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**THE PARADOXES OF EXTERNALIZATION STRATEGY IN A SAFETY
CRITICAL INDUSTRY**

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Abstract: How is the outsourcing of maintenance activities managed in the safety critical industries? What are the kind of difficulties created in this context and how can they be overcome? These are the questions we will try to answer in this article. We have built on an existing body of literature concerning safety critical industries, subcontracting, and joint regulation methods. We have had the opportunity to conduct in-depth empirical research inside the headquarters and the industrial plants of a large energy company. We analyze the ways in which safety imposes strong top-down procedures, while the local laws forbid direct management by the energy company of the subcontractors' employees; we observed some discrepancies between the official rules and the realities of field work that a more systematic investment in developing joint regulation may allow to minimize.

Key words: subcontracting; safety critical organization; control-based management; joint regulation; discussion spaces.

How is the outsourcing of maintenance activities managed in safety critical industries? What are the kind of difficulties created in this context and how can they be overcome? These are the questions we will try to answer, based on a case study conducted inside the headquarters and the industrial plants of a large energy company.

If many studies have been conducted concerning safety critical industries, we shall see that relatively few have looked at how these organizations manage their subcontractors' network and pay attention to safety implications. We have had the opportunity to conduct in-depth empirical research on these subjects. We have built on an existing body of work, which parts are not necessarily inter-connected, concerning safety critical industry, subcontracting, and joint regulation methods. We have tried to connect them and to evaluate how they influence (or not) the current subcontracting management practices in a safety critical industry inside a strong constraint system.

We conducted our research within a company which we will name the Contracting Company (CC)¹, and more precisely in one of its divisions: the Production Division of the Contracting Company (PDCC). CC is what the literature calls a "safety critical organization". It is made up of a national level that enacts national policy and goals, and of multiple local plants. On a regular basis, each plant stops to carry out the maintenance work. For that purpose, CC calls upon subcontracting companies that would operate wherever there is a maintenance shutdown. Our research is multilevel: we studied the PDCC's national management of the subcontractors and the national organization of the maintenance work. We also observed this management and organization at the local level, and how it affects daily work situations. We shall emphasize the paradoxes and tensions due to the outsourcing of maintenance works in a safety critical industry, and the methods to overcome or reduce them.

¹ As usual in this context, the company's name has been anonymized at the request of the undertaking; the analysis, results and recommendations are the unique responsibility of the authors.

We will start by a literature review: on safety critical industries; on subcontracting strategies and their impacts concerning traditional organizations, and more precisely concerning safety critical industries; on options identified for addressing the difficulties created by this kind of situations (I). We will then describe our methodology, the subcontractors' management and the organization of maintenance activities by the PDCC national level (II). Finally, we will analyze daily work situations which involve subcontractors, the difficulties that can be observed at the plant level, and develop some proposals to overcome them (III).

1. Literature

a. Safety critical industry: two main ways of thinking organization

There are two main ways of thinking safety critical organizations, which are ideologically opposed.

First, Charles Perrow proposed a theory of the organizations called “complex organizations” using “high risk technologies”, and built the Normal Accident Theory (NAT) (1984). According to him, design flaws are unavoidable, accidents are intrinsically linked to the safety critical organization's structure; they cannot be avoided and should be called “normal”. He used a systemic perspective to identify two of the major features of these complex organizations' unreliability:

- Interactive complexity: there are many unpredictable interactions. Systems and subsystems are highly interconnected because of the technology in use;
- Tightly coupling: involves time-dependent processes, many invariant sequences (action B must follow action A), global designs allow only one way to achieve a goal, little flexibility (short time period separates a reaction or action from another) (Mazzorana-Kremmer, 2016, p.73).

In this light, “individuals’ ability to adapt or improvise is low or even nonexistent” (Bernard, 2014). Bernard rephrased Perrow’s theory as follows: “safety critical organizations are doomed to fail due to endogenous causes”.

Nevertheless, Perrow didn’t focus on behavioral analysis in terms of human error, nor on the reasons leading agents to transgress procedures (Pesqueux, 2015), or on how “organizational design can contribute to creating and promoting some behaviors” (Bourrier, 2001, p.26). Thus, the organization is not seen as an effective counter to the deviance and transgression.

A few years later, a multidisciplinary group of scholars based at the University of Berkeley (La Porte and Rochlin (Rochlin and *al.*, 1987; Roberts, 1990) introduced the “High Reliability Organizations” (HRO) as a new way of considering safety critical organizations. This approach contrasts with Perrow: they argued that complex systems could operate without accident during a long period of time. They define HRO as follows: “These organizations are typically technologically complex, their technologies are highly interdependent, they have damage potential, and errors happen relatively rarely” (Roberts, Stout & Halpern, 1994). They highlighted that safety critical organizations “were doing far better than expected” (Bourrier, 2011) and wondered why do so few major accidents occur in safety critical organizations? They prompted an interest in organizational processes and design diversity, and they were interested in how they could influence (both positively and negatively) the safety critical organizations’ performance and reliability.

The HRO group (as Perrow) sees the organization as an “open system”, but whose structure complies above all with the external requests: the organization must attach importance to external constraints (regulation, safety authority, public opinion ...).

The HRO theory was partly renewed in the 2000s by Weick (2007). He presented the safety critical organizations as “organizations that accept the inevitability of an error and thereby shift from the ideal of error prevention to the more realistic goal of containing them” (Deltort and

al., 2014). According to him, safety critical organizations “think and act differently”; much of their success has been driven by the attention they pay to what happens (mindfulness).

How is externalization playing a role in this context? The analysis of the phenomena will provide us with a better understanding of this strategic practice and the organizational changes it generates, as well as of the different methods used to manage it.

b. Outsourcing : forms and management

Outsourcing has grown significantly since the 1980s. The need to outsource certain operations is affirmed by manufacturers for a number of reasons (which may be cumulative): to refocus on its core business, to use an expert whose work is not guaranteed year-round, to lower production costs, to handle peaks of activity ... Externalization can be defined in many ways, but it always consists in contracting with an external company to handle some tasks that were (or were not) previously carried out internally. It is a form of “vertical disintegration” (Foss, 1996).

So, between market and hierarchy, organizations using outsourcing can be characterized as “hybrids” (Williamson, 1985; Ghertman, 2003; Ménard, 2010). Desreumaux (1996) highlights that the outsourcing decision changes the structure of the firm. The outsourcer becomes the hub of a network whose contract is the “cornerstone” (Gosse, 2002). We will call them “network organizations”. They are linked with vertical partnership strategies where the problem is the “optimal coordination of resources along value chains” (Paché, 1995). Hierarchy remains present in the network structures that are both internal markets and external hierarchies (Guilhon & Gianfaldoni, 1990).

The hub firm undertakes three roles: conception (of the final goods or services and of the value chain), coordination (of the structure by ensuring the governance of transactions between partners), and control (of the structure by monitoring the level of quality achieved by the operators). With the outsourcing decision, firms are facing a new management situation: they

have to deal with opportunism and dependence's risks across subcontractors and suppliers, while welcoming learning opportunities (Barthélémy & Donada, 2007).

The choice of the network organization has many advantages (improvement of the companies' performance, costs reduction and control, refocusing on the core business, improvement of the outsourced activity management, ...) and disadvantages (technical dependence of the contracting company and loss of skills; opportunistic behavior; social risks: return to Taylorism; a regressive approach to HRM; segmentation of the subcontracting population; possible loss of control over subcontractors; subcontractors' underperformance...).

The appearance of a contracting company's technical dependence on subcontractors is one of the main risks identified. During the first years after outsourcing began, Barthélémy & Donada explain that the "differential of resources and skills" will be low, but it will increase over time (mainly with the retirement of the employees who had deeper knowledge of the technical work), imposing an adaptation of the hub firm's modes of control.

Moreover, outsourcing often creates a multi-steer system of management.

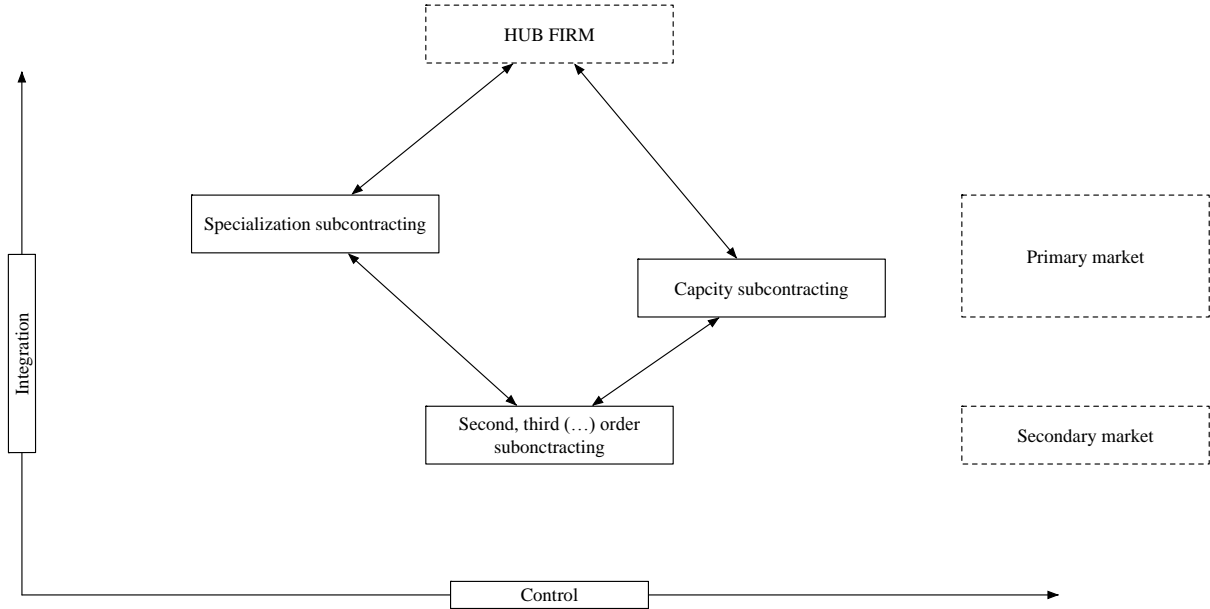
Table 1: Outsourcing markets (from: Doeringer & Piore, 1971; Paché, 1995; Gosse, 2002)

Internal Market	Contracting company's workforce		
	Low substitutability of know-how ; stability		
External market	Primary market	Specialization	Quasi-fixed labor factor Seeks efficiency by cooperation
	First-order partners	subcontracting	
		Strong integration	
		Capacity subcontracting	
	Low integration		
External market	Secondary market	Competitive nature	
	Second, Third-order of subcontractors	High turnover to « face the environment without supporting the rigidity of employment » (Paché, 1995)	

		Seeks efficiency by competition
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We schematize this multi-steer system below.

Figure 1: Subcontractors' integration and control



These populations are managed differently by the contracting company which cannot ensure direct control of “potentially dysfunctional behavior of the subcontractor” (Gosse, 2002), because of the legal limits imposed by outsourcing. We have classified these different management methods in the following table.

Table 2: Contracting company's subcontractors' management methods (adapted from Barthélémy & Donada, 2007)

When	Management methods	Definition
Selection phase	Qualification system	Establishment of a pool / panel of companies generally reserved for labeled companies: MASE, "qualification" for PDCC... These initiatives are the basis of quality assurance. The

		verification of the technical qualification of the staff and the need of a safety qualification must be added.		
Execution phase	Management control system Outsourcing driven by cost reduction	Market-based control	Permanent competition between the subcontractors.	Suits when : Large number of subcontractors.
		Bureaucracy-based control	Allows the creation of quasi-hierarchical relations between the contractor and its subcontractors.	Suits when : Need for flexibility; the contractor is in a situation of
			Formal evaluation of value creation processes. Implementation of specific tools for monitoring and measuring performance.	unfavorable asymmetric dependence.
	Relationalism management system Outsourcing driven by a	Management by relational norms	Development of shared values and expectations	Suits when : Long-term relationship; ongoing interaction with the subcontractors.

	search for competence	Management by trust	Anticipation that contractor's expectations will not be disappointed and that the moral commitment of the subcontractor will be sufficient	Suits when : Hard control; small number of subcontractors.
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According to Guilloux and al. (1999), the nature of a relationship “can be defined by the degree of control exercised by a firm over another”, and they described the place of control in the various levels of a relationship. For instance, quasi-hierarchical relationships will be managed by control, but if the relationship takes the form of a “cooperation in a common purpose creating mutual interdependencies”, then management by trust will be promoted.

Trust is not a management method favored by the contracting companies, which prefers to control their subcontractors (Barthélémy & Donada, 2007). To Gosse (2002), “outsourcing implies a trust based on calculations, strengthened by frequent control”: we cannot imagine a contractor/subcontractors relationship without any control, especially in a safety critical organization where the law imposes controls of the subcontracting activities. If trust “allows to go beyond the inherent limitations of formal control” (Barthélémy & Donada, 2007), it is often a “constrained trust because of the contractor’s difficulties in evaluating the performance of the subcontractor and of its progressive loss of competencies for the benefit of the subcontractors” (Gosse, 2002). Thus, the contract becomes very important and is reinforced by the lack of trust (Gosse, 2002).

In the literature, there is a consensus towards the management by relational norms, which allows deterring subcontractors from abusing their positions. The exchange of informations, the

construction of long-term relationships and of interpersonal relationships on the field, etc., will create trust, will deter opportunistic behaviors, and will facilitate interorganizational problem solving. But these recommendations are particularly hard to implement within the safety critical organization's network of subcontractors.

c. Outsourcing in a safety critical organization

In safety critical organizations, many activities are currently being conducted by subcontractors, including the maintenance operations that we studied. This evolution has increased the complexity of an efficient functioning in these sociotechnical systems, in which many companies are involved and where work processes need the collaboration of employees from different organizations and a coordination beyond firms' boundaries to be efficient. Milch & Laumann (2016) talked about "interorganizational complexity", stating that this is one of the consequences of outsourcing in safety critical organizations. Studies on outsourcing in safety critical industries' complex networks mainly concern workers' safety and seldom the impacts that subcontracting and its management can have on the whole system safety. Oedewald & Gotcheva (2015) called for a "need to better understand the links between management and coordination of the activities in a subcontractors' network and the overall system safety".

The "good" safety critical organization – from the point of view of the actors / designers of the organization – is often an organization which is mechanistic and hierarchical, extensively using strict procedures and control (Perin, 2004). This organization can be "ill fitted with network thinking and development of shared safety culture" (Oedewald & Gotcheva, 2015), and so generate a number of tensions.

All the operations are planned in advance, but as Oedewald & Gotecheva (2015) say, "despite all the preparations done, the activities did not proceed as planned and the actors perceived it necessary to carry out a local adaptation". Hence the hierarchical model often underestimates the need for local adaptation of procedures, and when changes need to be made, the

communication and decision-making processes are rigid and slow. Indeed, in the safety critical organizations' culture, local adaptations are ambiguous; they can be tolerated if no errors occur when the procedure has been adapted by the subcontractor's operator – but they are often seen as a threat. The involvement of a large number of organizations seems to lead to an even more complex and bureaucratic security management system (Jeffcot and al., 2006; Kongsvik & Fenstad, 2007; Milch & Laumann, 2016), and the need to write procedures seems to increase with the number of organizations.

According to Kongsvik & Fenstad's study (2007), employees of an offshore platform express their concern about the ever-increasing amount of procedures that they describe as an obstacle: the more procedures there are, the harder it becomes for employees to identify and use the appropriate procedure. Blindly relying on procedures can reduce the workers' ability to understand what is going on and lead to unsafe behaviors in unexpected situations.

To Oedewald & Gotecheva (2015), subcontracting operators have too little general information about the project and its conditions. Therefore, they can question some procedures because they might not know the functionalities of the system or the components they are working on. The lack of this systemic knowledge can lead to difficulties in understanding some requirements, to a possible inability to create links between activities, and may have negative effects on safety. The authors argue that the assertion “everybody knows what nuclear safety is and what the risks are” is wrong. Moreover, if there are local adjustments, “they need to be based on sufficient understanding of the system' characteristics in order to support system safety” (Oedewald et al, 2011).

Furthermore, when organizations operate on a project basis, which is temporary, this creates a continuous change of the subcontracting firms. Learning is bounded by the short duration of activities, and internal dynamics are bounded by the constant flow of people.

How to solve this tension (increased by the network configuration and the project mode) between a rigid scheduling and prescriptions on the one hand, and the complexity of the tasks and the hazards of the field on the other hand? Methods enabling a joint regulation are frequently proposed in the literature.

d. From joint regulation to discussion spaces

This is where the social regulation theory (Reynaud, 1988, 1989) can be useful. The rule is defined by Reynaud (1997, p.XVI) as an organizing principle that may take the form of an injunction or prohibition to strictly determinate a behavior, but it could also be a model that guides the action or that allows to make judgments. Reynaud differentiates two types of rules: “the rules that come from the company’s managing team (control rules), and those produced inside the company by groups of operators (autonomous rules)” (1988). Once the rules are defined, Reynaud analyzes how the interactions between these two types of rules will create what he calls the “rules of the game”.

The difficulty generated by the subcontracting of complex operations within safety critical organizations is exacerbated by the impossibility for the contracting company of operating a direct management on subcontractors’ workers. Subcontractors’ workers should just apply rules and instructions transmitted in previous training or stated in some documents provided to them: “subcontractors are required to follow plans and instructions” (Oedewald and al., 2011). As mentioned above, the safety critical organization does not officially want for an “autonomous regulation” to take place, but expects the issue to be reported so it can adapt the rule (control regulation). In fact, in a more unofficial manner, which is recognized by the literature, “managers in the field tolerate arrangements” (Terressac, 2012) because no rule or procedure can be exhaustive (Bourrier, 1996; Terressac, 2012). It is necessary not to follow them blindly, but operators cannot move too far away from them either: this in-between is seen as a “major burden” within the type of safety critical organization studied (Bourrier, 1996). Indeed, it will

tend towards an ambiguity between the compliance or non-compliance with the rule, the sanction of the deviation or not, a matter on which we will come back later on.

Autonomous regulations may counteract control regulations, while remaining linked to the results. Control regulation will seek to control the “areas of freedom and autonomy that they (the operators) grant themselves”, and also to “weigh from the outside on the regulation of a social group” (Reynaud, 1988). Strong power issues are tied with the meeting of these two regulations: “each one argues and seeks to impose on others the requirements of his specialty and therefore affirms his status” (Reynaud, 2003, p.105). The meeting of those two regulations may take the form of a “joint regulation” which constitutes “the product of an explicit or implicit negotiation and is a part of an agreement” (Reynaud & Reynaud, 1995, p.249) and represents “acceptable operating rules which are the result of initiatives, negotiation, and arbitration in a given situation” (Reynaud, 2003, p.113).

Furthermore, a growing body of research noticed a “sense of work intensification” (Gollac & Volkoff, 1996; Gollac, 2005; Raveyre & Ughetto 2006) which can be linked with the rise of market based requirements within organizations (Gorgeu and al., 1998; Raveyre & Ughetto, 2003). The latter results in many management tools that multiply performance objectives and increase tensions and contradictions on the work field (Detchessahar, 2013). Bartolli & Rocca (2006) report a work intensification due to the tension between a plurality of constraints and a required autonomy. Indeed, since the 1990s, new forms of organization have emerged, which can be qualified as neo-Fordist, that Seignour (2015) calls “market bureaucracy” because they are “associated to specific modalities of leadership, control and management, at the crossroad of commercial and bureaucratic logics” (p.156). However, according to the author, the characteristics of the market and bureaucracy are hardly compatible but constitute “the major characteristic of these large neo-Fordist firms” (p.157).

As a consequence, “teams and field managers must engage in an important work of regulation to fix, always temporarily, the meaning of the work” (Detchessahar, 2013). Detchessahar (2011) propose to fill the “blind spot of research claiming to be inspired by the social regulation theory” by tooling up the joint regulation with what he calls “discussion spaces” (2001, 2003, 2011, 2013), of which he proposes a theorization and that he considers “even more necessary when we need to combine multiple performance requirements in the activity” (2013,). Discussion space is a space of “joint construction of a common outlook” (Detchessahar, 2001) “which opens to the actors the possibilities of enunciation of the difficulties and contradictions of the work in order to construct compromises, most often temporary, but which will serve as a support for collective action” (Detchessahar, 2013).

In order to produce collective solutions, the discussion must be dialogical, intersubjective, and with a political purpose (Detchessahar, 2013). Therefore, it will allow “arrangements, compromises, modifications, involved by the prescription incompleteness and the fatally erratic character of the activity” and which can (or not) “be institutionalized” (ibid).

This discussion and its products will be helpful at different levels of the organization; first for the operators and field management (restoration of the meaning of work, learning, merger between the management and the field, building work recognition, ...), then to the different levels of management up to leadership, since these discussion spaces solve problems as close to the field as possible, this reduces the gaps between planning and operations, thus facilitates the handling of the problems by the higher levels. The institutionalization of the ‘Operating Experience Feedback’ can constitute such a discussion space, combining risk situations treatment, mutual learning, health and work collectives’ development”, provided that it organizes the dialogue and the interaction between the different actors involved in the design and implementation of the operations (Rocha and al., 2016). Casse called it “operating experience discussion spaces” (2015, p.304).

However, the discussion is not always easy, and the opening of these spaces is problematic because it allows a “critical debate about work”, carrying “strong interpersonal and organizational issues” (Detchessahar, 2013). It therefore requires strong methodological and organizational support in order to happen and to produce the desired effects. We will focus on their implementation in the organization studied, in order to reduce the difficulties encountered. We have here synthesized and connected different concepts and ways of thinking, highlighting some of the main difficulties that a safety critical organization using outsourcing may encounter. We identified areas of improvement able to mitigating these difficulties arising from the tension between a very strict mandatory control regulation and the complex and random nature of the operations to be performed. Literature calls for more studies on the daily operations, on the « how it works », and on the impact of outsourcing on safety management. That is the path we are going to explore.

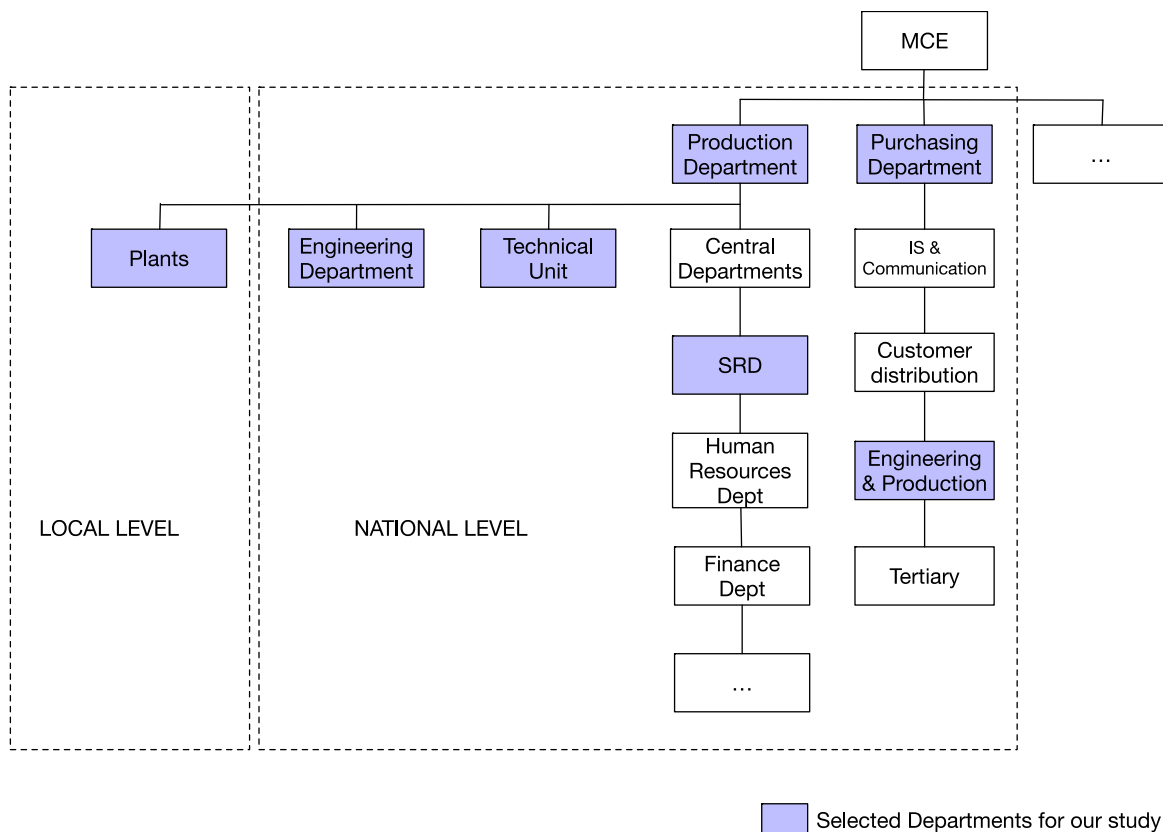
2. Subcontractors’ management and maintenance activities organization by the PDCC at national level

We first started our empirical research by studying the management of subcontractors and the creation of the procedures that play a major role in the structuring of field operations. The main elements of the methodology of our studies are stated in the table below.

Case study methodology
<p>Our methodology is qualitative. Our data collection took place at two levels :</p> <ul style="list-style-type: none">- National level: 21 interviews with the actors in charge of the national management of subcontractors, prescriptions and purchases;- Local level: the data collection took place on two PDCC sites, selected on the basis of two criteria arising from the literature review (the site’s geographical location; the results of the subcontractors’ satisfaction survey):

- Site 1: Ranked first in the subcontractors' satisfaction survey. Isolated site. 16 interviews, 15 observations.
- Site 2: Lowest ranked in the subcontractors' satisfaction survey. Clustered. 28 interviews, 20 observations.

Figure 2: CC chart showing selected departments and departments for data collection (in blue)



Our observations focused on subcontractors' work situations (operators and management), but also DPCC's field agents in charge of managing the maintenance work, as well as intra and inter-organizational coordination meetings.

All our interviews and observations were recorded (audio) and transcribed. We also collected documents.

We performed a transversal analysis of all these data, linking them to each other, to the context and to the theoretical concepts we mobilized.

In order to understand the difficulties encountered by operational staff and the potential solutions to overcome or mitigate them, it is necessary to present the Contracting Company (CC) and specifically its production division (PDCC), to analyze some of its constraints (outsourcing, safety, complexity of maintenance operations, human resources management, economic performance), and how the maintenance outsourcing fits into it. Within this framework, we will discuss the way PDCC manages outsourcing, and how the procedures that regulate the technical work are conceived.

During the first maintenance shutdowns, PDCC decided that the volume of the scheduled maintenance interventions, as well as the need for a specialized workforce and the difficulties of absorbing peak-loads, required the outsourcing of some of them.

As with any safety critical organization, an external safety authority (SA) has been created, which plays three main roles: inform the public, regulate, verify. The legislation of CC' country of origin, co-conceived with the SA, specifies the conditions of carrying out the maintenance activities in case of subcontracting. It enforces the creation of written procedures to work on the installations, as well as a monitoring of the outsourced activities. Subcontractors' operators perform interventions with documents that they have to complete and follow before, during (operating procedures), and after the procedure; interventions are tracked in computer databases to ensure compliance with the quality process and the material reliability: it is a part of the safety constraint. If a basic trend is emerging concerning the standardization of work processes, execution work "is never completely 'taylorized', in the same way as the work done by the workers on an assembly line (...). Because of the complexity of technical installations, the work done by the field teams (or by the subcontractors that they monitor) leaves an indeterminacy

and unpredictability that makes it difficult to prescribe every aspect of work” (Martin, 2012, p.121), and calls for local adaptation of the rules.

We will first discuss the maintenance and subcontractors’ management by the PDCC at national level, and then analyze the possible effects that these may have on local work situations.

a. Maintenance externalization history and management at PDCC

During the construction of the production sites, PDCC organized itself in a centralized way, deciding the policies and strategies at the national level, while leaving to the sites a certain management autonomy concerning their implementation.

PDCC’ technicians, who had themselves performed maintenance interventions, started to retire between 2005 and 2010. A generational renewal replaced people who “had done” by people who “would never do”, which substituted technical and managerial skills by mainly managerial skills.

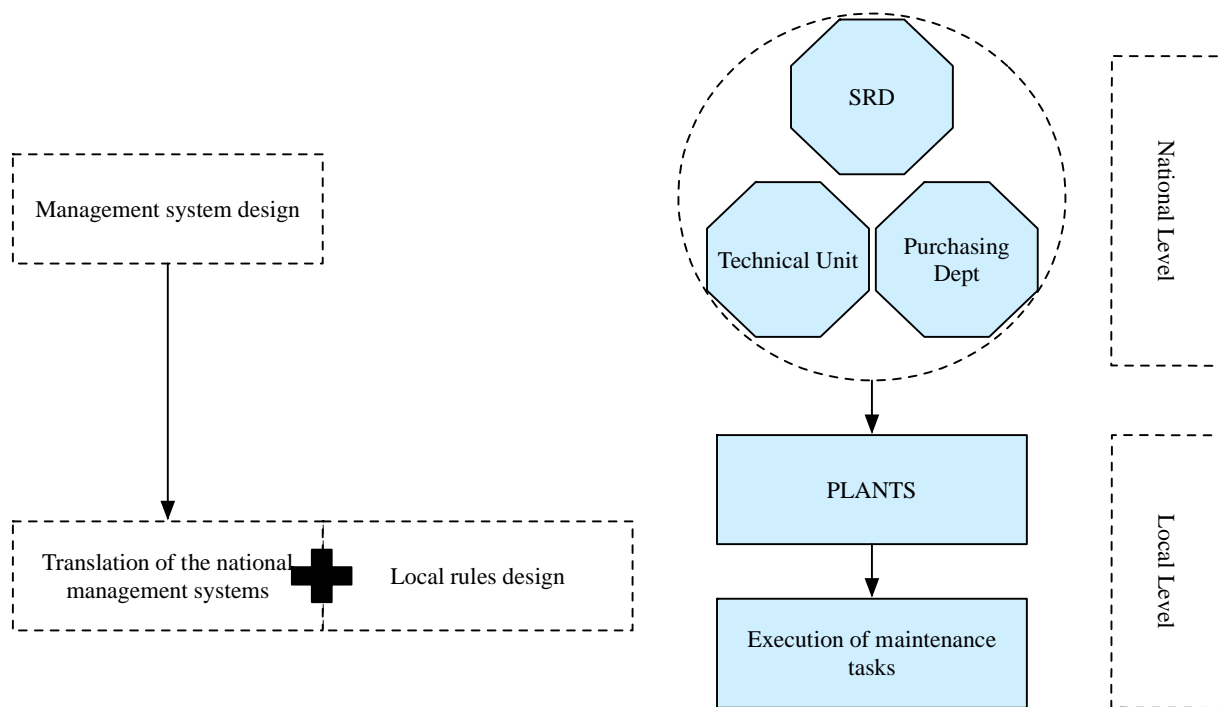
In the 1990s, the Subcontractors Relationship Department (SRD) was created at the headquarters to “encourage, coordinate, integrate, and monitor the initiatives of the sites in all areas where relationships with subcontractors are concerned” (engagement letter). It was necessary to support the subcontracting companies by training their staff, enabling them to better understand the PDCC’s constraints and setting up partnership relations instead of mere subcontracting relationships. Safety and quality training were (and still are) carried out, as well as surveys to get a clearer picture of the living conditions of this travelling staff. The latter reported difficulties related mainly to PDCC’s organizational failures. The SRD then proposed several measures to overcome these difficulties: conclude multi-year contracts designed to help subcontractors stabilize their staff, speed up the identification of activities to be outsourced, organize collaborations between sites from the same region to facilitate the bundling of contracts, associate the most important subcontractors in the maintenance shutdowns’ preparation phases... A progress charter (1997) was signed by PDCC and the subcontractors’

trade unions representative. Since 2005, CC has been engaged in a corporate social responsibility approach and had tried to integrate it within its value chain through several mechanisms: the progress charter, but also the agreement on socially responsible subcontracting (2008), etc. These agreements and charters gave rise to concrete actions including those set up by the SRD, which is represented on each site by a Subcontractors Relationships Manager (SRM).

SRD has been the source of the main subcontracting management processes at the national and local level. On sites, they are transposed into the deployment of the contract management, subcontracting operators' skills development actions, etc. Two other headquarters departments are also involved in the subcontractors' management: the Support Unit (SU) which manages (among other things) the subcontractors' qualification system (during the selection phase) as well as the analysis of the Subcontracting Evaluation Sheets (SES) declared by the sites; and the Purchasing Department which manages the tenders and contracts. All these national actors are aware of the importance of moving towards a quasi-partnership relationship with their subcontractors, and of the difficulties and the means to achieve it.

“CC is not good at transparency. We could work better with the subcontractors companies. We say “partners”, but partners do not exist. It is a contractual relationship. While remaining in an industrial relationship logic, we could work together better and co-create things. The position we have had for several years, when we think about the subcontractors' management processes, is to create them together. That's what brings acceptance and efficiency, because we have to stop thinking that we know what is good for others” (SRD, PDCC, National Level)

Figure 3: Subcontractors' management key actors at the national level



In the 1980s, the high rate of unavailability of the production sites led to higher energy prices and did not foster company efficiency. PDCC headquarters implemented a strategic plan focused on the improvement of its competitiveness: major opportunities for progress were identified in the control of maintenance operations. From the 1990s, controlling the duration of maintenance shutdowns became a priority. Progressively, the objectives of decreasing the maintenance shutdowns' extension were reached and the staff became more aware of the economic stakes.

The energy market liberalization in the CC' country of origin led to profound changes for both CCs and subcontractors staff (harsher contract negotiations, creation of the contract management, etc.). We thus observe the “market” turn that the literature describes and that led PDCC to become a “market bureaucracy” intensifying the work process, and reinforcing the economic constraint for the company.

Responding to this economic context, PDCC recently decided to apply contracts more strictly by creating contract managers' positions on the sites, coordinated by the SRD and joining the Subcontractors Relationships Manager's local team including mostly a purchasing manager, a

contract manager and a financial monitoring manager for maintenance shutdowns. This allows PDCC to manage the subcontracting contracts' financial aspect in a more rigorous way. For the national manager of this process (SRD), the contract management consists of “*following the commitments that have been made*”, and “*if we have set penalty requirements, we ensure that they are properly applied*”. The subcontractors responded to this financialization and judicialization by protecting themselves more and more when they carry out maintenance interventions, which may contribute to slowing the operations.

“The on-site people [PDCC and the subcontractors] are required to write most things, so that it can become evidence inside a growing contractual form. We told them that, for sure, information can be passed orally but there is no evidence. (...) They are surprised because the ways of working are impacted by this new kind of procedure, (...) it is a reality. We are now going towards a form of financialization and a quite large tendency toward judicialization in the Company; and we must get to the right level of professionalism on these topics” (Contract Manager, SRD, National Level)

In addition, the analysis of the maintenance subcontracting activities allows us to identify three major difficulties that operations still face. Two of these difficulties are inherent to subcontracting: it is impossible for the PDCC' staff to directly manage the subcontractors' operators due to a legal and costly risk of requalification of the commercial contract into an employment contract. Also, the majority of subcontractors move according to the maintenance shutdowns of the sites, which can make the construction of solid PDCC-subcontractors collectives difficult. Finally, the last difficulty is related to the maintenance work which is complex: the operations are subject to hazards while the work processes are standardized and autonomous regulation tolerated in an ambiguous manner.

The history of PDCC and these constraints will shape the way by which the procedures and rules governing the maintenance work are created, and will influence *in fine* work situations.

b. A top-down design of the procedures and rules

On PDCC' sites, operating procedures and work logs can be either designed by the subcontracting company, or by PDCC. We will not deal with the first case mainly concerning highly specialized subcontracting companies, exercising their expertise in a protected part of the sites that we have not thoroughly observed. We will talk only about the maintenance operations carried out following the PDCC's procedures.

The Engineering Department defines systematic preventive maintenance activities at the national level for a given period of time. When the sites were built, or when equipment is replaced, the "engineering experts" develop so-called "maintenance doctrines", which define "*major maintenance axes, rules, generalities oriented towards the proper functioning of the equipment*" (Engineer, Engineering Department, National Level).

From these doctrines, the preventive maintenance national programs are created by communicating with the suppliers / manufacturers of the concerned equipment: "*The supplier must provide a maintenance program concerning his equipment, and we can have our own imperatives, we must write our own program, take a critical look, and know if our practices are workable on their equipment, and also integrate the SA's requests*" (Engineer, Engineering Department, National Level). Following the discussions with the suppliers / manufacturers, the Engineering Department drafts the maintenance programs that are the "*maintenance obligations for the sites*" (Engineer, Engineering Department, National Level). It affects the maintenance work since the subcontractors "*have to carry out the content of the maintenance program. Their work is totally related to what we define*" (Engineer, Engineering Department, National Level).

The maintenance programs are used for the development of the national maintenance procedures (NMP) by the Intermediate Structures (IS). SIs were only created in 2011. Before

this date, national maintenance programs were transmitted directly to the method services on sites, which created their own procedures.

There are several types of sites, each type requiring specific maintenance. The role of each IS is to homogenize the operating procedures and streamline their creation process for the type of sites under its responsibility.

Once the IS has adapted maintenance programs into National Maintenance Procedures (NMPs), this information reaches the method services on sites via the PDCC's Information System. However, the methods services on sites do not always agree with the IS's national procedures, finding that they do not take into account the specificities of their site. Some sites of the same "type" may have different equipment since a site may have undergone a modification (equipment replacement) that others have not. Today, the NMPs are not often used by the sites: *"for various reasons, it is not applicable or technical information is missing. So I use the local procedure, not the national procedures"* (Preparer, Method Service, Local Level).

"Operating Experience Feedback" (OEF) exists between the local methods services and the ISs: the methods service informs its IS after noticing divergences between the operating procedures and the needs of the sites or when improvements are possible. ISs analyze this operating experience and modify the operating procedures, but the relevant information does not always reach the ISs, and the time taken for modification is very long: *"It's around one to two years. And that is only when we get the information, because we are in touch with the method services of the sites, but first it is necessary that the operating experience gets back from the subcontractor's operators to them"* (Unit Manager, IS).

The co-creation of maintenance procedures seems to remain a complex, difficult and slow process. Despite this, everyone acknowledges that the ISs' mutualizing work should bring some performance gains: *"instead of paying people to adapt maintenance programs separately, it's an entity that decides for everyone. Concretely, why would everyone adapt the programs while*

we have the same site, the same activities, and the same regulations? What I mean is that there is a gain. It's industrialization" (Preparer, Methods Service, Local Level). However, even the IS employees admit that this mutualization is still in the *"theory stage, because in practice, the workload has not decreased on sites that still apply the local procedures (...) because what we sent to them does not satisfy them"* (Unit Manager, IS).

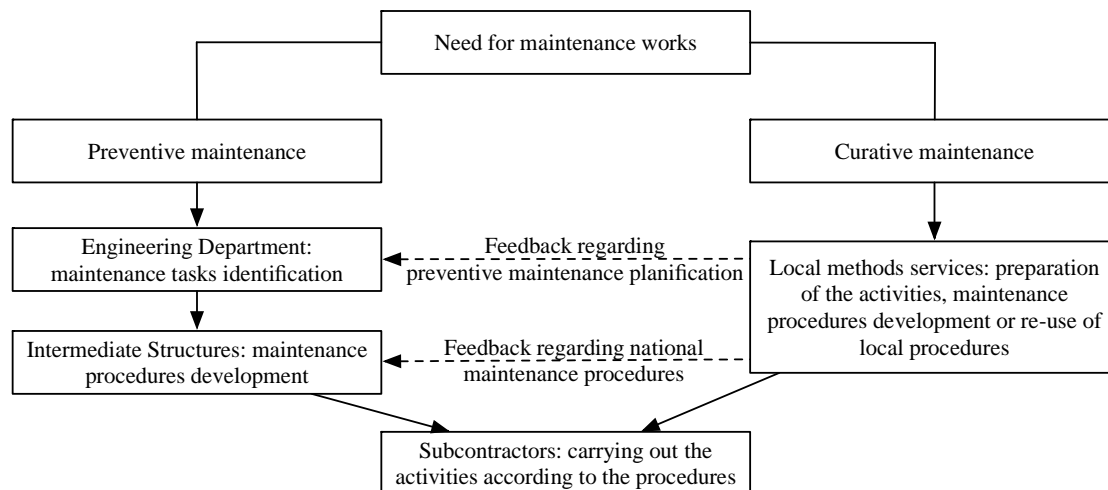
When preventive maintenance is conditional, which means *"depending on the unexpected appearance of key signs of the equipment's condition"* (Memento Security), operating procedures and work logs are developed directly by the local methods services.

The operating procedures used to carry out conditional preventive maintenance operations are created by the sites, and their obsolescence may be a problem. Often, they were designed by the sites during the first maintenance shutdowns and do not always follow the equipment's evolution. The inaccurate operating procedures are therefore modified on the spot during each maintenance shutdown by the methods service when the subcontractors forward the information, but some documents presented to them still remain the same year after year.

"There are many outdated operating procedures. Outdated is a mild word, when you see that there are 1993' operating procedures while the working conditions and the equipment have evolved a lot... documentation is a big problem" (Intervention Service, PDCC, Local Level)

These, procedures are often ill-suited to the field and can impact the work situation experience of the subcontractors' operators, and *in fine* the work they carry out.

Diagram 4: Maintenance needs, procedures design, and realization of the maintenance work



Beyond the operating procedures, the subcontractors' operators must also respect other rules on sites. According to an SRD actor, there are 503 rules that the subcontractor's operators must know: safety rules, security rules, fire prevention rules, behavioral rules, etc. Most of them are national and are listed in the "National Worker Guide", and the others are specific to the sites and communicated to the subcontractors upon on-site arrival.

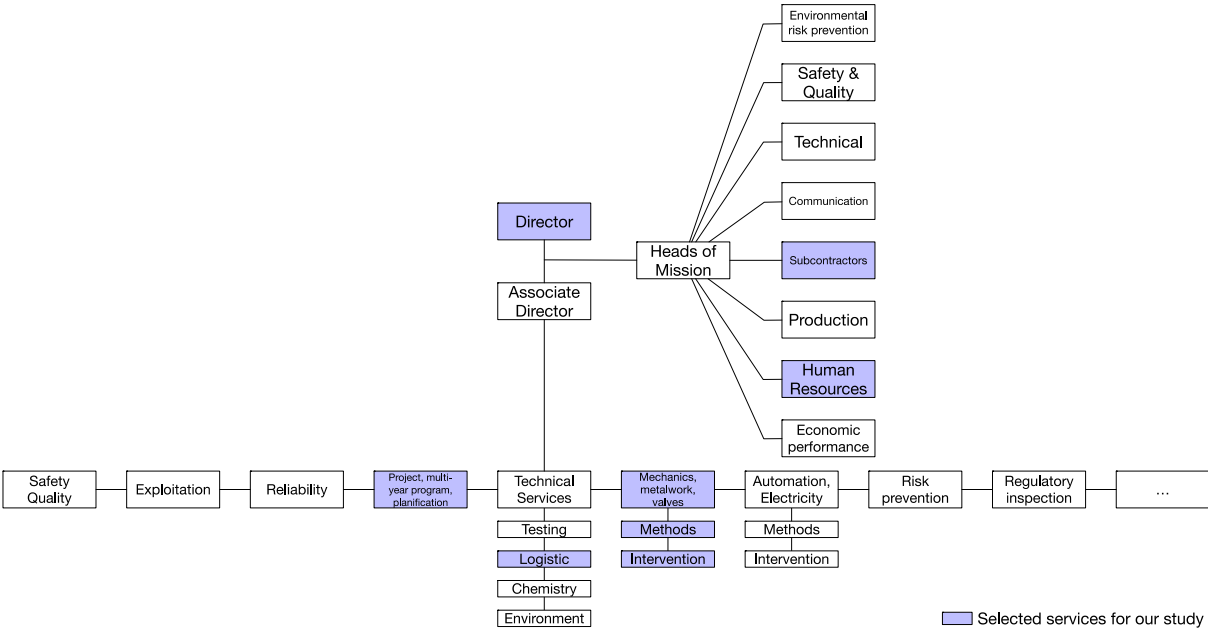
Some of the national management processes were created by the SRD and the TU to ensure that these rules and procedures are duly complied with: the "qualification catalogs" allow the necessary legal control of the subcontractors' skills and the monitoring of their activities to ensure the quality of their work, etc. More recently, the "contract management" facilitates the monitoring of their compliance with contracts and clauses listed therein.

To Martin's assertion that these rules and procedures are "leading to more standardized work processes, and the nature of the work and the relationship between employees and the machine are significantly modified" (2012, p.85), we will add and show that the change of the contractor / subcontractor relationship towards a control-based management system may modify this relationship and the way the maintenance work is carried out. Two essential relationships have thus been modified in recent years: between men and machines, and between men.

3. The work situation on PDCC sites

This section will address the potential impact of the gaps between the stipulated and real work on highly controlled work situations, in an environment where vertical and horizontal cooperation is not always widespread. We will also make joint regulation recommendations. We will first briefly introduce the actors we studied on the two chosen sites.

Figure 5: Example of a local PDCC organization chart



The PDCC’s actors located in technical services “Mechanisms, metalwork, valves” and “Automation, electricity” are the ones mostly in direct contact with the subcontractors in the field. Within each technical service, called “department” by the actors, there is a methods department that includes “preparers” managing the written procedures, and an intervention department that includes field managers and supervisors managing the real-time workflow. We were also interested in the steering team (project-team) of the “maintenance shutdown project” which plays a role in strategic, operational, and logistical management: they are theoretically animating and federating the diverse departments around a collective performance, and guaranteeing the achievement of the shutdown project objectives. They are the only ones in the field that have an overall vision. We were interested in the project manager (strategic steering) and the sub-project managers (operational steering).

a. Work situations: between a multiplication of rules and uncertainties

Uncertainties here means the unforeseen, unplanned events that require adaptations.

Maintenance activities are subject to many uncertainties. Here we classify those we observed:

- Temporal uncertainties: intervention B cannot be processed because intervention A (on the same equipment, or on related equipment) hasn't been completed;
- Technical uncertainties: the equipment is not in expected condition and additional work is needed (conditional maintenance);
- Document uncertainties: the documents and procedures are not in line with the intervention to be performed.

Moreover, local rules (which differ from one site to another) change frequently, and the geographic instability of the subcontractors' operators can lead to misunderstandings. For instance, on Site 2 (old, clustered, lower ranked on the subcontractors' satisfaction survey), a rule concerning the prevention of fire risk had recently been created by the security service of the site: the subcontractors' operators using gas bottles (allowing them to weld) had to remove them from the worksite as soon as the work was stopped (breaks, lunch, etc.). This rule contributed to the prevention of fire risk, but it was also problematic because the on-site conditions were not conducive to operator compliance (there were no trolleys to transport the bottles; the operators could handle them but they were heavy). Therefore, the subcontractors' operators and the local PDCC were opposed to this rule, calling it "counterproductive".

"It's been three months since they've created it, and now we're just carrying the bottles. We are not allowed to store them in our boxes; we have to go to the gas place. You can imagine the additional handling. We have to hide equipment, cheat ..." (Subcontractor's Operator, Local Level)

"Then, they hide the products in the toolboxes and that's it. It does not make sense anymore. It's counterproductive, it could not get any worse! It is the Security Service that has created

this rule. In any case we have not been consulted to ... at least, to know if it was a good thing or not” (Supervisor, PDCC, Local Level)

The “prescription renewal trend” (Martin, 2012, p.62), as well as the rules that were enacted without much intra or interorganizational consultation, and the differences between the sites, are considered by the PDCC’s workers and by the subcontractors as “constraints”.

Subcontractors’ operators therefore have to carry out maintenance work while complying with a large number of local and national rules, sometimes inconvenient in the field and in a hazardous environment. To carry it out, subcontractors’ operators sometimes feel ill-equipped, and will then implement different strategies depending on their relationship with the PDCC’s workers. This is what we will attempt to show in the following part.

b. Resolving discrepancies: between cooperation, partitioning and withdrawals

It should be pointed out first that the informal and interpersonal relationships will mitigate the effects of the control-based management processes by creating cooperation, mutual aid, support, etc. Nevertheless, the contract management process, considering the contract as the “cornerstone” of inter-organizational relationships, can lead to subcontractor withdrawal.

We observed that the relationships between PDCC’ sites and their subcontractors are situated on a continuum going from a quasi-partnership relationship to a strictly contractual one. The position on this continuum will depend on several factors: the volume and sensitivity of the subcontracting operations, the history of the site, the history of the site/subcontractor relationships, the upstream contractual negotiations, the interpersonal factors, etc. Depending on the relationship, the subcontractor’s operator can implement different strategies to carry out his work. We report three different situations that we could identify.

- Situation 1: Quasi-partnership relationship, management by trust, autonomous regulation and information feedback

When the relationship is a quasi-partnership, dealing with difficulties can be partly based on the trust between the actors, which does not exclude the verification of results. This usually occurs when the subcontractor has a large volume of work to carry out, when the technician on the site did not carry out this maintenance work in the past, and when the subcontractor is not really seen as being opportunistic according to Williamson's definition: "the willingness of individuals to act in their own interest by potentially intentionally deceiving others" (Ghertman, 2003). Within this relationship, we observed the subcontractors' operators practicing an autonomous regulation on site, and then reporting it to their PDCC's supervisor, allowing feedback.

Observation of a situation of an autonomous regulation with feedback to the local PDCC

A team of subcontractors' operators (O1 and O2) carried out an intervention in the machine room. While performing the work, the equipment cannot be disassembled complying with the operating procedure. Two hours are needed for the team to find a solution and achieve the expected result by other ways than those indicated. One of the operators will then explain to his PDCC Supervisor (SUP) the manipulation performed when he checks the work:

O1: I cannot disassemble it as indicated in the operating procedure, it didn't come loose. So I did [in such another way].

SUP: Ok, anyway you had to disassemble it. The information will be transmitted, so that we don't have this problem again.

The trust relationship between PDCC and the employees of this subcontracting company was interpreted differently by the actors. According to the local PDCC's employees, this relationship exists because the subcontracting company is involved in the preparation phase, "so they are more integrated, more like partners than the others" (Intervention Department, PDCC, Local Level). According to the subcontracting company management, this relationship

exists because “*the PDCC’ manager doesn’t have the necessary experience*”. These verbatim can be compared to Gosse's (2002) analysis, which states that when there is trust between the contractor and the subcontractors, it is often “constrained (...) by [the] progressive loss of skills [of the contractor] to the benefit of the subcontractor”. Finally, for the site’s management, this relationship exists because the subcontracting company is not seen (or seldom) as opportunistic. The consequences of this trust-based management may also extend to a lack of local application of certain national control management processes that can be illustrated by the following example:

“We are supposed to check the skills of people who work on valves. It's a request from site management, but we don't do it. We trust [Company X] to put the right people in the right place. We're supposed to get the report, but we don't ask for it. We trust them” (Manager, PDCC, Local Level, Site 1)

- Situation 2 : Contractual relationship, management by control, and hidden autonomous regulation

In most cases, the relationship will tend to be more restricted to the contract terms. This was observed when the local PDCC’ workers had already (in the past) carried out the maintenance work themselves; or if the site’s workers had never carried out this work, the site-subcontractors’ relationship would be more contract-based with the subcontracting companies who carry out smaller volumes of activities, or with those who have been or are seen as opportunistic.

When the relationship is uniquely contract-based, we observed some adaptations of the procedure by the subcontractors’ operators without reporting it to the local PDCC because of a lack of trust, or because the operators had already encountered and mentioned this inaccurate procedure without seeing any change occurring. We thus observed a situation where the tools needed to carry out the maintenance work were not adapted to the equipment (the pipe listed in

the procedure did not match the equipment in which they had to insert it). After several tests, the subcontractors' operators did not report the problem to PDCC (because of a lack of time: *"if we change the tools, we have to wait for one hour at the tools' department"*); and because of a conviction that nothing would change: *"we already did it, they never changed the procedure"*), and preferred "tinkering" the tool.

This situation is certainly not desirable. But qualified subcontractors' operators only take initiatives when they are convinced that there is no danger.

"Quality is important. But I know some tricks that I use as I am experienced. I don't necessarily have the right to do it, but it makes things progress, otherwise it never does! I do my thing, it's not dangerous, but it's not like it's written in the procedure. I'm aware of what I'm doing, that there's no risk, that it's not going to blow up. I get things done, I know my job, I know my people" (Subcontractor's operator, Local Level)

- Situation 3: Full acceptance of the control regulation and withdrawal.

Finally, a third path exists: when the operating procedure is not adapted, the subcontractors' operators stop their work and transmit the inaccuracy to PDCC, who unilaterally rectifies it. This compliance frequently leads to a loss of time (from a few hours to several days).

Observation of a situation of problem transmission from subcontractor to PDCC

We followed a subcontractor's manager (SM) during his working day. He received a call from one of his operators' teams who had a problem with an intervention: the plugs they had to put on some equipment had no joints but no welding was stated in the procedure.

SM goes to the worksite, acknowledges the problem, calls the PDCC's methods department, and then transmits the solution to the operators. SM tells us: *"Nothing is stated in the work log. So, we normally don't have to weld it. To solve the problem, to ask for the solution, I have to ask to the PDCC's methods department. I don't take the initiative to say 'put paste',*

if there is any problem later on people will say 'why did you do that?'. Only the methods department can modify the procedure. They are the ones who decide”.

Despite some pride they would take in exercising and demonstrating their skills through problem solving, the subcontractors mostly reported inaccurate procedures to PDCC, encouraged by their management; according to our observations, hidden as well as shared autonomous regulation are marginal. The situation has changed: it has been reported to us that a few years ago, the partnership situations were more frequent.

“Before, they [subcontractors] were more like partners, we worked together. But today, PDCC cannot make any mistake, so we cannot operate in this way anymore” (Contract Manager, PDCC, Local Level)

Today, the regulatory need to track the work carried out as well as the contract becoming increasingly important may result in what Stoessel (2008) summarizes as follows regarding a company’s local employees, which we extend to the subcontractors: “day-to-day decisions engage the responsibility of the individual more intensively than in the past. It therefore exceeds the capacity of the operational staff, which tends to defer the decision to the people with the appropriate hierarchical status”.

“As our subcontractors are very tracked and monitored, they increasingly do everything in writing. We modify the operating procedures, we countersign them, etc. We just finished the shutdown, and we've made a lot of modifications” (Methods Service, PDCC, Local Level)

This illustrates the turn that was previously described by the Head of Contract Management (SRD), and thereby the stiffening of the contractor-subcontractor relationship: as the place of verification, of the contract and of the legal field are increasing, “proof” is needed for every action performed, everything tends to be put in writing by the actors in order not engage their (legal and personal) liability in case of errors.

However, the PDCC's unilateral regulation is nowadays questioned by the subcontractors mostly because they do not see any evolution in the PDCC's procedures over the years despite their feedback.

“We have a lot of problems. Non-Conformity Sheets (NCS) are made to change the work logs, but each year it is the same work log. We have transmitted NCSs to PDCC for 16 years, we don't even do it anymore! We know: the work should not be carried out like that. But when this work will be carried out by another subcontractor, they will make a mistake for sure. We complete the NCS only when we have no choice. If they [PDCC] sneak up on us and see that we don't do NCSs, we are dead! We say that the procedure is not adapted, they approve it, we take the work log one year later, it is still the same thing ... We are fed up with NCSs! Nobody cares!” (Subcontractor's operator, Local Level)

This lack of progression of the procedures and of the organization is also highlighted by the PDCC's workers, as well as by the Subcontractors Relationships Managers (SRM) of the sites who admit that mostly no returns are made to the subcontractors concerning their feedback, and no changes are visible. These SRMs believe that the organization of the information collection and processing has to be questioned on the sites to allow the information to be processed and used to modify the problematic procedures, organization, rules, etc.

The three situations we described above are not static, and whatever the relationship is, the subcontractor's operator can regulate the situation in different ways; however, the autonomous regulation shared with PDCC was observed only when the relationship was a quasi-partnership. The development of the information system and more cooperation are certainly needed. However, even if we have often observed it, the cooperation is not always easy to establish, whether between the local PDCC's workers or the subcontractors, for several reasons.

First of all, we have observed compartmentalized PDCC's workers on Site 2. This partitioning is simultaneously due to:

- The structure of the organization by jobs “branches”, separate entities, having no or few possibilities for exchange in order to organize their cooperation / coordination; *“In the departments, everyone makes his own branch meetings, down to the branch manager, but it is done by each department, not between the departments”* (Manager, PDCC, Local Level);
- The competition between departments to complete activities, and more specifically “the imperative of not being liable for a delay” (Lot et al., 2016); *“The mentality has changed a lot, before we did not necessarily look for someone to blame, but now for every hour we are late we need to know who, why, how, ... Then everyone writes their reports to protect themselves, to prove that he is not the one who caused the delay”* (Intervention Department, PDCC, Local Level); The pursuit of individual objectives therefore prevails over the maintenance shutdown overall objective: *“Everyone looks at their priority and will not help others”* (Manager, PDCC, Local Level);
- The PDCC’s loss of skills: *“We broke the mutual aid between the departments. It is also due to the generational renewal, projects are less under control because there is less experience, so when you have less experience what do you do? You focus on your own work before helping your friend”* (Intervention Service, PDCC, Local Level).

This may contribute to:

- The time pressure increase: *“The generational renewal has broken the mutual aid between departments. The maintenance shutdowns are not shorter than before; they haven’t changed for 10 years. But we feel an increase in time pressure, it’s just because we limited the mutual aid between departments”* (Intervention Department, PDCC, Local Level);
- A loss of time for subcontractors who are dependent on PDCC’s workers: *“The departments are passing the buck. I have a problem with an operating procedure, I go*

to see someone, he tells me 'no, I'm not doing this anymore, you have to deal with another department' ” (Subcontractor Operator, Local Level);

- A possible disruption of maintenance work: *“We sometimes end up with 10 teams on 3m² at the same time; there is a lack of coordination between PDCC’s department”* (Subcontractor Manager, Local Level).

Specifically in the field, the departments’ partitioning throughout the maintenance shutdown procedure, in addition to the temporal uncertainties and the schedule delays can cause work backup, increasing the time pressure and leading to challenging work conditions.

On Site 1 (recent, isolated, highest ranked in the subcontractors’ satisfaction survey), the most frequently stated problem was the difficult cooperation between the PDCC department employees and the project-team. The department employees see the project-team as “inexperienced”: *“I am not even talking about sub-project managers! They change every week and we end up with people who never worked on a maintenance shutdown. They don’t know the sequences between the several departments, the whole maintenance shutdown suffers”* (Intervention Department, PDCC, Local Level). They see them as being cut off from field reality, but the department employees do not always give the needed information allowing for the best organization of activities. These representations may stem from the “deep ignorance of the logic, interests and constraints of each professional territory” established by Lot and al. (2016) concerning some project-team/department employees relationships. The project-team organizes the activities in a top-down way, with few exchanges made with workers, which does not facilitate the meeting of these different logics. The only moment of “exchange” (during which the project-team gives workers information on the overall progress of the activities in a top-down way) takes place throughout the “shutdown meeting”, every morning for 20 minutes. We observed a worker expressing his difficulties during one of these meetings, but the project-team put off any discussion. These tensions were confirmed by the Subcontractors

Relationships Manager of the site: *“The difficulties that our subcontractors may encounter are nothing but the result of the tension between the project team and the PDCC’s employees”*.

The cooperation between the subcontracting companies is not easier either for two main reasons:

- They are competing: this difficulty is however mitigated (at the operators’ level) due to the fact that the company which takes over the market must take the employees of the company who loses the contract;
- But mostly, each company is legally responsible for the activity it carries out: if an error is made by a company on an activity that is not its own, the “incumbent” company who has asked for help will be held responsible. As an error may have major implications, companies prefer not to establish collaboration/cooperation relationships during working hours.

Despite these two obstacles to cooperation, the subcontractors’ employees generally know, and get along well with each other (exchange of information, “basic” mutual aid in the form of advice, etc.). Notwithstanding these difficulties, the genuine safety culture has to be emphasized, developed simultaneously by training, information and work situations that does enable to mitigate the risks.

The turn towards an increasing control-based management may change the relationship between these actors: quasi-partnership relationships – which were common a few years ago – are gradually being replaced by contract-based relationships. These relationships may place the subcontractors’ field management in a situation of withdrawal – they accept less easily the requests or arrangements from the contractor, which go beyond the original contract. It leads the operators to solve fewer and fewer difficulties by themselves (which may be desirable) or in a shared way with the contractor (this cooperation induces the respect of the rules while avoiding errors and losses of time). Rather, the subcontractors’ managers and operators tend to

put the responsibility of this regulation on the contractor. It allows them to not bear the burden of the proof in case of an incident. A greater horizontal and vertical cooperation could facilitate the communication between these actors that a control-based management increasingly distances.

c. Horizontal and vertical cooperation to be strengthened

That is why we proposed the implementation of discussion spaces, facilitating both vertical and horizontal cooperation, which could help strengthen a joint regulation, adapting the procedures and rules to the field, and thus mitigate the effects of control-based management. The necessary communication has not been sufficiently established in the existing meetings both too short and not really interactive as well as through the “Operating Experience Feedback” (OEF) device which should organize this on-site communication but often remains a dead letter and do not play its role. It is facing capitalization and transmission issues, which may lead to a loss of time during maintenance shutdowns due to PDCC’s regular internal turnover.

<p><i>“Nowadays, if we want to find the operating experience feedback of an earlier shutdown, it’s very complicated. If you didn’t work on it, you don’t know where to look. There are no common bases, where everything is tidy, clean ... It’s not transmitted to the national level”</i> (Manager, PDCC, Local Level)</p>
<p><i>“On each shutdown, they wonder how are we going to perform the [activity X], how are we going to do that, while we’ve been doing it for 30 years”</i> (Intervention Department, PDCC, Local Level)</p>

Rethinking the OEF could reinforce the often too tenuous link between the autonomous and control regulations.

Based on our studies, we proposed to invest in the development of new kinds of OEF inspired by the experiences of discussion spaces and to increase the types of actors involved in them: specifically we promoted more communication with the national levels and the subcontractors

(their management or their operators' representatives), and more horizontal and vertical exchanges. We wrote a first draft of the different discussion spaces that could be implemented and would have to be designed more thoroughly with the relevant actors; we presented them to the management of the two sites where we had conducted our research after presenting the results of our study.

Table 3: Discussion spaces proposed to the sites

The proposed discussion spaces: Participants and Topics	Justification	Concerned sites
Participants: Local PDCC and subcontractors. Topic: The real maintenance work, the difficulties encountered by the subcontractors' operators and managers.	Allows constructing "temporary" work collectives, placing managers closer to the field, developing skills through a better understanding of each other's work.	Site 1, Site 2
Participants: IS (or other rule designers) / Local Methods Department / Workers / Subcontractors' management. Topic: Adaptation of operating procedures and local rules to the field work.	Allows the direct communication between autonomous and control regulations in order to modify or co-produce rules and procedures better adapted to the real work.	Site 1, Site 2
Participants: Project-team / Workers (intra local PDCC)	Allows a better scheduling of the activities with the workers; taking into account the difficulties encountered by	Site 1

Topic: the real organization of the activities by the workers and the project-team	the actors concerning the modification of some organizational processes.	
Participants: Workers / Hierarchical line (local PDCC) Topic: the organizational work of the activities and the difficulties resulting from a lack of cooperation between the workers.	Allows constructing stronger work collectives; bringing management and workers closer; developing skills; contributing to solving the difficulties of cooperation between the different workers.	Site 2

These discussion spaces were generally approved by the management and the workers on the sites. However, the local PDCC' actors stated that they would prefer to first implement the discussion spaces to solve the PDCC's difficulties of cooperation (intra site and with the SIs). From their point of view, it was necessary to overcome the internal cooperation difficulties that may impact the subcontractors' work, before including the latter into the process. This supports our interpretation that part of the difficulties encountered by the subcontractors is rooted in the PDCC's organization.

We summarize here the reactions following our proposals.

Table 4: Sites' reactions to our discussion spaces proposals

Participants to our restitution meeting	Main reactions
Site 1 - Management	The PDCC workers / project-team discussion space: To the SRM, it is essential to solve these difficulties, which are partly leading to the ones encountered by the subcontractors.

(Subcontractors Relationships Manager SRM)	The PDCC / subcontractors discussion space: <i>“The one who always loses the game is the one who doesn’t have a say”</i> (SRM). To the SRM, it is important to understand the subcontractors’ difficulties and beyond that, to solve them with the subcontractors.
Site 2 - Management (Head of the financial management & industrial policy HFMIP ; Subcontractors Relationships Manager SRM) PDCC’ workers	<p>The HFMIP wishes to set up discussion spaces on his site and asked us for methodological support. He is convinced that the organization and procedures have to be modified with the subcontractors to mitigate their difficulties in the field.</p> <p>On the contrary, according to the SRM, there are already enough “discussion spaces” (from our point of view mainly top-down, not dedicated to change the organization or procedures, and not including subcontractors’ operators) where subcontractors can talk about their difficulties: safety meetings, subcontractors’ management boards, etc.</p> <p>The workers prefer discussion spaces to be first set up in order to modify the PDCC’s organization and specifically the relationships between the different departments. From their point of view, it is necessary to deal with intraorganizational difficulties before opening discussion spaces to the subcontractors, that they envision as “Operating Experience Feedback” taking place just after the shutdown and allowing a discussion of the difficulties encountered, the procedures that have to be modified, the inadequate communication channels, etc.</p>

4. Conclusion

Our results confirm the previous research on safety critical organizations, concerning the tensions that they experience between the standardization of imposed procedures, the

complexity of the operations to be performed, and the gaps that remain between the activity detailed scheduling and its actual proceeding.

In the case we studied, these gaps are exacerbated by three phenomena: the outsourcing of maintenance activities, which creates a workforce geographical and contractual instability and prohibits an operators' direct management by the contractor; the increase of the volume of work to be done in order to make the installation profitable and to extend its lifespan, which increase the need for outsourcing; a weakened financial situation that, when combined with a loss of the contractors' technical skills, has led to increased control management processes. Moreover, the inaccurate rules or procedures are not always rectified. This situation leads to an increase of everyone's accountability concerning the decisions taken and also the control regulation by PDCC instead of a more shared regulation (tending to decrease the ambiguity in the application of the rules). It is also leading to delays that reinforce intra and inter-organizational partitioning, and ultimately to the dwindling of an organizational slack that contributed (among other things) to the arrangements between the contractor and the subcontractors.

A relevant solution in such a constrained context would be to develop the discussion spaces which more traditional companies have experimented with; in line with the large number of cooperation efforts already supported by PDCC. The safety culture developed by all should facilitate the negotiation of a joint regulation despite the constraints, the differences of mentalities and the divergences of interest. Even if it is not the only solution (we spoke about a necessary development of the information system but the HRM of the contractor's employees would also need to be investigated), even if some difficulties inherent to the organization and its context would remain, it would allow improving the procedures, agreeing on the meaning of work and on the areas of autonomous control that can exist without compromising safety. If these discussion spaces have a cost (temporal as well as financial), it is certainly less onerous

than the hidden cost of some inefficiencies, of the circumvention of rule or of the subcontractors' withdrawal behaviors.

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