Fukushima Accident: Was it preventable or unavoidable? - A sociological perspective

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1. Introduction

Global renaissance of nuclear energy was widely predicted and accepted before the Fukushima accident of March 11, 2011. The prospects for nuclear energy now appear to face a turn-around point. Serious debates about the adequacy of nuclear power utilization and safety regulation are underway in many national and/or international settings. Many investigations and analyses have been and will be conducted to identify the causes and consequences and to seek lessons to be taken into account in their own nuclear power programs. These efforts evidently will contribute to preventing accidents caused by such extreme damage conditions as Fukushima desperately encountered. But, in order to discuss the future of nuclear energy, new approach to the nature of the accident needs to be sought rather than the usual and conventional way of viewing the accidents with the benefit of hindsight.

This paper examines institutional and sociological aspects of Fukushima accident to get some clues as to whether it was preventable or unavoidable.

2. Institutional failures in historical Accidents of nuclear reactors

It is believed that safety improvements can be made on lessons learned from past accidents or incidents. Actually, many safety features have been and continue to be embodied in nuclear power plants ranging from equipment installation or replacement to additional applications of operating procedures or new programs. However, it seems that many such enhancements are limited to responses to the causes of mechanical failure or human error at the operating frontend. Several studies have been made to address the upper-level factors of organization, institution and social context in which failures are incubated and errors are triggered.

After describing seven classic reactor accidents of NRX, Windscale, SL-1, Fermi-1, Lucens, TMI, and Chernobyl, Mr. David Mosey states in his book of "Reactor Accidents" [1]:

> Institutional failure is rooted in the failure to recognize the long established principle that operational safety in any technology is not solely the responsibility of operators at the man machine interface – that is, the operating institution has clearly definable material responsibilities for safety which may not always be fully understood or adequately discharged by the management of the institution.

He extends his arguments to include the failures of the regulatory authority to discharge its responsibilities to both the public and its licensees. According to his book, four interrelated types of management error leading to institutional failures can be found:

- Misperception of hazard
- Dominating production imperative
- Unassigned/undefined safety responsibility and/or authority
- Denial or unawareness

All the seven accidents had more than one types of management error and as such they are called to be institutional failures (refer to Table 1). It is uncertain that lessons were learned and improvements were made on institutional aspects in nuclear industry. It is also questionable that similar institutional failures don't recur since it is difficult to judge the effectiveness of remedial actions, which usually include changes in personnel attitude, organizational structure and social arrangements, compared to equipment replacements.

Table 1. Institutional Failures in Seven Reactor Accidents

	Date	Rx. Type	Failures
NRX	12 Dec. 1952	30MWt Heavy Water Res. Rx	Production imperative Unassigned responsibility Denial or unawareness
Windscale	7~12 Oct. 1957	Graphite air-cooled Pu Production Rx	Production imperative Unassigned responsibility Denial or unawareness
SL-1	3 Jan. 1961	3MWt natural circulating BWR	Production imperative Unassigned responsibility Denial or unawareness
Fermi-1	5 Oct. 1966	300MWt LMFBR	Production imperative Unassigned responsibility
Lucens	21 Jan. 1969	28MWt Heavy Water Exp. Rx	Misperception
TMI	28 Mar. 1979	2,772MWt PWR	Misperception Unassigned responsibility Denial or unawareness
Chernobyl	26 Apr. 1986	3,200Mwt RBMK	Misperception Production imperative Unassigned responsibility Denial or unawareness

3. Argument that Fukushima was preventable

Fukushima accident belongs to institutional failure, too. It is even said that it represents cultural failure referring to the practice of '*amakudari*' and '*amaagari*' [2]. Considering the unexpected size of the earthquake and tsunami as well as the complicated institutional and cultural deficiency in terms of nuclear safety, the accident seems not to be escapable.

A recent paper, however, argues that it was preventable [3]. The major arguments are:

- Had the plant's owner and Japan's regulator followed international best practices and standards, it is conceivable that they would have predicted the possibility of the plant being struck by a massive tsunami.

- The plant would have withstood the tsunami had its design previously been upgraded in accordance with state-of-the-art safety approaches. Japanese operators were aware of a flooding incident at Blayais Nuclear Power Plant in France in 1999 and they could and should have upgraded Fukushima Daiichi.
- Japan's regulator lacked independence from both the government agencies responsible for promoting nuclear power and also from industry. This is one of the reasons why operator and regulator failed to follow international best practices and standards.
- In the Japanese nuclear industry, there has been a focus on seismic safety to the exclusion of other possible risks. Bureaucratic and professional stiffness made nuclear officials unwilling to take advice from experts outside of the field.
- Those nuclear professionals also may have failed to effectively utilize local knowledge.
- Many believed that a severe accident was simply impossible.

4. Unavoidable accidents: Normal and Epistemic

Until the late 1970s, the question of what caused technological disasters belonged almost exclusively to engineers. By the 1980s, however, social scientists had begun to recognize that such accidents had social and organizational dimensions. One major strand is Normal Accident Theory (NAT) first proposed by Yale sociologist Charles Perrow [4]. His argument is that seemingly trivial events and non-critical failures sometimes interact in unexpected ways that thwart the very best engineering designs and cause catastrophic system-wide failures. He calls these failures 'Normal Accidents'. Dr. John Downer highlights properties of Normal Accidents in his paper [5]:

- Normal Accidents are unpredictable and unavoidable
- Normal Accidents are more likely in 'tightly-coupled', 'complex' systems
- Normal Accidents are unlikely to reoccur
- Normal Accidents rarely challenge established knowledge
- Normal Accidents are not heuristic

It implicitly holds that non-Normal accidents are, in principle, foreseeable. These non-Normal accidents include those that are caused by technological faults but which do not qualify as 'Normal' because they involve linear and predictable interactions. These accidents, he argues, are caused by institutional shortcomings and so fit into the sphere of theoretically avoidable disasters: if engineers are perfectly rigorous with their tests, thorough with their inspections and attentive with their measurements, then such accidents should not happen. The previous argument that Fukushima was preventable seems to be based on its belonging to 'non-Normal' category. In another case of belonging to 'Normal' category, we may feel comfortable to recognize that it is unlikely to reoccur.

Dr. Downer argues, however, that some accidents are not normal but not avoidable either. He suggests new category of disaster−Epistemic Accidents and highlights it in this way:

- Epistemic Accidents are unpredictable and unavoidable
- Epistemic Accidents are more likely in highly innovative systems
- Epistemic Accidents are likely to reoccur
- Epistemic Accidents challenge design paradigms
- Epistemic Accidents are heuristic

Epistemic Accidents can be defined as those accidents that occur because a technological assumption proves to be erroneous, even though there were reasonable and logical reasons to hold that assumption before (if not after) the event. They are unavoidable because engineers necessarily build technologies around fallible theories, judgments and assumptions. What can we do with such epistemic uncertainty that can lead to catastrophe? External threats to nuclear installations are dynamic. In recent years, threats due to natural causes have been augmented by threats from sabotage and terrorism.

5. Conclusions

This paper doesn't make any firm conclusions. Rather, it intends to initiate studies on the nature of accidents that can occur in nuclear power plants in terms of sociological context. If Fukushima accident turns out to have been preventable, then it seems enough to follow the usual way of improving safety through feedbacks from the accident. In case of its being unavoidable, future prospects for nuclear power remain uncertain and will have to be rerouted. Here, an important question remains: what makes an unavoidable accident into the prevented nuisance?

The only barriers to avoiding normal and epistemic accidents may be social, psychological, organizational and cultural ones. Managing the unexpected accidents, rooted in the epistemic limitation of people, need to make strong responses to weak signals, be alert to every small error, and be mindful for day-to-day minor changes. Only social, psychological, organizational and cultural approach could sustain the responsiveness, alertness and mindfulness.

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