

Irrespective of the official nuclear policies of countries, these accidents have "deeply affected perceptions" [28], and raised concerns of the public not only about the personal safety and the safety of their livelihood in the aftermath of the accidents, but also about the future of the coming generations to inheriting environment charged with radioactivity and having meager opportunities to live a healthy life and to grow healthy food on the contaminated land, using contaminated water and inhaling contaminated air.

The Chernobyl accident caused evacuation of 115,000 local people and resettlement of 220,000 [29], whose lives have changed overnight. Within three years of the accident, Ukraine became an independent State and had to deal with the economic and social consequences on its own.

Similarly, according to the factsheet on Fukushima prepared by Physicians for Social Responsibility, it will take "decades before the full scope of the impacts of this ongoing disaster (Fukushima) is fully understood but significant health, economic, environmental and social consequences are already evident and quantifiable"[30].

Among these are the health consequences such as an increase in thyroid cancer in children exposed to radioactive elements and high doses of iodine. It is said that some 80,000 farms in Fukushima prefecture might have been contaminated, resulting in billions of Yen of losses to local agriculture. [31] The cost of decontamination and waste management in the aftermath of the disaster will continue to overburden the public exchequer for a long time.

Globally speaking, no significant change in the demand of nuclear technology has taken place as a result of these accidents. Japan and Germany, in a quick reaction declared a change of direction to lessen reliance on nuclear power and shut down power plants; whereas Japan returned to reopening nuclear power plants within a few years,[32] Germany intensified her efforts to materialize renewable energy options. On the other hand US, France, China and UK continued to pursue their existing nuclear programmes or even expand e.g. the Hinckley Power Plant project, recently moved ahead in UK as mentioned earlier in this paper. [33]

What is missing from the scene is an elaborate and well-publicized public information programme and participation procedure in the decision making process. Irrespective of the governments' decision to quit or adopt nuclear energy option, the right of people to be informed of the risk and to voice their opinion cannot be overlooked.

The public should be informed and consulted at least on the three main aspects: radiation risk and hazard to public health and in particular to the health of workers engaged in the energy sector as well as the probability of nuclear-accidents and their consequences, [34] the 'intergenerational risk related to waste management' [35] and the 'dual use of reactor technology in the backdrop of non-proliferation treaty (NPT).

The persistent withholding of information will be tantamount to violation of human rights including the 'right to information'/'right to know' as well as 'right to occupational health and safety'.

Lack of information breeds uncertainty. "When people feel uncertain, higher risk perceptions lead them to express a higher demand for government regulation, and open risk communication leads to more trust in risk-managing institutions".[36]

4. Short Experiments

To understand the communication scenario in the specific context of nuclear risk in the energy sector, the author has conducted two short exercises, in the aftermath of Fukushima Daiichi accident; to test the waters.

- Textual analysis of a newspaper article using Critical Discourse Analysis to interpret the message(s) on nuclear risk and public safety. The article is based on a conversation with a middle-aged, semi-skilled cleanup worker who represents the collective thinking of the people, both workers and managers, engaged in the clean-up operation. Please see below Experiment A.
- A brief survey of a selected professional group of 'Development Evaluators' on Nuclear Risk Communication. As a result a practical approach to communication among various professional groups is being evolved. Please see below Experiment B.

The results of the first test (Experiment A) show that although there is ample emphasis on the nuclear risk to workers engaged in the cleanup operation of the Fukushima Daiichi Power Plant, safety concerns about the well-being of workers including orientation to balancing the personal safety/health and economic interests have not been sufficiently addressed. The messages given in the article are not clear enough on the role and responsibility of various actors in bringing home the importance of personal safety of cleanup workers and the residents of nearby cities

(like Tokyo) in order to attain a sustainable solution for removing the debris and waste management. There is lack of alignment and disconnect between the workers' understanding of the job and the government's ambition to restart the power plant as soon as possible. The close competition among the social, economic and political agenda resulted in setting political and economic priorities ahead of workers' personal safety requirements.

The second test (Experiment B) results also show disconnect between access to information and engagement in the risk matters. The evaluators' community has access to information and is well-aware of key issues such as the risk emanating from nuclear power plant and damages caused by accidents as well as consequences in terms of displacement of people, radiation exposure, health consequences, progressive loss of life and need for safety. However, this awareness is neither translated into motivation to initiate communication with stakeholders in the power sector including the scientific community nor is used to engage in practical experience in the area of nuclear risk assessment and other relevant matters. Both parties thus hold responsibility for loss of opportunity for two-way communication and missing collaborative action.

Following the above tests, a communication model is being evolved to open doors for discourse on the issue. The model focuses on the three core processes i.e.:

- Access to relevant information
- Interaction and communication with and among stakeholders
- Engagement and participation of all stakeholders in the decision making process regarding nuclear policies and projects

The model places particular emphasis on the role of scientific community and other professional groups (sociologists, anthropologists, and evaluators) to be engaged in the discourse and include media for further release of information to the general public upholding the 'right to information' as stated in ICESCR . The model can be enhanced to encompass all key stakeholders as described at the start.

4.1 Experiment A: Textual Analysis of the Article – March 2016

"Fukushima keeps struggling to fight radioactive tide – Small army of workers defies hazards in clean up that could take a century" by Jonathan Soble, International New York Times, March 11, 2016

4.1.1 Introduction

The nuclear accident at Fukushima Daiichi Power Plant (Japan) on 11 March 2011 created strong shockwaves across the world. A 15 meter high tide caused by a powerful tsunami severely damaged three reactors at the power plant; consequently, making them dysfunctional. Due to the failure of cooling system, the uranium core started to heat up and leak radiation. [37] In order to save people from radiation exposure, the authorities evacuated them and cordoned off the area. Five years, down the line, the work of cleanup is still going on.

The radiation leaks not only contaminate soil, water and environment, but also cause cancer among people exposed to radiation. Therefore in the aftermath of Fukushima accident, there is a concern about the safety of people engaged in the cleanup operation.

4.1.2 The Issue

Radiation safety depends on how an individual, institution or a society perceives risk, prioritizes and manages it. While pursuing the short term economic interests, certain actors (stakeholders) such as the authorities and/or the power supply companies in the arena downplay the criticality of safety measures, hence exposing the less powerful actors - the workers engaged in the cleanup - to radiation related health hazards. Likewise the workers downplay the risk undermining their own safety to further economic interest and to achieve higher objectives of serving a national cause. Both sides are looking for short term gains. Should they decide to pursue the long term national humanitarian, socio-economic interest, the focus would automatically shift to safety and well being of workers as part of skilled and semi-skilled human resources available to serve the country in need, not just now but in the future, too.

4.1.3 Selection and Merit of the Article

The selected article seems to make a strong case on the dilemma faced by the workers who opted to sign up as paid employees for the cleanup job at Fukushima Daiichi Power Plant against attractive economic package and perks. At the same time undertaking responsibility to practice safety measures prescribed for workers and avoid over exposure to radiation. Due to fear of losing the job, at times, the workers and their supervisors are tempted to temper with the instrument (personal radiation monitor dosimeter) measuring the level of radiation exposure. This dilemma is hard to be resolved at the individual level, and therefore the institutional level actors need to make some adjustments in setting priorities without compromising on the personal safety as well as the economic interest of the individuals because they are in a position of power that could be used positively.

4.1.4 Research Questions

Meta Question: Why the radiation safety is a concern to the society and what is the national discourse on it?

Central Question: How does the article (explicitly and implicitly) conceptualize/define personal safety?

Operational Question: How can the personal safety measures be operationalized and ensured?

Sub-questions: Is personal safety a priority for the individual, institution and the society? Is there a competition among social, economic and political interests on safety?

4.1.5 The Methodology

For many decades**,** sociologists have been trying to understand the language and expressions used by media/journalists to represent social issues. As the world of media expands from print to electronic and from news to social chats, the methods also follow various routes to catch up with the media dynamics.

In the pursuit of learning and understanding the dynamics of journalism, the media discourse analysis and critical discourse analysis methodologies have been developed by communication experts and sociologists, who not only tested and practiced it but also used it to inspire the process of social change.

For the purpose of experiment A, the method of critical discourse analysis (CDA), as defined and elaborated by Teun A. van Dijk, is applied. The reasons to apply the CDA method are varied.

Firstly, it "does not primarily aim to contribute to a specific discipline, paradigm, school or discourse theory. It is primarily interested and motivated by pressing social issues…" [38]

Secondly, CDA addresses issues related to 'social inequality' and 'power relationship', which is not an easy task according to Teun A. van Dijk because " it requires multidisciplinarity, and an account of intricate relationships between text, talk, social cognition, power, society and culture." [39]

Thirdly, according to van Dijk, "(unlike) other discourse analysts, critical discourse analysts (should) take an explicit sociopolitical stance: they spell out their point of view, perspective, principles and aims, both within their discipline and within society at large." [40]

How do I justify?

The issue of Nuclear Risk Communication has emerged as a pressing social issue in the aftermath of Fukushima accident. It is multi-disciplinary encompassing political, economic, social, behavioral, environmental and technological aspects and represents power relationship between two groups of actors – the government authorities, power companies and scientific community on one side and the general public and other professional groups such as sociologists, anthropologists, journalists and evaluators on the other. The discourse gives me the leverage to take a stance.

4.1.6 The Process

Applying the above methodology, firstly some key words, phrases as well as specific narratives and metaphors in the headline, sub-headline and the text were identified, sorted, listed and interpreted. Then, from a reading of the text, a number of themes were selected and developed into three categories: social, economic and political. The phrases (or combination of phrases) related to these categories were arranged and tabulated, and subsequently a commentary was prepared to elaborate various notions that emerged from these texts. The rationale of narratives and relationship dynamics among categories were studied to develop an understanding of issues contained, both explicitly and implicitly, in the article in the context of the main subject. Findings are given below.

4.1.7 The Findings

Nuclear Risk Communication requires defining the concept of 'Risk' and 'Safety' which was done in earlier sections. Further, it is to be mentioned that 'Safety is not a stand-alone notion. It is used vis-à-vis a risk, a hazard, a threat or an exposure; therefore in order to focus on safety, one has to first ascertain the risk or hazard. Risk is considered an independent variable whereas safety a dependent variable with a positive relationship. The stronger (more intense) the risk or hazard, the higher the safety needs! The said article provides a full context of the risk in order to introduce the safety concept and its application at the Fukushima Daiichi Power Plant site.

The general findings below capture the discourse on nuclear risk to set the stage for safety. Whereas the risk is mostly defined explicitly in this article, safety is defined implicitly. The authenticity of concepts is assured by quoting the conversation with the central character of the article – a cleanup worker.

General Findings

The Headline: "Fukushima keeps struggling to fight radioactive tide."

The cleanup operation at Fukushima Daiichi plant site is equated with 'fight' implicating that there is a situation far from the normal in which a virtual adversary (virtual risk) existed. The metaphor of 'tide' is used to warn the public against the danger of radiation leak, implicating that the radiation tide will cause as much destruction and loss to life, livelihood and environment as occurred in the wake of the tsunami tide. Since the tsunami's after-effects are still being seen at the site, it creates a sense of 'realization' among people/workers who have experienced the disaster.

It is a very powerful phrase. Imagine a tide of radiation attacking and overwhelming you and you

are struggling to fight it to protect yourself. It makes you feel suffocated and partially helpless.

Another caution was thrown more directly to workers in which radiation was called a 'constant enemy' (article column 4, last line); a metaphor that can be related to the word 'fight' used earlier. It not only invokes fear of radiation and need for safety but also prepares to stand up against it for a long time as the radiation risk is constant and not transient. The reason being that once you are exposed to radiation, you cannot be totally free of its effects. The article is explicit in citing risk in the outset.

The sub-headline: "Small army of workers defies hazards in clean up that could take a century"

Two key words are important in the above statement: they are 'defies' and 'hazard' which indicate underlying need for personal safety against the hazard of radioactivity. Defiance is described as 'a challenge to meet in combat or in a contest' [41] Hazard is described as 'an unavoidable danger or risk, even though often foreseeable'. [42]

At the same time, the theme of 'fight' is further stretched to define workers where it turns into a mature concept. It is not a group of workers, employees, staff or technicians, but an 'army' of workers who are fighting against the virtual enemy in the form of 'radioactive tide' which is an unavoidable and constant challenge.

Rest of the text: In column 2, paragraph 3, the author compares the expectation of the government to complete the cleanup in 40 years with the 'other estimates' that count it in terms of a century. It is not clear who made the 'other estimates' and whether it is a reliable source or not. To make up for this ambiguity, the final sentence states that officials acknowledge that Fukushima remains 'vulnerable'; another warning to the audience.

There is a reference in column 4, paragraph 2 to 'Chernobyl' accident that took place almost three decades earlier in Ukraine (then part of the Soviet Union); Ukraine is still dealing with its aftermath. [43]

Despite several warnings in the article, there is no explicit emphasis on how and on whom to fix the responsibility for lapse of safety measure in the cleanup operation.

Specific Findings

The personal safety is described in the multi-dimensional perspective in the article, out of which, I have chosen the following three categories. I looked at specific narratives as well as their rationale and relationship among these statements.

- Social/Human Rights perspective
- Economic perspective
- Political perspective

The findings are as follows:

- Social/Human Rights Perspective of Safety:

The phrase 'safety' appears only 3 times in a half-page 6 column article and always accompanied with negative connotation that is reflective of both individual and institutional attitude and practices towards personal safety. The following phrases taken from the article reflect the gravity of situation:

'Vexing safety trade-offs'

'New safety measures put in place were inadequate'

'Safety practices found underreported'

The individual concern on safety is overtaken by economic motivation as is reflected in various statements made by the cleanup worker, the main character of the story. For example: "You think of it as totally normal work" said Mr. Tatsuta (not the real name) (Article column 2, paragraph 6). "The work is not hard," he said, if you don't think about radiation." (Article column 6, paragraph last).

It gives the impression that the understanding of individual 'right to occupational health and safety' [44] as a fundamental right against which no trade-offs should be possible, is not fully incorporated in the cleanup operation, neither the workers nor managers engaged in it are made aware of it.

- Economic Perspective on Safety

The trade-offs between economic and health interests by tempering the dosimeter mentioned in the article seem to be an option for an individual worker who is middle-aged, semi-skilled, nationalist, and is in need of a job. "In order to avoid being laid off or assigned to a lower-paid job, temptation to cheat can be strong..." (Article column 6, paragraph 2). The word 'cheat' is a synonym to deceive, trick, defraud, swindle or con [45]. Use of the word 'cheat' underplays the act of compromising personal safety and violating the human right to health for economic gains. The statement gives the impression that defiance to safety regulations is not a crime as long as you get away with it. Another motivation is the eligibility of worker's compensation "should he contract cancer during his lifetime"... (Article column 6, paragraph 8). The competition between social and economic interests is fierce as reflected in the statement, "… radiation is a constant enemy - though many see it more as a threat to their livelihoods than their lives." (Article column 4, paragraph 4 continued to column 5).

The World Health Organization (WHO) claims that "Globally roughly 19% of all cancers are estimated to be attributable to the environment, including work settings. Understanding some of the facts about environmental and occupational health and cancer can help mitigate the risks. Decreasing exposure to carcinogens also reduces health care costs, and contributes to the overall well-being of communities. Environmental and occupational interventions are critical to achieving a reduction of cancer". [46]

- Political Perspective on Safety:

The following statement indicates that personal safety is not expressed as the top priority despite having strong regulatory requirements in place.

"A smooth cleanup is a priority for Prime Minister who wants to rebuild Japan's tattered nuclear power industry." (Article, column 1, paragraph 9)

Since the cleanup is the priority which will allow rebuilding reactors to start generating business once again; it seems legitimate to let go of some failures in the total and strict compliance to regulations for personal safety of workers and violation of human right to health. This is also supported by the fact that there is no procedural manual for cleanup operation despite a lapse of 5 years after the Fukushima accident as reported in the article.

4.1.8 Conclusions

In the light of the above findings, three main conclusions are drawn:

- 'Safety' is being described in a muted way. It is less explicit and visible in the article vis-à-vis the radiation hazard which is well elaborated. The cleanup staff may be skilled for the job, but lacks the technical knowledge about the hazards posed to them and takes the work lightly in the spirit of nationalism. There is a compromise on the fundamental human rights such as the 'Right to Health' of workers that includes weak compliance to safety regulations, lack of information in the backdrop of the 'Right to Know' and economic trade-offs.
- Safety does not seem to be the priority from the social, economic and political perspectives at the individual and institutional levels, however at the societal level; there are 'other' abstract voices that raise the issue to contradict the official stance. These unheard voices include the concerns expressed by environmentalists. There is no expediency in efforts towards the safety of people generally and the occupational safety and health of the cleanup workers.
- There is a close competition among the social, economic and political agenda; as a result the economic and political causes are gaining at the cost of the social cause of workers' personal safety against radiation exposure.

4.1.9 What is missing?

Even from a cursory look, the reader will notice that many big players and important issues are missing from the scene.

The Tokyo Electric Power Company (TEPCO) – that seems to be hiding behind the façade of government authorities. TEPCO is 'the utility that ran the Fukushima nuclear plant' [47].

TEPCO was blamed for not releasing sufficient information on time to warn the people as "(a)n investigative report released … by three company-appointed lawyers said TEPCO's then-President Masataka Shimizu instructed officials not to use the specific description under alleged pressure from the Prime Minister's Office, though the investigators found no proof of such pressure."[48] The Prime Minister Office subsequently denied the allegation. It is conspicuous why the role of a big player like TEPCO left un-described in the said article. Apparently, the company is supposed to restart running the plants once the cleanup operation was completed and the workers are moved out of the site to be replaced by the technical staff.

The International Labour Organization (ILO) that should have been more vocal and visible on the site during and after the accident to ensure the occupational safety and health of both the technical/skilled or non-technical workers. This raises the question if the UN system or the ILO as a tripartite organization [49] is geared towards addressing such huge natural disasters and/or industrial accidents affecting a whole generation of power plant workers.

The International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) complementing ILO's Convention No 115 were developed jointly by three UN related agencies namely, the Food and Agriculture Organization (FAO), the International Atomic Energy Agency (IAEA) and the International Labour Organization (ILO) in collaboration with many other international/UN organizations [50].

One would like to know if these organizations have delivered their responsibility in the aftermath of the accident and how? Was ILO C-115 and BBS was implemented in its true spirit to provide cleanup workers with adequate protection from radiation? What actions were taken in case of tempering with the instruments by the workers/managers at the site for economic reasons?

Important information missing from the article is the treatment of radioactive material cleaned up by the workers. Where and how the radioactive debris and waste material (besides the damaged rods and spent fuel) will be stored or transported and what guarantees are being provided that it would not be accessed accidently by any member of the population living close to those sites? These questions will continue to haunt the readers.

Finally, no mention of human rights violations, particularly against 'right to occupational health and safety' and 'right to information'/'right to know' was made in the article.

4.2 Experiment B: Nuclear Risk Communication Survey (March-June 2016)

4.2.1 Planning and Launching of Survey

Apropos to the 5th anniversary of Fukushima Daiichi Nuclear Power Plant accident that occurred on 11 March 2011 in Japan following a massive tsunami and earthquake, a survey of development evaluators is being conducted to draw the attention of stakeholders/actors in the arena and in particular the scientists community to the criticality of communication with people including professionals in other disciplines on nuclear risk and safety. The professional discipline selected for the purpose is development evaluation and the selected community was the participants on International Programme for Development Evaluation Training (IPDET) on IPDET listserve. [51]

4.2.2 The Methodology

Prior to the survey, a brief literature review on Fukushima Daiichi nuclear power plant accident was conducted to select a list of phrases which were organized under a number of categories ranging from general terms to specific terms used for people, emotions, finance, evaluation and so on. These words and phrases had multiple links with categories and as such were treated in conjunction with other relevant terms to reflect the issues more comprehensively. For example the phrase 'disaster' when making a reference to WWII created a deeper sense of understanding to the audience than as a stand-alone phrase.

4.2.3 The questionnaire

The questionnaire consisted of four parts. The first part was used to collect demographic data of respondents whereas parts II, III and IV were focused on the following three thematic aspects of communication, respectively.

- Access to relevant information on nuclear risk;
- Communication and interaction between scientists and evaluators communities; and
- Engagement of evaluators in nuclear risk and safety assessment.

At the beginning of the questionnaire, a brief introduction of the theme was provided to the respondents. The survey was conducted on line.

4.2.4 Findings of the Survey:

Part I: Demographics:

In total, fourteen evaluators participated in the survey from Africa, Asia and Pacific, Europe and the United States of America. No responses were received from Latin America and Caribbean and North America. There were nine female and five male respondents in the age group of 31-60 except one who was above 60. It included five Ph. Ds, eight Masters of Arts or Science and one Bachelor of Arts. Three were in government service, three in international civil service, and two in the corporate finance sector, four working as free lance consultants and the rest in other sectors.

Part II: Access to relevant information on nuclear risk

As to the responses to questions related to the access to information; one third of the respondents received the news about Fukushima disaster immediately whereas the rest of them received the information within 24 hours, mainly through TV and Internet.

In response to specific question, "What were the first words and/or phrases that caught your attention?" in Category I- General Phrases; out of 86 hits on a checklist of 19 terms, 5 highest ranking terms are reported in the following order:

Table 1: Category I- General Phrases

Disaster	69.20%
Damage to Nuclear Power Plant	61.50%
Tsunami	53.80%
Earthquake	53.80%
Loss of human life	53.80%

Almost 70% respondents marked the word 'disaster' that caught their first attention when they heard the news. More than 60% marked the term 'damage to Nuclear Power Plant'. Next come the terms tsunami, earthquake and loss of human life; all three at the same level. After that come other terms health, children, livelihood, community and elderly.

In Category II- People Phrases, the checklist consisted of 22 phrases and received 90 hits. The respondents reported the 'health consequences' of the disaster as well as the 'loss of life' as the top concerns. At the same time, they were reminded of Chernobyl accident and associated concerns with the displacement of people, evacuation and safety. There were two references to WWII; however, no reference to Three Mile Island accident was made. See ranking table below for more information.

Table 2: Category II - People Phrases

Health Consequences	76.90%
Loss of Life	69.20%
Reference to Chernobyl accident	53.80%
Displacement of people	46.20%
Evacuation	46.20%
Safety	46.20%

In Category III-Emotions Phrases, 58 hits were received on a checklist of 9 phrases; 'Fear' ranked the highest, around 77% hits. Each of the terms shock, chaos and insecurity was marked by 70% of respondents. Grief and distrust were the next, both above 50%.

Table 3: Category III - Emotions Phrases

Fear	76.90%
Shock	69.20%
Chaos	69.20%
Insecurity	69.20%
Grief	53.80%
Distrust	53.80%

The Category IV-Financial Phrases consisted of 9 terms that received 23 hits; the top ranking term was 'cost of damage' with 100% response.

Table 4: Category IV - Financial Phrases

Cost of damage	100%
Impact on International Market(s)	30.80%
Estimates in US$	23.10%

In Category V-Entities/Actors Phrases, 30 selected phrases received 98 hits and not surprisingly, the highest ranking five phrases are about the Nuclear Power Plant management, related agencies and individuals i.e. nuclear scientists/scientists. Politicians, public representatives and many other actors did not receive much attention.

Table 5: Category 5 - Entities/Actors Phrases

Nuclear Power Plant (NPP) management	61.50%
Electricity/Power Authorities	53.80%
Atomic Energy Agency/Agencies	53.80%
Nuclear scientists	53.80%
Scientists	46.20%

The Category VI - Evaluation Phrases listed 19 phrases and received 113 hits. 'Risk to people' seems to be the main concern of evaluators, followed by 'risk to environment', 'international concern about safety, 'risk to community' and of course, the 'assessment of causes and consequences'. That makes the evaluation community a strong party in the pact of nuclear risk communication and that is why, in the author's view, there has to be an exchange of information and more concrete interaction between the scientific community and evaluators.

Table 6: Category VI - Evaluation Phrases

Risk to people	92.30%
Risk to environment	69.20%
International concern about safety	61.50%
Risk to community	61.50%
Assessment of causes and consequences	61.50%

In Category VII - Reaction Phrases, the checklist consisted of 14 phrases which received 85 hits. The top five terms are reported below. The main concern in this case is obviously the uncertainty regarding the 'future of nuclear energy, followed by the need for monitoring and evaluation, alternate energy options, risk awareness and risk assessment. Conceptually all together, this set of phrases depicts the post Fukushima scenario that is tilting towards change both in respect of technology to look for alternate energy options and in respect of behaviour for creating awareness and conducting monitoring and evaluation as well as risk assessment in the energy sector.

Table 7: Category VII - Reaction Phrases

(Uncertainty regarding) Future of nuclear energy	76.90%
Need for Monitoring and Evaluation	61.50%
Need for Alternate energy options	61.50%
Risk awareness	53.80%
Risk assessment	53.80%

The Category VIII-Technical Phrases had the longest checklist consisted of 32 phrases which received 145 hits. 'Nuclear accident', 'radioactivity' and 'emergency' were on top of the list. Other phrases that received more than 40% response included impact of radiation, power plant shut-down, nuclear reactor and terms related to safety issues including human error and exposure of people to radiation. Conceptually, this set of terms deals with nuclear accident and resulting danger of radiation and safety concerns.

Table 8: Category VIII - Technical Phrases

Nuclear accident	76.90%
Radioactivity	69.20%
Emergency	61.50%

Impact of radiation on natural resources/ environment	61.50%
Power plant shut-down	53.80%
Nuclear reactor	53.80%
Human error	53.80%
Safety standards	46.20%
Safety regulations	46.20%
Exposure to radiation (people)	46.20%

Part III: Communication and interaction between scientists and evaluators' communities

It included two key questions as follows:

The first question was: Have you come in contact with one or more persons affected by Fukushima accident in any capacity? It was followed by a number of subsequent qualification questions.

Out of fourteen, only two respondents said, 'yes'. The contact took place in the first two years and both respondents met more than four individuals, both male and female, during this period. According to the list below, all in all thirteen people came in contact with the two respondents.

Table 9: Interaction with Relevant People

Member of general public	2
Scientist	1
Nuclear scientist	1
Plant manager/operator	1
Regulator	1
Academic/Researcher/ Writer	1
Farmer	1
Government official/staff	1
Public representative/politician	1
UN official/staff	1
IAEA official/staff	1
Journalist	1

The second question was: Have you identified words and phrases captured in Part II during your communication and interaction with relevant persons? Give a rough estimate of resonance.

In response, it was reported that the resonance between the phrases picked by the evaluators at the beginning and those discussed during the interaction with relevant persons was between 21-30% in one case, 41-50% in two case and more than 50% in other two cases.

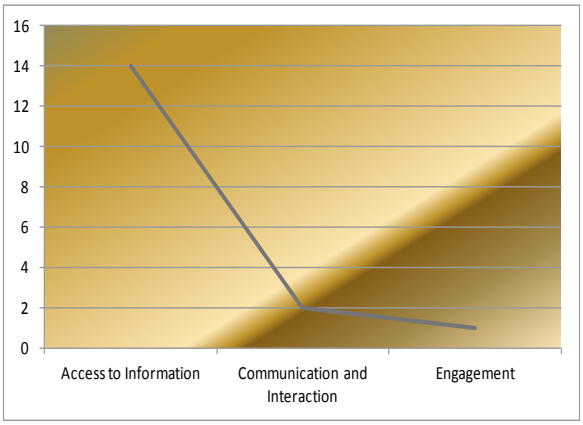
Table 10: Resonance of Phrases

>50%	2
41-50%	2
21-30%	1

Part IV: Engagement of evaluators in nuclear risk assessment and safety

As far as the engagement of evaluators in nuclear risk assessment and safety issues is concerned, out of fourteen, only one respondent said, 'yes'. The respondent was part of a team in the non-profit sector. The report of the evaluation is available for public use on the website.

The overall picture is not very encouraging. All fourteen respondents had access to information, out of them only two had the opportunity to communicate with the relevant persons and only one respondent was practically engaged in an activity related to the Fukushima Daiichi accident. See the graph below.



4.2.5 Conclusions

My take from the above responses is that:

- The evaluators' community has access to information and is well-aware of key issues such as the risk emanating from nuclear power plant and damage caused by accidents as well as consequences in terms of loss of life, radiation exposure, health consequences, displacement of people and need for safety.
- However, this awareness is neither translated into motivation to communicate with the relevant scientific community nor is used to engage in practical experience in the area of nuclear risk assessment and other relevant matters.

- This brings home the point that the channels for two way communication and collaborative action is missing at the moment, for which both parties bear an equal responsibility.
- For the evaluators, without physical presence in the field side by side the scientific community and without direct experience, the process of being informed may not be complete, as explained by John Adams in the diagram presented earlier in this paper.

4.2.6 Lessons drawn

Currently, the risk from the nuclear power plants and other peaceful civil operations is not fully grasped by the people due to power distance between the direct stakeholders, i.e. the government and its regulatory institutions, Nuclear Power Plants (NPP) management, the corporate power sector and the associated scientific community, and the indirect stakeholders including development evaluators, various professional groups in social and humanitarian disciplines, non-profit sector, media, academia and the public at large.

In 1986, when the Chernobyl accident occurred in Ukraine (former Soviet Union) the public did not expect a smooth flow of information knowing the restraint on freedom of press in the former Soviet Union. There were doubts in the minds of people about the quality of plant safety practices and as was later found out, one of the reasons for the explosion at the plant was the human error. We learnt that "(t)he Chernobyl accident in 1986 was the result of a flawed reactor design that was operated with inadequately trained personnel."[52]

It was not the case with Japan as the country has shown political and economic openness during the past many decades and has championed high standards of governance including freedom of information. However, we observed that at the time of Fukushima accident only selected information was relayed to general public supposedly to avoid panic among people due to "very nature of nuclear physics and its apparent complexity"[53]. Japan with her acumen for technological development, innovation and quality standards was expected to maintain excellent safety standards and practices at the Daiichi Power Plant. It transpired that that was not the case. The global community suddenly realized that the country as a whole was insufficiently prepared for the grave emergency caused by the tsunami and the earthquake, and the consequent damage to the power plant.

The civil use of nuclear energy in the case of an accident could be as deadly as any nuclear explosion, only that it targets its own friends. Even if it would not cause direct deaths, it would lead the affected individuals to a slow and painful death through cancer due to radiation overexposure, besides destroying their means of livelihood and polluting the environment for generations.

4.3 A Practical Approach to Nuclear Risk Communication

Based on the above experiments, the question arises as to how the above analysis is translated in to an adequate 'Nuclear Risk Communication' Model? The assumption is that the access to information leads to changes in the behaviour of people and motivates them to take informed decisions. There are three stages:

Stage I: Access to Information
Stage II: Communication and Interaction
Stage III: Engagement and participation

This assumption is derived from the theory of information exploitation and liberation as elaborated by Tim Jordan who while pressing his argument about the 'simultaneous complete use of information', emphatically argued that increasing controls over the level of access to information and involvement minimized the opportunities for consumers 'participation in the making of cultural goods'. [54]

The concept of human rights (right to information/right to know) provides adequate framework to develop and implement the model. It emphasizes on the fact that the access to information as a 'human right' leads to 'empowerment of people' and that the communication helps to built mutual trust and 'shortens the power distance' among stakeholders. In particular, communication between the government authorities and scientific community with specific knowledge, and the general public with skeptical understanding of nuclear risk is crucial in the case of nuclear power.

Trust is crucial in effective risk communication, particularly on issues that directly touch the lives and well being of people like the decision to build a nuclear power facility that not only requires huge investment but also carries tremendous health risks for the population in case of an accident. In experts' view "(t)he immediate issue is a mutual suspicion and loss of confidence in the good faith of the other side."[55] ""Risk Communication" refers to the actions the organization takes to address this loss of confidence. The burden is on the organization to discover not only risk but whether a perception of risk exists, and to initiate contact with the community."[56] In order to dispel the effects of mistrust, it is imperative to engage diverse social and humanitarian groups together with scientific community to lead various streams of discourse and to open multi stakeholders' communication channels.

The above survey analysis verifies that the first step 'access to information' is well functioning for the evaluators' community; however, the next two processes of communication and engagement are

almost non-existent. Considering that evaluation function is a tool for change in the development scenario, the world is not utilizing this tool to its potential. Neither the evaluation community with scanty engagement seems to make an impact on public opinion building on/for nuclear policy making.

Positive 'engagement of actors' on both sides in policy discourse and decision making process is a hallmark of democratic nations. More interaction generates more information as well as feedback from diverse stakeholders and helps to dispel myths about the sensitivity of the subject, thus enhancing chances for stronger support for government policies.

At this point not only that scientist community needs to talk to ordinary people like you and me and explain the risk in case of an accident, safety measures in place and the plausible ways to protect ourselves and our families, but also people should seek information on their own initiative under the Right to Information laws[57]. Preparedness for that eventuality is more important than the idea of maintaining an artificial calm to avoid panic among people. They should not be caught unaware in the middle of an accident.

In practical terms, the existing state of reservation in communication regarding nuclear risk should be flexed and adjusted to accommodate new players/spokespersons from indirect stakeholders' such as professional groups among sociologists, evaluators and journalists. Their roles, responsibilities and obligations in nuclear risk communication should be defined within the context of their expertise.

A new pact based on transparency, openness, information sharing and collaborative action should be signed among the parties to keep the public, and particularly workers in nuclear sector informed on the risk, build their knowledge and capacity on safety to protect them both in normal conditions and in the case of an accident.

Introduction of human rights framework to implement the above model will steer things to fall in place. The union between the 'right to information'/'right to know' and the 'right to occupational health and safety' in the context of UN/ILO human rights instruments will be globally more appealing than the simple advocacy for communication as a management tool. It will receive support not only from national stakeholders, but also from international networks that will fetch indispensable resources to ensure protection of human rights.

Why is it important to invoke international order in the case of nuclear risk? An international order provides safeguards to citizens against both external and internal (state) violation of human rights. Although "… global nuclear energy and nuclear weapons proliferation are not implicated in the kind of human rights violations as are genocide and ethnic cleansing" yet it seems justified "(g)iven the risks of exposure to harmful ionizing radiation arising from nuclear plant meltdowns or an attack on a nuclear facility" [58]

The metagovernance theory as applied to nuclear power argues that "in the face of interdependent networks of powerful societal actors, governments cannot realize their policy through command and control mechanism". [59] This brings my argument on criticality of communication on nuclear risk and safety concerns to the final conclusion that the national authorities, corporate energy sector and scientific community need to treat information as 'not-rival good' and facilitate 'simultaneous complete use' through access to information, interaction/engagement and participation to enrich the' information impoverished parties'. [60]

5. Acknowledgements

As a former IAEA staff member, I had the privilege to use IAEA library extensively and frequently for data mining and literature review. I am grateful to my former colleagues at the library for their continued support.

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