Psychological empowerment in French nuclear power plants

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Abstract: Since the eighties, nuclear safety has been discussed in organizational studies and constitutes nowadays a specific stream with several standpoints. Regarding the reliability of nuclear plants, the nuclear safety literature has emphasized on the crucial role of individuals and human factors. Especially, some researchers have noticed rule breaking behavior and the impact of individual self-confidence on the behavior; but without deepening their analyses. As high self-esteem and confidence, *i.e.* psychological empowerment, naturally lead to innovation and rule breaking, the behavior can be analyzed, in such a regulated industry, as opposite to safety. Thus, this article aims at explaining the roots and discernable features of the observed psychological empowerment. Methods include an in-depth qualitative study in 4 nuclear power plants owned by Electricité de France (EDF), the French national nuclear operator. Focused on the leading team of the plant, the set of data is composed of 35 interviews, 6 weeks of non-participant observation and internal documents. The content analysis has revealed two main pillars of psychological empowerment. On the first hand, the strong professional identity developed at the opening of the plants is based on initiative and risk-taking. In some ways, this professional identity fostered by commitment to a demanding job and the team, influences behavior more than do professional rules. On the second hand, the management discourse is perceived as ambiguous towards the strict application of the rules and tacitly legitimizes rule breaking behavior. This article details and exemplifies these phenomena and discusses the implications.

Keywords: psychological empowerment; professional identity; rule breaking behavior

1 Introduction

Since the first nuclear power plant openings 35 years ago, nuclear safety has been at high stake for each nuclear country, leading to the creation of several international and national associations. Today, nuclear safety is ensured by many different and complementary mechanisms: formal and national procedures, external and internal controls of technical and managerial aspects of plants, and feedback learning are all attempts to minimize the dangers of running a nuclear power plant. These precautions, however, cannot ensure that there will be no incidents caused by technical or human failures. With technical improvements, individuals appear as the weak part of the chain. Therefore, the main purpose of nuclear safety research is to create processes and organizational environment facilitating the individual and team accuracy; through learning and professionalization for example.

Nuclear safety literature has overlooked some crucial aspects for the understanding of nuclear safety; the micro-level, the individual level and the consequences of being part of a high-reliability organization (HRO). Research has never studied potential consequences on human behavior: To which extent can constant training lead to over-confidence? To which extent can professionalization lead to individual initiative? What is the limit between appropriate and risk-taking behavior? While the crucial aspect of these questions has been underlined by the literature, they have yet to be fully analyzed. This article aims at explaining overconfidence, the psychological empowerment noticed in literature and observed in our case study. In the modern rationalized world and more especially in such a regulated industry, psychological empowerment is a crucial issue at least in two ways: it allows for innovation and creativity to improve the system, but also regulates overconfidence to potentially dangerous levels. For this reason, we first summarize the literature and the need to appeal to other sets of research. In the second part we describe the case setting and methods before presenting our results.

Received date : September 3, 2010
(Revised date: December 16, 2010)

2 Rule breaking and psychological empowerment in nuclear safety

Until now, two schools of thought have constituted the basis of nuclear safety literature in the organizational field[1]: normal accident theory (NAT) and HRO. Completed with the human factors approach, these streams offer some insights and illustrations of rule breaking and overconfidence behavior in HRO, and in particular within nuclear plants. However, the understanding of these phenomena is still limited and especially has not been deepened at the individual level. In this article, I suggest taking an enriched look at such behavior, using meaningful factors such as risk underestimation and psychological empowerment.

2.1 Rule breaking and overconfidence in nuclear safety

Nuclear safety can be understood from two main perspectives: an optimistic one – considering that some specific conditions can prevent accidents; and a pessimistic one – assuming that accidents will inevitably occur.

The HRO stream is based on the basic assumption (seen as unrealistic optimism by the NAT defenders) that shared organizational goals and adequate organizational processes and culture should prevent accidents. Complex and hazardous organizations like nuclear power plants could thus be made highly reliable. Consequently, the main focus of HRO studies is to underline and generalize the necessary conditions of several types of HROs, including nuclear power plants (for a review of those conditions see, for example, Roberts 1990) [2].

Initiated by Perrow with his book "Normal accidents" in 1984, and taken up notably by Sagan [1] and Vaughan [3], the NAT stream controverts the HRO's organizational vision. An organization, it argues, is not a closed and rational system, but a natural open system both influencing and being influenced by its environment and political forces. Claiming the garbage can model, the NAT defends a more political vision of organizations, including organizations characterized by tight coupling and interactive complexity, such as nuclear power plants.

Although some researchers have tried to overcome the differences between those two streams [4, 5], the debate probably makes even less sense now [6]. Moreover, these attempts have overlooked the micro level of analysis.

On the HRO side, while promoting constant training, professionalization and organizational learning obviously makes sense, potential consequences on human behavior have never been studied. Some questions are legitimate and would enrich our knowledge. To which extent can constant training lead to overconfidence; and professionalization to individual initiative? What is the limit between appropriate and risk taking behavior? If the crucial aspect of those questions has been underlined by the literature, they have yet to be fully analyzed. As an illustration, Rochlin [7] pointed out the duality of risk representation: how can an operator at the same time have high confidence in the inherent quality and design of the equipment and still remain alert and attentive for weak signals? According to Rochlin [7], one of the most remarkable findings of the HRO team is the ease and unselfconsciousness with which operators appear to maintain this duality of representation. Similarly, Bourrier [8] noticed the place of group identity and rules violation in nuclear power plants, but his analysis was not deep enough to deal with the complexity of the issue. Finally, Doniol-Shaw [9] described how the imperfection of rules compels sub-contractors of EDF to actually transgress rules to do their jobs.

On the NAT side, researchers have demonstrated how bias of decision making could lead to overconfidence and some other specific behavior, such lying as a result of being blamed for failure or pursuing self-interest in opposition to organizational objectives. In the same way, redundancy is neither a guaranty of safety nor desirable for at least two reasons. Redundancy often means a duplication or overlapping system that increases interactive complexity and encourages operators to run more risks. Beyond those observations, the NAT does not propose any in-depth analysis or conceptualization.

The human factors approach has developed some research focused on transgression and rules violation

in HRO [10, 11]. Reason [10] emphasized the place of human contributions in catastrophic accidents and especially suggests an error classification, including not only slips and mistakes, but also routine and exceptional violation. In this article, the author of this paper would like to focus on routine violations. This is as such behavior that involves habitual deliberate deviations from the written rules, which may become an integral part of a skill [11]. In her research on English railways, Lawton suggested several reasons for professionals' routine violations – time pressure, high workload, self-pressure or external pressure to do the job more efficiently – and also related skills to violation. More particularly, high self-esteem and self-confident workers reported more violations.

In conclusion, nuclear safety literature is more focused on the organizational level and processes than on the individual level. In addition, it does not provide potential reasons and consequences of the prescribed conditions – such as intensive training or professionalization. Instead, it simply underlines the potential risks of self-confidence and rule breaking in a regulated industry. Regarding the nuclear safety literature, the fact that self-confidence and rule breaking occur eventually is not that surprising. In the next section, I first take a look at the risk perception literature that confirms this analysis. Secondly I would like to suggest, based upon my in-depth qualitative analysis, the apprehension of these behavior using the concept of psychological empowerment, which offers a better understanding of our observations.

2.2 Risk underestimation and psychological empowerment

Research on risk perception and interpretation bias in organization [12-14] have shown that risk-taking behavior may occur in any organization, including non-expected organizations such as nuclear power plants. The individuals' natural tendency is to underestimate risks [12]. On the one hand, risk perception is shaped by pervasive optimistic bias, as illusion of control or self-confidence, leading people to take risks that are more important than they appear [14]. On the other hand, Denrell's adaptive sampling model implies that access to information about foregone actions may increase risk-taking behavior [13]. Lastly, reproduction of success generally creates some biases limiting risk-taking behavior. Two modulating factors have been underlined [14]: slow and imprecise adaptation would increase the frequency of risky and novel activities. The rapidity of adaptation is slowed by any rules, norms, or beliefs associated to ideology or social legitimacy, while the precision of adaptation depends especially upon the possibility to determine the outcomes and the interpretation of experiences. In this perspective, nuclear power plants constitute an interesting setting which may actually stimulate risk-taking behavior. Indeed, rules and norms are based on ideology and social legitimacy and are often subject to several interpretations.

On the opposite side, literature has shown that overconfidence and optimistic bias could logically lead to risk-taking and rule breaking behavior. To enrich literature and suggest an individual and in-depth understanding, the author of this paper would like to introduce, based on my empirical data, the notion of psychological empowerment. Defined as the motivational concept of self-efficacy [15], psychological empowerment is a cognitive perception leading to innovation and creativity [16], and encourages both organizational commitment and risk-taking [17-19]. This is one way to create room for maneuver in everyday activities, and also innovate and depart from the rules. In this sense, psychological empowerment is different from other concepts such as delegation: this is not a policy or incentive coming from the management, but is rooted in individuals. An organization will never empower all its members; and the same individual will not feel empowered in every company. Psychological empowerment depends upon certain criteria, such as working conditions [20], access to information, and self-esteem or reward system [15]. Psychological empowerment results from the combination of four main components: *meaningfulness* – how meaningful and important to me is the work I do? *Self-efficacy* [21] – am I confident in my ability to do my job? *Self-determination* – do I take decisions and carry their responsibilities in my job? And finally *impact* – do I produce intended effects on my environment? Psychological empowerment stems from a 5 stage process [15], from conditions leading to a

psychological state of powerlessness (organizational factors as working conditions or access to information) to behavioral effects. Resulting from self-esteem and self-efficacy, empowerment usually leads to innovation, deviance and overconfidence [15, 22]. Psychological empowerment, through its psycho-individual roots and superior suitability to organization studies than self-confidence, enriches our understanding. In such a rationalized world, and more especially in such a regulated industry, psychological empowerment is a crucial issue in at least two ways: allowing innovation and creativity to improve the system but also regulating overconfidence. The above methods and results sections will exemplify and discuss its relevance.

3 Methods

Methods involved an in-depth case study in 4 nuclear power plants, owned by the French national power producer Electricité de France (EDF). This case study is an extreme case, as defined by Yin [23]: the risk and uncertainty associated with rules breaking and empowerment is particularly high in nuclear power plants. The potential dramatic consequences make an example of this case.

3.1 Case setting

In the eighties, France had a stake in its energy independency. This political purpose found expression in a national project: 19 nuclear power plants and 57 reactors built in less than 5 years, producing 90% of French energy consumption. The conditions of the nuclear plants' opening have definitely marked identities and behavior towards the rules: France had no managerial experience in running nuclear power plants and this lack of knowledge partly explains both the excitement and liberty of operators. At that time, no formal rules governed workers' actions: operators would learn by a trial-and-error process, record their insights and processes, and share that experiential learning. Operators gradually created rules of operation, which became official and regulated norms in 2000.

This nuclear safety enforcement is an interesting research setting for studying rule breaking and empowerment. Learning by doing has been fostered by the organization, aiming at learning the best way to conduct the plant management as fast as possible. After 20 years of nuclear operation, the learning process has almost been achieved. Therefore, requirements evolved towards assessing the context and applying appropriate official rules. Officially, the place for rule breaking and empowerment is limited.

At this point, a brief incursion in the functioning of the plant, and especially of the team and actors observed and interviewed, is probably relevant. A nuclear power plant is divided in different services: maintenance, electricity, automation, and operation the crucial one the author of this paper would like to focus on. To run a plant, 7 teams of 10-13 individuals work in shifts, all year long. During their shifts, those teams have the responsibility of running the plant safely. Each team is led by the foreman and his adjunct, ultimate decision makers, 3-4 operators handling the plant from the control room in coherence with the 5-6 technicians working on the installation. The author of this paper observed and interviewed the 3 different roles within a team: leader, operator (operational decisions, revised by leaders if necessary) and technician (discuss and apply operators' decisions). Safety and production responsibilities are shared among members: each role implies decision-making, action and room for manoeuvre. Each actor is accountable for his own intervention, even though teams are usually in solidarity. As an illustration, technicians usually discuss their interventions on the installation with at least one operator, but once on the field, they act on their own, without any control. This structure leaves space for rules violation. Rules violation is defined here as a violation or non-application of the official or tacitly admitted rules. As described, rules violation can cover a wide variety of situations. As an example, at each alarm in the control room, operators should check the name of the alarm on the monitor, go through the official specifications of the alarm, understand where the problem is coming from, and eventually stop the alarm. However, alarms are so usual and happen so many times in a shift that nobody strictly applies the rules. Following the same example, violation of the tacit rules would be not looking at the alarm at all, or stopping the alarm without either looking at it or checking the control room. The author of this paper's purpose in this

article is not to focus on the obvious discrepancy between official and non-official rules, but to understand the underlining mechanisms of the observed behavior.

3.2 Data collection and analysis

To understand the phenomena, the author of this paper worked intermittently for 4 years at EDF and used multiple data collection sources. the author of this paper signed a year research contract, and extended for one more year, which offered the possibility to deepen my knowledge of the nuclear field by holding many meetings and interviews with nuclear engineers and trainers (15 interviews). During my in-depth analysis, the author of this paper led 39 interviews with 10 foremen, 17 operators and 12 technicians. In addition to those interviews, the author of this paper had done 6 weeks of non-participant observation, following 6 teams from 4 nuclear power plants. During the observation, the author of this paper experienced the life within an operation team: the author of this paper was on the field with technicians, in the control room with operators, in meeting with foremen. The author of this paper took 80 pages of notes explaining in detail observed situations, events and accidents: briefing, debriefing, and decisions in various situations (normal production, slow production, strike, beginning of one reactor, and significant incidents). Notes range from decision-making during a meeting, observation of a technician on the field, to the conversation during dinner. Informal exchanges, rich to the author of this papers' study, have been collected on the logbook, filled after each day and each interview.

For the data triangulation as were made by Eisenhardt[24] and Yin[23], the author of this paper also studied many documents: internal such as procedures and notes, and external such as nuclear safety authority reports and discourses about nuclear practices. All interviews, except one, have been recorded and transcribed. The data represented 60 hours and almost 1000 pages. The questions were not directly on rules violation and self-confidence. The author of this paper's research was presented as identity-oriented. The main question was "*What is being a professional in the nuclear field?*" The author of this paper's stimulate questions were about what makes a good/bad professional in action, and the place of rules and decision-making.

The author of this paper followed an iterative analysis of the qualitative data, moving back and forth between collection, analysis, and literature. The author of this paper proceeded to a content analysis of interviews. The author of this paper first discovered any transgressions told or observed and then focused on their main sources. Once psychological empowerment appears to be the best concept to understand the phenomenon, the author of this paper coded the 4 components of the concept (meaning, self-determination, self-efficacy and impact) and it appeared that 93% of interviewees were empowered. The author of this paper was finally able to determine the sources of this psychological empowerment. The author of this paper found that two main reasons were covering 76% of quotations and therefore express sources of violation as perceived by interviewees. The professional identity appeared as the main explanation of the observed behavior. Professional identity is defined as "the relative stable and enduring constellation of attributes, beliefs, values, motives, and experiences in terms of which people define themselves in a professional role" [25] and is characterized in this article by two main features, representing 68% of quotations. An analysis of individual specificities towards professional identity would be interesting, but it is not part of this project. Those analyses, combined and reinforced by the author of this paper's in-situ observations, constitute the basis of the results, exposed in the next section.

4 Results – sources of psychological empowerment and rules breaking

As described in literature and observed in the author of this papers' case study in France, some rule breaking and overconfidence behavior take place in high-reliability organizations, such as nuclear plants. This article aims at explaining the underpinning mechanisms of these behavior by using the concept of psychological empowerment. The qualitative analysis helps the author of this paper to come up with two main mechanisms: professional identity and management discourse ambiguity.

On the first hand, a strong professional identity based on initiative and risk-taking has been developed thorough the years. In some ways, this professional identity, fostered by commitment to a demanding job and self-confidence, would shape such behavior. The author of this paper would like to develop below the main characteristics of this professional identity, as described by its actors, and discuss how it fosters psychological empowerment.

On the second hand, the perceived ambiguity of the management discourse towards rules application appears to be determinant in individual behavior. The author of this paper would like to explain how this perceived ambiguity tacitly legitimizes rules breaking and reinforces professional identity.

4.1 Nuclear operator professional identity

The opening, in the eighties, of French nuclear power plants required knowledge acquisition in several domains: civil engineering, enriched uranium conversion and nuclear operation. More particularly, nuclear operation teams were composed of new hiring and previous thermal power station operators. Without any experience in nuclear trade, these operators had to figure out their job duties and create what would become the standards of this new corporation. Individual and collective competencies and corporate professionalism have been developed through experience, learning by doing, trial-and-error, and failure. At this time, a nuclear operator learnt to assess situations, make a professional judgment and build adequate responses. The two main virtues of a nuclear operator became experience and innovation, fostered by the know-how and the 'feeling' of the plant (smell, sound). Built and shared over the years, this ideal conception of a professional operator, to which the author of this paper will refer to as professional identity in the author of this papers' article, is still vivid in 2010. Its spread throughout the years is not really surprising: in a beloved lifetime job with quasi-null turnover, operators are recognized by their peers and rewarded by the management based on their experience and know-how. The omnipresence of the elders in apprenticeship and training processes, as tutor and trainers, solidifies this respect and adoration of experienced workers.

Professional identity and behavior have mainly been shaped in this context, fostering innovation, experience and rules improving.

"We (the elders), we arrived in a brand new plant; we were the nuclear pioneers, and we were looking forward to learn. Nobody was able to teach us. So we went on the installation, we worked, we snooped around to understand its functioning."

After 25 years of nuclear operation, there is little place for learning: this is not about exploration anymore but rather about exploitation [27]. The rules, created, tested and amended by operators, have become constraints and official rules. The official conception of the profession has literally changed: the strict application of rules in a normative and regulated environment is now relied on more than experiences and searches.

"This (nuclear operator job) is more and more normative, we fill wretched papers all day long, just to fill wretched papers…this is insane, we have created these rules and now we just fill tons of paper proving we apply those rules, rather than improving the system and our competencies."

Beyond noticing the crucial place of professional identity in behavior, this articles aims at specifying the two main features of professional identity fostering psychological empowerment, as described by members: commitment and self-confidence.

The first dimension of professional identity, evoked by all the interviewees, is a physical, moral and emotional commitment.

"Being a nuclear operator, this is above all being available, in solidarity and committed."

Staying after a shift, coming in during days off, and in case of emergency, helping colleagues during holidays, are not exceptional behavior. Professional commitment is also synonymous with mutual help; collective problem solving to ensure both safety and production. The organizational structure emphasizes – probably voluntary – this commitment: a demanding job in shifts within one same team, usually for years, sharing meals, Christmas Eve,

missed weekends and birthdays, incidents at five in the morning. This team life fosters commitment within the profession and the team, but also because commitment is useful in spare time and management of critical situations.

"According to me, the main idea is being available, again and again. We are here for the colleagues, we need to be in solidarity, otherwise it can't work. Me, for example, I easily come during my days off. Don't kid yourself, this is part of the job, this is being a real professional. And you are here for the team and the team is here for you."

"The leading team? This is a world apart. It is easiest to divorce from your wife than from your team. You share 8 hours a day with your team. We dress together, we eat together, we talk together, we live together, usually in the same housing estate. We share the same concerns; we work together at Christmas, Easter. We have the same difficulties toward our families; our kids are in the same school…it is part of the meaning of the job."

If this first dimension is not surprising, the second one evokes self-confidence and even overconfidence. This high self-confidence finds its expression in two ways: first, a clear affirmation of operators towards their skills, and second the complex dialectic between high responsibilities, risks, stress and fear.

On the one hand, being a professional is by essence being self-confident and having no doubts in one's own skills: they have to be able to handle every potential critical situation properly. An operator with a low level of self-confidence would probably not be able to react efficiently and promptly to a new situation. Official rules are a necessary support but not a sufficient one: questions of specific context, problem solving and tacit knowledge arise. The nuclear operator thinks himself as a more complete and adaptable defense line.

"The nuclear safety audit? I don't care, I always do well my job. I know my job."

"When there is an incident, we are always told by the management that this is a human error, but given the lamentable work conditions we have, of course we make mistakes."

"Procedures can't be exhaustive, otherwise for each situation you would have to foresee each case, and this is impossible. And even if it were possible, after you have to learn how to manage it. It would be intellectually insurmountable. And it would not be possible to use our intelligence anymore. Smart people need to understand what they do. As an operator, this is where I stand, I am here to think, I am a defense line which uses procedures and not the opposite."

This self-confidence stems also from the seeming opposition between awareness of responsibilities and lack of stress. If operators are aware, and even proud, of their crucial role in nuclear safety, those responsibilities do not generate any stress or doubts. Being innovative, rigorous, creative problem solvers is part of the job. Various technical challenges create the willingness to master the plant and maintain an enjoyable working environment. Responsibilities, underlined by every interviewee, are more a commitment factor than a source of stress. The stress is reduced by self-confidence, confidence within the team and the plant. Moreover, the lack of major issues or mistakes, meaning a lack of confrontation to reality, probably reinforces this illusion of control and competence [13].

"I have never been annoyed. I have never been afraid. Oh yes, I could have been afraid sometimes when I was on a night shift and I had to do the patrol, because sometimes we could see some coypus or cats, things like that. Cats were not chickens, they were fitting."

"Responsibilities, we know them and we live with them. We know exactly in real time what is happening. The nuclear is not the most important risk, the most dangerous ones are pipes with 600°F hot water, 70 bars of vapor; if it broke, it rips off your head. You are not afraid otherwise you do not go. When you are new, you are not aware of what it is. But you know, while driving you car, you are a postponed dead."

Psychological empowerment is fostered by those aspects of professional identity but also by the perceived ambiguity of management discourse.

4.2 Ambivalent management discourse

The perceived ambiguity of the management discourse towards rules application appears to be determinant in individual behavior. More especially, this perceived ambiguity tacitly legitimizes rules breaking and reinforces professional identity.

As described above, rules enforcement rigidity took place in 2000. Logically, the management discourse has evolved in parallel. The new constraints appealed to many changes in the working and training processes, and in the expectations towards operators. In particular, tracking and traceability are ever present. Operators must fill official forms, tracking the reasons of each decision. Therefore the management has supported the newly expected behavior by a discourse enhancing the benefits of traceability, the interests of forms and rules in nuclear safety. This official discourse is supported in different ways: changes in training process, nowadays focused on applying procedures and adopting a nuclear safety culture; increase of expectations, implying written justifications and controlled decision-making processes.

In parallel to rules enforcement and official discourse, operators perceived an unofficial and tacit discourse:

"*Tacitly, we all know that olds ways of doing things are allowed, they know we don't really follow the new rules and expectations; this is tolerated and even more, promoted."*

This perceived unofficial discourse comforts operators in their perception: as professionals, they do not need external constraints and justifications to do their job well.

"You have to know this classical joke in nuclear plants: do you know why it runs so well? Because we do not follow rules! I experience it and this is exactly what happens. If you'd just have to follow some rules, you'd buy a robot. We are here to apply written rules, but also to not apply such rules. And we do not need anyone or any stupid discourse to explain that. You never really know what is the management positioning: applying rules or not, being transparent or not."

The management, aware of this fact, would then foster transgression or at least non-strict application of the rules. Faster, cheaper and more efficient work would be their motivation.

"*Implicitly, the fastest worker will be congratulated; nobody wants to know how he made it. Nobody cares. The job has been done faster, that's great and that's it."*

An illustration could be the way management tends to hide error, mistake, and well-know transgressions from external audience. They do not blame the worker who in return feels encouraged to work faster.

"*Everyday you are confronted to two opposite discourses. You have the safety/security discourse but you also have the economic one. And now I have understood this is the same thing for failure management. Now, you cannot close the plants because we don't follow the rules. Sometimes or even regularly. You need nuclear plants for the French and European energy. This is why you have the economic/internal discourse versus safety/external discourse."*

The author of this paper would like to point out here a usual slack in organization between official and unofficial discourses. This gap is partly due to the high stakes of the trade: management has to put the actions into a frame in order to ensure nuclear safety. It would not be conceivable to admit the opinion that the nuclear plant conduct depends only on workers' experience and is not guided by rigorous procedures. For all those reasons, experience plays a central role and rebellion is underlined by the workers and known by the management. Management is bound by the official discourse and the idea that procedures ensure nuclear safety. The place of human feeling and experience in the supervision of nuclear plant is voluntarily reduced in official discourse, mainly because the reality would trigger criticisms and fears.

Eventually, the conjunction of professional identity and ambiguous management discourse leads to psychological empowerment and rule breaking behavior in nuclear power plants.

4.3 Sources of psychological empowerment

The two described dimensions of professional

identity, commitment and self-confidence, reinforced by the ambiguous management discourse, directly appeal to the notion of psychological empowerment, defined in literature by 4 criteria: meaning, self-efficacy, self-determination and impact.

Let us briefly go back to the two first criteria, which as a matter of fact, are a direct part of professional identity. Unlike a doctor or a lawyer, the nuclear operator is aware of the national, environmental and social stakes related to his profession: it overcomes individual considerations. The analysis of professional identity has shown that meaning of work does not exclusively stem from collective stakes but also from professional commitment and the everyday challenge it represents. The individual interests, such as mastering the plant, problem-solving or mutual solidarity within their "second family", create work meaning. Specific work conditions and professional identity build meaning.

Psychological empowerment is also defined as self-efficacy: self-confidence and self-assessment in one's own skills. The author of this paper has already explained above the crucial place of self-confidence and high self-assessment in professional identity. This positive self-evaluation is probably reinforced by the ambivalent discourse: it shows the necessity of tacit knowledge and know-how of operators. As perceived by the operators, their skills are so good and they master the plant so well that rules are not needed. Somehow it insinuates that they are better than the rules and the system. Undoubtedly it reinforces their self-confidence and willingness to break the rules.

This ambiguous management discourse reinforces self-determination as well. As it is tacitly admitted that operators can depart voluntarily and blamelessly from official rules, their self-determination appears to be important, and moreover indispensable for an efficient running of the plant. If the management discourse reinforces self-determination, autonomy appears to be above all historically rooted. The brief historical presentation and professional identity description has already shown us the importance of autonomy and decision making at every level of the leading team. Self-determination is both part of the professionalism and the identity. As mentioned above, those have been built on a positive paradigm of innovation and creativity. The past rules enforcement tends more to attempt controlling autonomy rather than really decreasing it. Problem solving and decision-making are still determined, without a direct and in-time control, by operators.

"I like this job, I master the process and I take some decisions. I am autonomous, and if the foreman does not agree, I usually do my own way."

"When I do my patrol on the installation, nobody ever came with me. I always acted according to my consciousness and I think I do right. I am trusted."

"In this job, you have a quite large autonomy, nobody controls you. So somehow you could say that you can do whatever you want. And finally you are free."

"As an operator, we are in the hearth of the process…we are more crucial and foremen usually do not have time to supervise us. So as an operator, I am the boss in the control room."

The last criterion of psychological empowerment is impact which is defined as the opportunity for an individual to act on operational or strategic decisions. As just mentioned, decision-making is an everyday activity among the leading team. Each day at work means turning valves, balancing the reactor pressure, and sometimes decreasing nuclear power or stopping the reactor. Stakeholders are aware of this potential impact – management, nuclear safety authority, workers, as stated in an official report of French nuclear safety authority report in 2007 [26]:

"Men have a crucial place in ensuring nuclear safety, through their ability to adapt, ask and react to unplanned situations. Their role in the leading, tracking and maintenance is fundamental"

This global awareness is testified in different ways: apprenticeship and tutor practices, training program adaptation, operators' evaluation and intense training.

"This is a nuclear plant, not a chocolate factory, so we need to be careful. We must produce."

"We are in the hearth of the process. The other trades, as maintenance, they support us. But we decide. Everything depends upon us."

The author of this papers' empirical study shows that both strong professional identity shaped throughout the years and ambivalent management discourse foster psychological empowerment in nuclear power plants. These results which can be illustrated as shown in Fig. 1, give some insights on the mechanism which leads to overconfidence and rule-breaking of operators in nuclear plants.

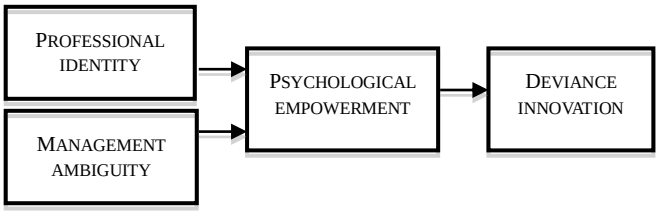


Fig. 1 Summary of the author's study results.

5 Discussion

After discussing nuclear safety literature and especially integrating the risk perception research [27], it appears that rule breaking behavior and overconfidence were not that surprising, even (or especially) in such high-reliability organizations as nuclear power plants. In such a regulated area, where rules enforcement and strict application are crucial to ensure nuclear safety, a rich understanding of those behavior seems relevant. If the gap between prescribed work versus effective work is nowadays integrated as a part of organizations, discussing its sources and implications in the nuclear power plants setting remains interesting on theoretical and managerial standpoints. Especially, nuclear operations are founded conjointly on formal rules application and slight adaptation to specific contexts. Therefore, the border between appropriate and non-appropriate behavior, *i.e*. between adaptation and violation, is sometimes difficult to evaluate.

Those behaviors have not been deeply analyzed and therefore, this article aims at understanding the underpinning mechanisms of these observed but non-studied behavior. On the theoretical side, this research presents two interests. First, it focuses on the individual level, which is not the usual perspective of nuclear safety research. The main idea is to integrate the influence of organizational features and processes on individual behavior. From that purpose, the author of this paper has backed up an in-depth and qualitative study, offering an in-depth approach of various individual experiences, as well as organizational features. Second, using the psychological empowerment will perhaps help organization studies to deepen their analysis on the individual level: stages of psychological empowerment, as antecedent of empowerment in high-reliability organizations, could be studied. The in-depth study of French nuclear power plants constitutes a complementary knowledge of high-reliability organizations.

On the managerial standpoint, this research offers some interesting insights. First, it gives a name, an operational concept, to these well-known, tacit and diffusive behavior perceived by the management. This is a way to show them the reality of those behavior. Also, the results underline the influence of the management, especially the management discourse, on individual behavior. The importance of discourse, tacit discourse and the way they foster professional identity is as important as professionalization and training. These side effects could clearly be a source of new management style and tools. Evaluating empowerment levels, finding levers to influence empowerment, and fostering or reducing it deliberately, could be part of the future HRO management.

6 Concluding remarks

As the concluding remark by the author of this paper the presented research by the author has also eventually underlined the crucial place of identity and self-esteem in organizations. Self-enhancement, high self-esteem and optimistic bias partly explain human behavior.

In nuclear power plants, rules and routines, and especially rules rigidity enforcement since 2000, appear as identity threats and are collectively disapproved. In affirming their identities, engineers create novelty, and invent new behavior and activities. In other words, the perceived discrepancy between professional identity and current enforcement of rules rigidity leads to self-affirmation.

The author of this paper can underline only a few of the limitations of this study. First, this study is focused on one kind of high-reliability organization, in one country. The described mechanisms are partly shaped and biased by idiosyncratic features, such as French identity and work conditions in nuclear power plants. Therefore, the question of the model applicability to other types of organizations has to be discussed. Further research is needed to establish the validity of the described mechanisms. Second, this study provides a limited exploration of a multi-level of analysis and could benefit from quantitative data.

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