



The evolution of the nuclear emergency response plan using mechanisms of learning, innovation and communication

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ABSTRACT

In a modern world, where technological development becomes part of their daily lives, human beings are either consciously or unconsciously submitted to a variety of risks. Considering that any industry generates some type of risk to man or the environment and that to face these risks, it is necessary to develop emergency response plans for those situations, which despite being considered of low probability of occurrence, such as in the thermonuclear electrical energy generation, when they occur, they can have a significant impact on its surroundings. In this sense, this work aimed to identify and analyze the dynamics of preparation and response to possible emergencies in a nuclear power plant, based on the evolutionary change of an emergency plan and, aiming to understand the evolution of these plans, in light of the organizational learning processes, innovation and risk communication. Therefore, the research adopted an exploratory character, seeking evidence in documents, in emergency response planning meetings and in a so-called General Nuclear Emergency Response Exercise, conducting interviews with stakeholders and applying a questionnaire to the population living in the surroundings of the facility. The work also presents a model that facilitates the understanding of the proposed approach and values the importance of participation and cooperation between the actors involved within a perspective with the effective participation of society, confirming, in addition, the importance of the three studied processes, demonstrating that they can be treated and evaluated in an integrated and systematic way.

Keywords: Organizational learning, Innovation, Risk communication, Preparedness and response for a nuclear emergency, Integrated and systematic evolutionary model.



1. INTRODUCTION

Currently, there are 443 nuclear power plants (NPP) in operation [1], distributed over 30 countries, with the purpose of producing electricity from the use of energy obtained from nuclear fission.

Brazil is part of this select group of countries, with the implementation of the Almirante Álvaro Alberto Nuclear Site (CNAAA), an industrial facility located in Angra dos Reis, Rio de Janeiro, comprising the Angra I, II and III nuclear power plants, the last under construction.

Normally, the implantation of nuclear power plants, whether in Brazil or in other countries, is surrounded by discussions on political, economic, social, environmental, and technical aspects, which reflect concerns about the risks and benefits of this application of nuclear energy.

To address these concerns and contribute to the establishment of an adequate level of safety for the regions surrounding these plants, most countries implement some type of organizational structure, considering different national stakeholders, which, among other attributions, is responsible for the preparation and response to nuclear emergency situations.

Actions to prepare and respond to emergency situations are complex and multidisciplinary, demanding continued learning from the people and organizations involved, acting in an integrated way, having, on the other hand, the ability to innovate based on real and simulated experiences and the establishment of communication channels between participating organizations of the emergency preparedness and response system and the public directly involved.

With the purpose of identifying and analyzing the dynamics of elaboration and improvement of the preparation and response to emergency situations at CNAAA, the work carried out intended to understand the evolution of this system over time and its synergy with the processes of learning, innovation and communication.

Therefore, the research was divided into the following specific objectives: (1) To examine the characteristics of an emergency plan, highlighting its evolutionary dynamics; (2) Identify the internal and external actors, or stakeholders, involved in the construction and improvement of the Emergency Plan; (3) Analyze the learning process, highlighting the actions and methods used to appropriate knowledge; (4) Investigate the predominant type of innovation in the Emergency Plan

and the relevant attributes for its dissemination and; (5) Investigate the Emergency Plan's risk communication process, verifying practices, types of communication channels used and factors that may hinder the effective establishment of communication.

Thus, in the end, the research can confirm the importance of learning, innovation and communication processes for the evolutionary dynamics of the CNAAA Emergency Plan, perceiving that they can be treated in an integrated and systematized manner, enhancing and valuing participation and cooperation between the actors involved (organizations and local population), within a not only scientific-institutional perspective, but also a socio-participatory one, which contributes to the improvement of the dialogue between the Government and Society.

2. MATERIALS AND METHODS

An exploratory research was carried out, respecting the following steps: (1) the bibliographic survey, where the main concepts used were deepened; (2) the analysis of examples that encourage understanding, allowed the deepening of specific questions about the preparation and response to an emergency situation, including participation in meetings of planning committees for emergency situations and direct observation of the General Exercise of Nuclear Emergency Response - 2013; and (3) the interviews with stakeholders who had practical experience with the subject, were carried out following a script that included concepts identified in the literature and documents inherent to the emergency response plans at CNAAA. Some representatives of organizations participating in the response and members of the Praia Vermelha Residents Association were submitted to this procedure, to collect information that allowed supporting the arguments and assertions about the response plan, from a systemic perspective related to the processes of learning, innovation and communication.

Complementarily, a questionnaire was applied to the population of Praia Vermelha, as it was perceived the need to conduct interviews with more focused and objective questions, aiming to capture the perceptions of part of the population about the emergency response plan.

In addition, interviews with representatives of organizations allowed collecting qualitative evidence from the interaction with actors, Government and Society, involved with the emergency

response plan, providing the discovery of new perspectives and elements for the development of the research.

3. RESULTS AND DISCUSSION

After analyzing the various forms of learning processes and how these are considered in CNAEA emergency response planning development, it was possible to obtain greater clarity on the importance of this process, considering its multiple dimensions that sometimes overlap and feed themselves [2], contributing to the prospection and detection of new possibilities and ideas. These are observed in the evolutionary dynamics of the CNAEA Nuclear Emergency Response Plan through doing, using, interacting, adapting and failing. Those practices highlight the transversal characteristic of organizational learning within the emergency planning system.

The work carried out also identified that the natural trajectory [3] of emergency preparedness and response in a nuclear power plant is characterized by incremental innovations [4], which are presented from a dual perspective, based on the concepts of Demand Pull and Technology Push [5-8].

It is known that the implementation of nuclear power plants in a country involves issues that contribute to the induction of technological demands that influence both the trajectory and the rate of innovations adopted by the nuclear emergency preparedness and response system considering the permanent need to increase the protection of the local population and the environment. This clearly ends up influencing the perceptions of the risk associated with the use of nuclear technology.

On the other hand, no less important, is the approach based on the concept of impulse for technology, which in a version considered [6] less deterministic and is known as impulse for organizational capacity [3].

When we consider that the availability of technological resources plays a determining role in the rate and direction of innovation within organizations [6], we understand the importance of organizations investing in generation of knowledge to expand their absorptive capacity [9], to enable exploring new opportunities.

The evolutionary dynamic consists of incremental innovations that are either induced by internal or external demands, guided by scientific and technological advances, thus promoting learning and increasing technological capacity in organizations.

To better understand the risk communication process, a questionnaire was applied to the population at Praia Vermelha, and it allowed us to identify and verify that:

- there is an absence of fear, from the nearby living population point of view, related to the NPP;
- the population is unaware of the possible risks associated with day-to-day activities at CNAAAA;
- wrongly practiced procedures have the potential to produce negative changes in risk perception;
- improving access to information is a key factor in reducing the population's uncertainty about the activities of the plant and the emergency response plan;
- the existence of formal and informal relationships with NPPs workers and participants in the emergency response system, providing a certain "know-who", which can be useful in times of crisis;
- the existence of some residents with an effective or temporary employment relationship in the NPP, results in the existence of people in the region with more specific and advanced knowledge about existing plans and actions;
- the recognition by the population that the organizations participating in the response plan have a high degree of technical knowledge;
- there are evidence points related to the existence of a path of gradual increase in the level of confidence in the emergency system;
- the innovations introduced at Praia Vermelha, in the last two exercises, related to the use of navy vessel, sheltering and distribution of potassium iodide tablets, contributed to improving the population's perception of the emergency response plan evolutionary process;
- there is a need to bring the organizations, participating in the emergency response, closer to the population and workers, especially outside the period where general exercises are carried out;

- it is important to take into consideration the period for performing general exercises, during high season and or weekends, due to the travelling population;
- the adoption of a strategy to improve the emergency plan and conditions for carrying out the planned actions, whenever possible, in line with the population's demands for improvement of the local infrastructure;
- the need to establish formal protocols for organizations, to work with the local population whenever any type of failure in emergency preparedness and response procedures is observed; and
- the need of the establishments of specific communication and training actions for their professionals.

Thus, considering the relevance of organizational learning, innovation and risk communication processes in the construction of the evolutionary path of the emergency response plan at CNAAA, allowed us to identify and understand the relationship between these processes and their importance (Figure 1).

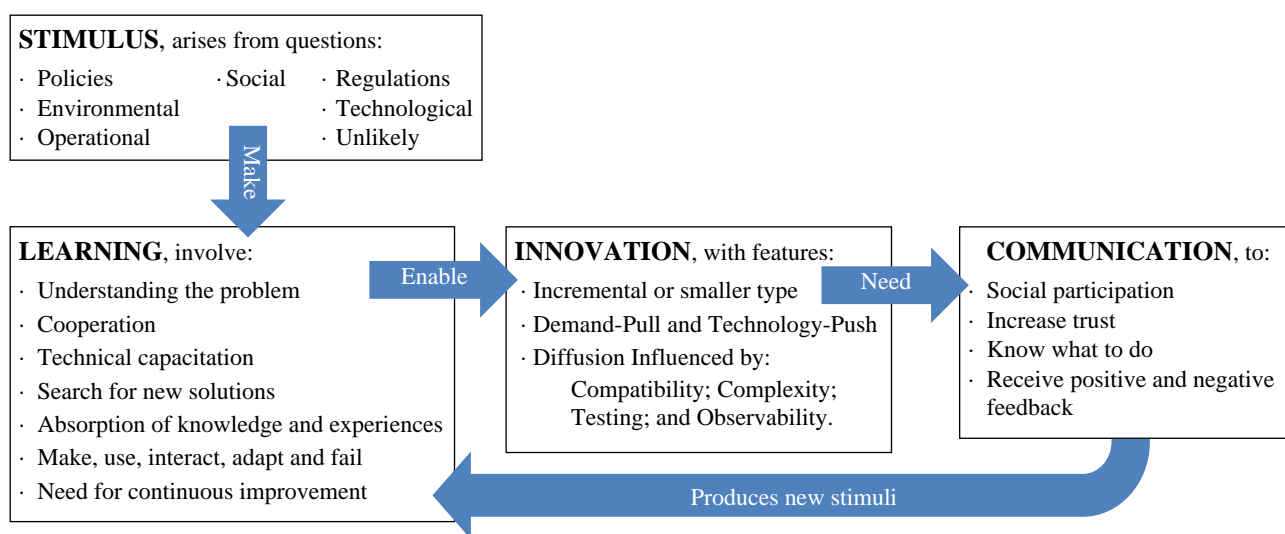


Figure 1: Systematization of the Dynamics of the Emergency Response Plan of CNAAA

Source: Adapted from QUADROS, 2014 [10]

This systematization is based on the evidence that indicates that the improvement of the emergency plan and its evolutionary dynamics are influenced by stimuli that drive and demand, to

in some degree, to a reaction that is motivated by political, social, normative, environmental and technological issues.

The need to respond to these stimuli can motivate the search for a better understanding of the problem and for new knowledge for its solution, contributing to the increase in the absorptive capacity of organizations [9], obtained through the various dimensions of learning related to doing, using, interacting, adapting and failing. This accumulation of absorptive capacity within organizations promotes the emergence of new ideas and the development of innovative solutions, which are important for the plans continuous improvement process.

Learning initiatives and knowledge production in the context of the emergency system are fundamental for the development [11,12] of the emergency plan. In this respect, the importance of interaction and cooperation between the various stakeholders involved is highlighted, given the multidisciplinary and social characteristics related to the plan and the need to consider both the use of existing knowledge and skills and the exploration and experimentation of new alternatives [13].

It is believed that the organizational learning and innovation process is at the heart of the emergency system itself, through the performance of the participating organizations. On the other hand, it is considered necessary for the successful adoption of innovations in the emergency response system that these are communicated to the population, which benefits from the new solution.

To better understand the risk communication process between the emergency response system at CNAAA and the surrounding population, represented by residents and workers, the identification of the perceptions that this population has about some aspects of the plan was considered as a starting point.

Therefore, understanding that risk is a social object and that it would not exist without a population or individual who perceives it [14], the research intended to identify the perceptions of the population living in Praia Vermelha, through the application of a questionnaire containing eight questions, whose results are summarized in Table I.

Table I: Summary of the results of the questionnaire applied to the population of Praia Vermelha

Question	Result
Has the feeling of risk of living or working near the Nuclear Power Plant reduced over time?	72% said they had never been afraid to live or work until 5 km from the NPP.
Were the exercises for evacuating the population by sea, sheltering and distributing potassium iodide tablets important novelties presented in recent exercises?	83% considered these actions good or very good.
How do you assess the degree of technical knowledge of organizations that work in the emergency actions planned for your location?	72% perceive organizations participating in the emergency response plan as having a good or very good level of technical knowledge.
How do you assess your knowledge of the actions planned in the Emergency Plan?	70% consider that they have good or very good knowledge of the plan's actions.
Before carrying out the emergency exercises, have you observed whether the population is informed about the activities planned for your location?	72% said they had observed activities promoted by organizations participating in the plan, in order to inform in advance, the actions that would be carried out in general exercises of 2013.
Do you receive enough information about what actions to take in the event of a nuclear emergency?	70% feel they are getting enough information about the Emergency Plan.
Would you like to submit proposals for improvements to the actions of the Emergency Plan planned for your location?	59% say they have little or very little interest in presenting improvements for emergency actions for their locality.
Have you noticed whether after the emergency exercise is carried out the population is consulted on which points could be improved?	76% did not observe contact with the population to receive their feedback on the activities carried out during the general exercise of the Plan.

Source: QUADROS, 2014 [10]

Thus, the risk communication process, in the proposed model, takes place in the relationship and establishment of bidirectional information flows, between the emergency response system and the population potentially affected by the presented innovation.

In response to the stimuli and information received, this population can produce a feedback effect, producing new stimuli, demands, doubts, suggestions, proposals, and messages that would be transmitted from the population to the emergency response system, which can promote the beginning of a new cycle of search and accumulation of knowledge [2].

4. CONCLUSION

From an approach based on organizational learning, innovation and risk communication processes, new perspectives and contributions were presented for understanding the evolutionary dynamics of the CNAAA emergency response plan and its improvement.

The work highlighted that the evolutionary dynamics of the plan has a multidisciplinary, multi-organizational and cooperative character. In addition, the work contributed to discussions on some points for improvement, particularly about the transformation of the local population into an increasingly active and participative actor within the dynamics of improving emergency response planning.

The emergency preparedness and response system have its backbone based on routines, codified in plans, norms and procedures, and non-codified, incorporated in the practices of individuals and organizations. These routines and their modifications over time are established as genes [15] that store information, memories of this system, preserving its past and enabling the repetition of already consolidated practices.

This organizational learning is born from learning-by-doing and using routines that are improved and promote the specialization of knowledge within this system and influence its future trajectory, its development.

The buildup of experiences and knowledge [16] that influence the evolutionary dynamics of the plan, allows the increase in the absorptive capacity of the participating organizations, enabling them to take increasingly challenging steps.

The experimentation of new scenarios, resources and possibilities are an important factor for the balance between the use of existing competences and the expansion of the knowledge frontier in the emergency response system.

Thus, it is concluded that this system is being improved over time through a double influence, which lead to discussions about how much and how *Demand Pull* determines the rate and direction of emergency planning actions and, on the other hand, how the availability of technological capabilities and resources - *Technology Push* contribute to the evolutionary dynamics of emergency planning.

The research allowed us to observe a path of gradual evolution in the risk communication process of the CNAEA Emergency Response Plan, with actions being carried out since the 1980s and which show the expansion of the population's access to information about the plan.

However, there is a need to improve formal communication channels, aiming to expand the socio-participatory characteristic of the plan, which is considered important for increasing the confidence of the local population and establishing commitments that contribute to reducing tensions between skepticism layperson and professional expertise [17].

Finally, it is important to reiterate the importance of organizational learning, innovation and risk communication processes related to the nuclear emergency response system, valuing the participation and cooperation between the different stakeholders that are involved, which includes the population potentially affected in the event of an emergency.

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