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Have the risk policy shifts related to Seveso Upper Tier establishments in France led to an improvement in risk prevention? A focus on three risk prevention tools

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Résumé — "Si vous ne pouvez pas le mesurer, vous ne pouvez pas le gérer" - Peter Drucker. La politique de prévention des risques majeurs et de gestion de crise autour de l'industrie (péto)chimique à haut risque (par exemple, les sites Seveso Seuil Haut) en France repose sur sept grands principes qui déploient différents outils/instruments. Ils vont de la réduction à la source au processus d'information et d'apprentissage par l'expérience. Par exemple, les entreprises sont tenues de soumettre dossier d'autorisation d'exploiter contenant notamment une étude de dangers (EDD) réalisée sur la base d'une analyse des risques. Sur la base de ce EDD, plusieurs autres outils sont élaborés, tels que les plans de prévention des risques technologiques (PPRT) pour la réduction des vulnérabilités, les plans d'opération interne (POI) pour l'intervention en cas de crise, et bien d'autres. Ainsi, le processus décisionnel lié à la gestion des risques s'appuie, dans une certaine mesure, sur l'évaluation des risques pour prendre de décisions "efficaces" en matière de gestion préventive des risques et de sécurité. La loi sur le risque du 30 juillet 2003, faisant suite à la catastrophe d'AZF du 21 Septembre 2001, a pris en compte les leçons de cette dernière afin d'améliorer l'effectivité de la politique de prévention et de gestion des risques d'accidents majeurs. Par conséquent, l'objectif de cette étude est d'aborder l'efficacité/effectivité de ces outils de prévention et de gestion de crise en explorant des indicateurs/indices d'évaluation pertinents et représentatifs pour chacun d'entre eux. La méthodologie mobilisée repose sur (i) l'examen du rôle des outils tel que prescrit par le texte légal, (ii) l'évaluation de l'utilisation de ces outils telle que discutée dans les rapports d'enquête et le retour d'expérience (Rex) du récent accident *Lubrizol - Normandie logistique* de 2019 (Rouen, France), et, en conséquence, (iii) le développement d'indicateurs/indices sur la base de ces résultats pour, enfin, discuter les implications de cette étude de cas. Enfin, pour chacun des trois outils choisis, l'ensemble des indicateurs identifiés et développés devrait servir un cadre d'évaluation plus holistique dans un avenir proche.

Mots-clefs — *politique publique, évaluation des politiques, gestion des risques, risques industriels majeurs.*

Abstract — "If you can't measure it, you can't manage it" – Peter Drucker. The major risk prevention and crisis management policy around the high-risk (petro)chemical industry (e.g., Seveso Upper Tier sites) in France relies on seven main principles that deploy different tools/instruments. They range from the reduction at the source till the process of information and learning from experience. For instance, operating companies are required to submit a safety

report (EDD) (i.e., in which a complete risk assessment (RA) is achieved and submitted to the regulator). Based on that EDD, several other tools are elaborated such as the Technological Risk Prevention Plans (PPRT) for the vulnerability reduction, the Internal Operation Plans (POI) for crisis intervention, and many others. Thus, the decision-making process, related to risk management, relies, to a certain level, on the RA to make "effective" preventive and sound safety management decisions. The Risk Law of 30 July 2003 proceeding the AZF explosion, a major accident that has occurred in 2001, shaped the policy evolutions for the purpose of enhancing its effectiveness in preventing and managing major accidents. Therefore, the aim of this study is to address the effectiveness of these tools by exploring relevant and representative assessment indicators/indices for each tool. The method relies on (i) the review of the tools role as prescribed by the legal text, (ii) the assessment of the use of these tools as discussed in the inquiry and learning from experience (REX) reports of the recent 2019 *Lubrizol - Normandie logistique* accident (Rouen, France), and, as a result, (iii) the development of indicators/indices that are revealed by the results and discussions of this case study. Finally, for each of the chosen three tools, the set of identified and developed indicators is expected to serve a more holistic assessment framework in the near future.

Keywords — *public policy, policy assessment, risk management, major industrial risks.*

I. INTRODUCTION

In France, since the early attempts to cope with industrial risks with the Napoleonic Code (1810), the prevention of major industrial risks have always relied on several pillars served by various tools. These pillars and tools have been going through continuous evolutions after each learning situation (e.g., major accident, political crisis, etc.). For instance, several tools were recently reinforced by the Risk Law of 30 July 2003 - also called the "Bachelot" law - following the AZF major accident that has occurred in Toulouse in 2001 (for more information about the accident's lessons learnt, refer to [1] and [2]). The induced evolutions of these prevention and management tools aimed to enhance the policy effectiveness for a better major accidents' prevention by enhancing the methods, scopes, applications, content, etc. of these tools.

The manifestation of such shifts/evolutions in the adopted approach when dealing with major risks is explicit through the design and application of different risk prevention tools. Little do we know about the effectiveness of these tools (in practice) in preventing major industrial accidents and managing crises since a limited number of studies have addressed these issues; some are summarized in this study. Also, some preliminary policy assessment indicators (i.e., number of accomplished prevention plans, payment credits, etc.) were found in governmental reports [3]–[8]. This is besides a number of specific case studies focused on the assessment of the tools' implementation in certain geographic area [9], [10].

Also, the debates over the role and the effectiveness of these tools did not escape the discussions of the inquiry commission of the 2019 *Lubrizol – Normandie Logistique* accident [11]–[13]. It is during these occurring events that the effectiveness and scrutiny of policies and tools is especially raised; major accidents are often a window of opportunity to learn and improve the prevention system. For instance, AZF major accident (2001) has served as a catalyst to adopt many changes including the reliance on the probabilistic approach in RA [1], [2] while the 2019 *Lubrizol – Normandie Logistique accident* has brought to light several blind spots as quoted in its inquiry report as follows: “*the industrial risk prevention policy deployed for 40 years in France reveals significant and unacceptable blind spots.*” [11, p. 9]. Therefore, in light of these revealed policy blind spots, there is a clear need to build a better understanding of the effectiveness of the deployed tools and approaches as no explicit “effectiveness” measurements/indicators seems to exist. This study is driven by the need to measure the effectiveness of these tools as per Peter Ducker’s quote “*if you can't measure it, you can't manage it*”.

This paper explains the boundary of these tools, their application in practice (e.g., through the recent *Lubrizol – Normandie Logistique* accident), and their coherence with respect to the set objectives. It aims to address three of these major risk prevention tools: safety reports “*étude de dangers*” (EDD), technological risk prevention plans (PPRT), and deliberation committees (CLIC/CSS). A brief global overview of the risk policy pillars in France is explained in Section II. The applied method is described in section III. Section IV explains each of the three tools (i.e., EDD, PPRT, and CLIC/CSS) by (i) clarifying the content/design of the tool, (ii) stating the tools' prescribed roles and requirements as per the Law of 30 July 2003, (ii) summarizing the related assessment studies found in the literature. Subsequently, results and discussions (section IV) include five parts: the first three parts discuss how each of the three chosen tools was addressed in the inquiry reports, the fourth part proposes a set of related assessment indicators, and the fifth part elaborates a general discussion. Main conclusions are summarized in Section VI.

II. FRENCH POLICY: INDUSTRIAL RISKS & POLICY PILLARS

Before introducing the set of major risk prevention tools, it is essential to define what major industrial risks are in the French context. According to the French regulation, the industrial risks are considered the risks resulting from two groups of industries: (i) the chemical industry and (ii) the petrochemical industry knowing that the industrial risks belong to the

category of technological risks [14]. In particular, the major industrial risks are characterized by their low probability of occurrence and significant damage reflecting a high level of uncertainties as defined by [14]. Among the risk community, there are several ways to define risks of which a definition can be limited to probabilities of occurrence and consequences' severity while another definition can include probabilities and uncertainties considerations (for more information, refer to [15]).

Having defined the industrial major risks, it must be noted that the French procedural guideline for major risk prevention policy relies on seven pillars/principles including (i) knowledge of hazards and risks, (ii) monitoring, (iii) preventive information, (iv) consideration of risks in urban planning and management, (v) vulnerability reduction, (vi) crisis anticipation/management, and (vii) learning from experience. Under each of these principles, there is a set of tools and measures designed to ensure the application of the set objectives into efficient and effective actions. For instance, the PPRT serves iv) and mainly focuses on vulnerabilities whereas EDD serves i) and mainly focuses on hazards. These tools can be grouped under regulatory, contractual, and informative type of tools. Overall, principles and tools tend to be more hazard centered than vulnerability or risk centered. Discussions about these tools are detailed in Section IV.

In particular, the industrial risk prevention approach in France relies on four main pillars including (i) the risk reduction at the source by ensuring an in-depth defense approach multiplying the independent prevention and protection layers. The State, through the intermediate of the facilities' inspection body, known as DREAL (regional directorate for environment, planning and housing) plays an important role in the preventive approach; (ii) the urbanization management by avoiding the increase, and/or reducing, the population density, around the industrial sites with major industrial risks (when this is possible). This pillar depends on the efforts of the State and the local authority; (iii) the emergency planning since the probability of an accident occurrence is never zero. Hence, among the various tools, the EDDs (safety reports), PPRTs (technological risk prevention plans), PPIs (external emergency plans), and POIs (internal operation plans) play an important role in planning emergencies and evacuation plans; (iv) the information about the possible accidents and the way to react in case of its occurrence. For this, as an example, the CLICs (local information and consultation committees) were launched by the Risk Law of 30 July 2003 to encourage the discussion and information sharing among the various stakeholders around Seveso Upper Tier (UT) sites.

The paper focuses on three of the previously mentioned tools: EDD, PPRT, and CLIC/CSS as there are three of the main tools that are required around Seveso UT sites (i.e., sites classified as the most hazardous).

III. METHOD: DOCUMENT REVIEW

A better understanding around the effectiveness of the previously deployed policy tools and approaches is needed. This study aims, by adopting a bottom-up perspective, to investigate how three of these tools (EDD, PPRT, and CLIC/CSS) were used and deployed in practice. This is

examined through the recent *Lubrizol – Normandie Logistique* accident that has occurred on 26 September 2019 in Rouen, France [13]. The study considers the changes introduced by the Risk Law of 30 July 2003 [16] and, hence, tested through this recent accident in 2019. It aims to answer the following questions: how did the actors involved in risk prevention rely on these three tools? How can the effectiveness of these tools be assessed?

The method relies on a document review aiming to address the risk prevention and crisis management tools' goals, conceptualizations, methods, and applications in practice. The case study focuses on 2019 *Lubrizol – Normandie Logistique* accident by scrutinizing three main lessons learnt reports: 300-page and 466-page inquiry reports (Tome I and II) and 135-page learning from experience (Rex) report. Lessons learnt reports, also called after action or post response reports, focus on the observations that different stakeholders (i.e., public health officials, communication experts, first responders, other local representatives, etc.) have made on a particular event (i.e., major accident, focusing event, etc.). To learn from these events, intensive investigational studies must be seen as an on-going process rather than an outcome or a goal in order to inform the policy process. This helps in finding evidence of some sort of change. The effectiveness and usefulness of these reports is debated and challenged by [17]. Considering that similar sudden events are important examples of agenda drivers and that a public policy process maintains a punctuated equilibrium until something upsetting the system occurs, this study examines an occurring event (i.e., 2019 *Lubrizol Normandie Logistique* accident) through its lessons learnt reports. Looking at these reports, the following questions are raised: How were the policy tools used in the context of the *Lubrizol – Normandie Logistique* accident? Were these tools effective? What are the implementation gaps (related to these tools) that were revealed by this accident?

Therefore, within the scope of this study, the following industrial risk management tools are considered:

- The EDD includes the risk assessment (RA) conducted by the operating company or its risk assessor as required for the Seveso UT sites.
- The PPRT regulates the urban planning around Seveso UT sites and defines a set of regulatory measures to reduce the vulnerabilities of structures and infrastructures within the PPRT perimeter. It is conducted by the State services with the participation of representatives from the industry and the municipalities “*collectivités*” concerned by the PPRT.
- The CSS (site monitoring committees), formerly known as CLIC before 2012, is based on a participatory approach “*concertation*” around Seveso UT sites. It is set up by the Prefect and includes the participation of various stakeholders.

The assessment of these tools' effectiveness can rely on different criteria and principles found in the governance literature, specifically the public and risk governance literature. For instance, ‘good’ governance relied on criteria like effectiveness, efficiency, public acceptance, fairness, etc. (refer to [15] and [18] for the complete set of criteria). Depending on the context and the scope of application, certain criteria seem to be more relevant or important than the

others. For instance, within the French context, this study relies on the criteria, also called principles, set by the Ministry of Ecological Transition (MTE). Without challenging the exhaustivity and the definitions of these criteria at this stage of the study, the considered assessment criteria are summarized in TABLE I as they were listed in [19].

TABLE I: CRITERIA/PRINCIPLES OF A GOOD ASSESSMENT PROCESS [19].

Criteria /Principle	Brief explanation
Impartiality	A sufficiently autonomous decision-making process must be ensured to avoid any possible conflict of interests throughout the entire process.
Transparency	The content of the assessment, tools, process, etc. throughout its lifecycle (i.e., data, methods, etc.) must be explicit.
Pluralism	Various points of views of, not only experts, but also, diversified stakeholders must be included as an integral part of the assessment.
Competence	The individuals involved in the assessment process/tool lifecycle must have specific qualifications, experiences, and recognition by peers to be considered as expert assessor.
Exhaustivity /Completeness	All known data must be included and all biases, gaps, approximations, etc. must be identified and clarified.
Trackability	A posteriori reading by a third party should be possible for the purpose of reconstructing the choices made and facilitating monitoring of the actions and their subsequent consequences.
Proportionality	The consideration of the used means with respect to the considered issues must be considered.

The motivation of this work is driven by the need to pave the way towards the measurement and the categorization of necessary assessment criteria related to the effectiveness of these tools.

IV. THREE POLICY TOOLS: CONTENT, PRESCRIPTIONS, AND ASSESSMENT

A. EDD: a shift from a vulnerability-centred deterministic approach to a more hazard-centred deterministic-probabilistic approach

1) What is an EDD?

Risk assessment is a fundamental component of the safety report (EDD). An EDD is submitted upon the licensing request by the operating facility. It serves the elaboration of the POI, PPI, and PPRT. Its technical summary serves the public inquiry conveniently placed in the calendar before the prefectural *arrêté* (equivalent to a license for operation) as well. Before the Risk law of 30 July 2003, the French procedure mainly relied on a deterministic approach where

the RA considers, in some cases, the maximal potential consequences associated to major accident scenarios. Back then, based on the maximum expected values, when accident scenarios crossed the boundaries of the industrial site/plant, constructions were restricted around the sites. This draws on the concept of protecting people exposed to maximum risks/major accidents using different tools other than the EDD. EDD allows to react to scenarios confined within the site boundary. With the introduction of the probabilistic approach at a territorial level through the Risk Law of 30 July 2003, the conceptualization of the risk in the space started to rely more on the probability of occurrence of an event by combining hazards, exposure, stakes, and vulnerability. The concerned calculations relied on three components: (i) probability of occurrence, (ii) severity of consequences, and (iii) risk acceptability which result in mapping their product in a certain geographical area (e.g., hazard maps). Consequently, the risk analysis, based on which the PPRTs are elaborated, relies now on a semi-quantitative approach to cope with the use of probabilities; this is coupled with a hazard mapping weighted by the probabilities' intervals while relying on the expected severity of the effects. Thus, post-AZF accident's safety reports should, now, describe, to each of the potential accidents, the probability of occurrence, the kinetic, and the severity. This considers one category of uncertainties (i.e., temporal uncertainties) behind unexpected events, scenarios, and consequences and, thus, neglects the other uncertainties.

2) *What does the Risk Law mention regarding the EDD?*

Article 4 of the Risk law mentions the obligation to submit an EDD (safety report) by the operating facility requesting an environmental authorization (AE). As per this article, the EDD must then (i) precise the risks to which the facilities are (in)directly exposed in case of an accident including both internal and external sources; (ii) include a risk assessment that takes into account the probability of occurrence, kinetics, and severity of potential accidents based on an explicit method; and (iii) define and justify the proper measures to reduce the probabilities and effects of these accidents.

3) *How was the effectiveness of EDD addressed in the literature?*

The **safety reports (EDD)** include the risk assessment that can follow a deterministic, a probabilistic, or a combined approach. For instance, [20] scrutinized the level of the representativeness of the probabilistic approach when it comes to the real representation of the territorial risk challenges. They highlighted some of the encountered challenges such as: (i) the limitation to the quantitative vision of the probabilistic approach in the territorial management combining the product of the probability and the severity where the severity is strictly reduced to the number of direct victims; (ii) the resulting blurriness around hazard factors and their nature (e.g., thermal, toxic, overpressure) induced from the usage of the probabilistic approach; (iii) the various meanings given by different actors to the terms "probability" and "severity" (effects or harms); (iv) the lack of harmonization of the criticality grid used by different operating companies. Also, on a more technical note, [21, p. 43] compared the deterministic and the probabilistic approach at different stages of the risk analysis. As a result,

they encouraged the combination of both approaches and the careful application of each depending on the case under study.

B. *PPRT: a shift from facility-centred to neighbouring-centred prevention approach*

1) *What is a PPRT?*

The urbanization management has been firstly instituted through the transposition of the first Seveso directive (1980) into the French law through plans that are annexed to the local urbanization plans (PLU). Since the 1990s, the shift towards the control of the urbanization in the major natural risks prevention policies has been obvious by mapping the "protection perimeters" that determine construction limitations and, hence, population proximities from zones at risk. The tools serving the control over urbanization include both (i) the public utility easement compensated by the operating high-risk facilities considered as the source of risks and (ii) the PPRT. In particular, the PPRT was firstly proposed following the AZF accident within an inter-ministerial reunion on 28 September 2001 in Toulouse. The first meetings in which the PPRT was proposed came as a result of (i) "political crisis" after the AZF accident fueled by (ii) an important media intervention especially by the mayors of the municipalities where the industry existed within their territories [22]. The scope of the PPRT aims to both (i) limit future risks from getting worst by restricting/controlling the urbanization and (ii) fix the currently dangerous situations around high-risk sites. Overall, the PPRT aims to maintain the chemical and petrochemical industry in their territory while ensuring a management of the urbanization and protection of the neighboring residents by identifying the potential accidents' severity and ensuring a cohabitation of the concerned facilities in these territories. Besides its technical role, PPRT has served as a tool to co-design a local prevention policy and restore the political acceptance following the lessons learnt from a major accident like AZF.

2) *What does the Risk Law prescribe regarding the PPRT?*

The PPRT is one of the major tools for the technological risk management in France at a territorial level. It relies on inputs derived from other tools including both the EDD mainly (section A) and the CLIC (section CB). Its elaboration involves different stakeholders besides the State services. Its output is annexed to the PLU (Local Urbanization Plan) as well. The PPRTs were initially established by the law Barnier of 2 February 1995 for the natural risks before being elaborated for the technological risks through the Risk Law on 30 July 2003. It aims to regulate the land use planning in the municipalities prone to major risks. Four documents constitute the PPRT including (i) a note on the plan presentation, (ii) documents explaining the vulnerable stakes in hazard maps (i.e., including thermal, overpressure, and toxic effects), (iii) different regulations explaining the measures to be implemented, and (iv) some recommendations to reinforce the population protection.

Article 5 and 6 of the risk law mentions that the **State** elaborates and puts in place a PPRT for the purpose of

limiting the effects of potential accidents that can intervene at a facility subject to a public servitude and can have effects on the public sanitation, health, and safety directly or through the pollution of the environment. The measures expected by the PPRT are gradually put in place, by the State services, **depending on (i) probability, (ii) severity (i.e., related to the potential number of victims or irreversibly affected individuals), and (iii) kinetics (i.e., velocity of occurrence) of potential accidents** within the protection perimeter of the PPRT that takes into account **(iv) the intensity (e.g., physical effect in a single point) and (v) the nature of technological risks** (e.g., thermal, toxic and overpressure effects) as stated in the EDDs. Based on this information, the perimeter of the “technological hazards” are drawn. The implementation of these measures depends also on the balance between the **cost required to implement these measures and the expected gain in safety**. This reflects a ‘nonexplicit’ cost-benefit analysis approach. Also, the Prefect gathers opinions of the involved (i) operating facilities; (ii) municipalities; (iii) inter-municipal public establishment for cooperation around urban planning; and (iv) CLIC to submit them to the public inquiry for the final approval which is achieved through a prefectural *arrêté*. PPRTs are related to not only the Code of the Environment but also the Code of Urban Planning where the property pre-emption, expropriation and dereliction mechanisms can be applied. Also, the legal text (Risk Law) does not specify the way with which the PPRT-related measures are constructed or/and locally put in place. For this the Ministry of Ecological Transition produced a text detailing the principles of elaboration of a PPRT [22]. Despite having the PPRTs focused on **risks outside of the site**, it seems to start including some risk reduction measures at the source as stated in [12, p. 335]. This has pushed the operating facilities to invest millions of euros to comply with the PPRT requirements at this level as it will be subsequently discussed.

3) *How was the effectiveness of PPRT addressed in the literature?*

The evolution of the PPRT elaboration and their applications was addressed in [22] by revealing the positive effects of PPRT and some of the encountered limitations upon their implementations. Also, several case studies related to the implementation of the PPRT were encountered. The results of these studies were rather specific to a certain area than generic. In other words, they addressed the implementation of these tools in a specific geographical area. For example, in the Bouches-du-Rhône, the study tested some hypotheses related to the trust around refineries and anti-PPRT mobilizations [10]. Also, in the Dunkirk area (North of France), the dynamics of risk governance within the occurring shifts and transitions were explored [9].

C. *CLIC: a shift from an expert-centred top-down approach to a more inclusive dialogue-based approach*

1) *What is a CLIC?*

Communication and stakeholders dialogue are considered as one policy instrument to encourage changes. Drawing on the Aarhus Convention (1998) that made the public participation a fundamental principle of the environmental law at the level of the European Union (EU) Member States. This is besides the Seveso I Directive (1982) and the European Council

Directive of 7 June 1990 related to the public rights to information. In the mid-twentieth century, the French participatory democracy originated in regionalization and decentralization policies. For instance, the environmental governance in France, through the environmental pact of the Grenelle (2007-2012), involved more stakeholders in the consultation process leading to decisions that are better understood and more democratic. Also, after the AZF accident, the Risk law was promulgated to, among several objectives, reinforce the implementation of the PPRTs and create mandatory consultation bodies around Seveso Upper Tier sites. Thus, it can be noticed that CLICs are also related to the elaboration of the previously mentioned PPRTs; it is considered a key for the long-term effectiveness of the PPRT through the inclusiveness of various stakeholders. The participation can refer to the “*contribution to the preparation of a project, by offering opinions and viewpoints*” that will contribute to the decision making process [23, p. 19]. In February 2012, these CLICs were transformed into CSS (Site monitoring committee) grouping five categories of stakeholders defined in the “Environmental Grenelle” and the Code of Environment (Article R125-8-2) as follows: State administration, territorial municipalities, ICPEs/operating facilities, workers at the classified facilities, and neighboring residents. The CSS is required by the Prefect for every industrial basin including one or various facilities with environmental authorization (AE). Seveso Lower Tier (LT) sites can be also subject to a CSS if the Prefect decides to request a CSS. These committees are informed about the ICPEs projects and incidents. CSS can provide opinions regarding the POI of ICPEs. It is finally intended to improve the relationship between industrial facilities and the residents.

2) *What does the Risk Law mention regarding the CLIC?*

Based on Article 2 of the Risk law, CLICs are created by the Prefect (regulator) for each industrial basin. In particular, the Prefect can call for third expertise in some cases. He/she is kept informed about incidents/accidents related to classified facilities and is provided by the State means to fulfil the required tasks. CLICs are also involved in the elaboration of PPRTs as per Art. L515-22.

3) *How was the effectiveness of CLIC/CSS addressed in the literature?*

The role and the limitations of the **public participation** around industrial sites was addressed in [24] by zooming on (i) the trust and transparency that were proven to be high in local authorities such as firefighters, police, and mayors in Dunkirk and low in industrial actors in certain studies and paradoxically high in others; (ii) asymmetries between participants associated with the scientific complexity and the differences in value systems; (iii) legitimacy of the participants who often include retirees and lack young and working people; (iv) (in)formal discussion spaces where the formal structure was judged as not providing equal opportunities to different participants while the informal bodies lacked the presence of the administrative authority; and (v) the intersection of the participation process with the decision making process; this means that the politico-industrial actors (especially involved in the decision making process) were predominating the participation devices while the public opinion weighs depended on the selected approach.

V. RESULTS AND DISCUSSIONS

This section examines the use of each of the three tools through the three learning from experience (REX) (or lessons learnt) and inquiry reports.

A. How was the EDD mentioned in the 2019 inquiry and LFE reports?

EDD was mentioned 8, 16, and 13 times in Tome I of the inquiry report, Tome II of the inquiry report, and the LFE report respectively. The EDD, which must be elaborated by the operating facility, is one of the main pre-requisites for licensing requests.

The reliance on the EDD during the crisis management has been thoroughly discussed in these reports. For instance, when it comes to the monitoring plan, INERIS has relied on the EDD and the information communicated by the DREAL (classified facilities' inspection body) to have information regarding the **products that might have been involved in the fire**. As a result, this has led to a relatively "high number" of substances to be investigated through the post-accident assessments [25, p. 119]. Also, the DREAL and the Sdis (firefighters) have relied on the first analysis of the EDD **to evacuate the most hazardous substances** [25, p. 45]. Additionally, a detail regarding the exemption of the concerned facility from the **obligation of a safety report** in 2019, despite being subject of an environmental authorization (i.e., highest licensing grade), was mentioned in Tome II. This exemption has benefited from the law evolution [12, p. 104]. Moreover, acknowledging the vital and fundamental role of the EDD in risk management and in risk communication arounds high-risk sites between the operating facilities and the administration, **the sufficiency of the considered accident scenarios** in the EDD was criticized (as in the 8 November *arrêté*) [12, p. 173] similarly to the non-considered scenario revealed through the AZF accident case in 2001. Also, the **focus of the EDD on acute, severe, and immediate risks** around Seveso sites neglected the health consequences at medium and long term resulting from the inhalation of fire smokes or through the effects on the environment where the pollutants fallbacks settle [12, p. 218], [25, p. 25]. This has raised a transparency issue. The accident has, also, revealed the difficulty to access, **in real time**, by the administration, **the information regarding the stocked material, health risks, and molecules** to be looked for within the first samples [25, p. 25]. Hence, they urge the need to **integrate diverse health effects** in the risk prevention tools such as the EDD, POI, and PPI. Yet, it was debated that the toxicity cercles of the accident scenarios have already existed in the EDD [12, p. 337].

Finally, looking at these issues, several indications regarding the completeness/impartiality, transparency, and communication ease around the EDD content/details are revealed important. All the raised concerns, gaps, and usages urge the need to enrich the management tools and the indicators taken into account to serve the assessment of the "effectiveness" of these tools throughout their whole lifecycle.

B. How was the PPRT mentioned during the Lubrizol accident investigation?

The PPRT was mentioned 57, 85, and 3 times in the inquiry report Tome I, Tome II, and LFE reports respectively. *Lubrizol* is part of a PPRT elaborated by an *arrêté* on 31 March 2014 and including the municipalities of *Rouen* and *Petit-Quevilly*. The PPRT concerns the Seveso UT sites and aims to reduce the exposure of the sites' surrounding to residual risks through the control of the urbanization around the sites. Ten PPRTs exist in the Seine-Maritime department in which Rouen exists. They were approved between 2010 and 2018 [25, p. 24]. PPRTs are elaborated by the State services under the Prefect authority. They aim to find the balance between (i) the public health and environment protection and (ii) the coexistence of industrial activities on the territory.

The first appearance of the PPRT was related to the **three types of major hazards ("acute"/short term)** considered in the PPRT (i.e., thermal, mechanical, and toxic). It was later linked to the detection of deficiencies in the fire prevention system and the FM Global insurance (insurance company) report that declared having noted deficiencies in the retention system since 2008 as well (p.40). Yet, it must be noted that the insurance company's observations are considered as recommendations with no legal obligations. Additionally, it was revealed that the elaboration rules of the PPRT need to adapt to the **specificity of the zones** taking into account their industrial platforms and cultures and, hence, calling for a collective governance (e.g., to mutualize resources among different site to cope with fires for instance). Moreover, the **communication channels** in some involved municipalities within the PPRT were not efficient (e.g., Petit Quevilly residents were forgotten by the communication). Additionally, the PPRT elaboration process was launched in 2003 (p.97) and accomplished in 2014 which means a **PPRT elaboration time** of 11 years. Besides, the implementations of land-use planning measures have not led to satisfying results (e.g., 18% of these measures are achieved). Also, the **State budget credits** related to the technical risk prevention within the PPRT context has been decreasing over the past years; the budget includes (i) the PPRT elaboration; (ii) supplementary measures alternative to the land reform measures of the PPRT; and (iii) the land reform measures proposed within the PPRT scope. A mechanism of **cost advances** to the individuals must be instituted. A **gap between the voted budget by the finance law and the spent budget in practice** was highlighted (p.100). As per the PPRT, in the areas where the construction is forbidden, the human and immaterial damage are not covered by the technological catastrophe guarantees since they are covered by the common law of responsibility. Finally, it was noted that the local actors feel the **property price depreciation** upon the application of the PPRT despite having this impact limited as demonstrated by some economic studies (e.g., [26] and [27]). At the level of the pluralism and actors' involvement, **the mayors (local actors) do not feel/feel little associated** to the elaboration of PPRTs and PPIs that are organized by the State services. Finally, the information communicated by the PPRT, PPI, or any other safety-related public document might be subject to changes with respect to

the information principle to further consider the “malicious acts” reasons. Therefore, several issues related to PPRT’s costs, scope, and perception of the local actors regarding its elaboration and the implementation were highlighted through this case study. This calls for indicators that can serve the measurement of the effectiveness of the PPRTs.

Before proposing the assessment indicators, it must be noted that, 15 years after launching the PPRT, the estimated costs of PPRTs in France ranged between **1.4 and 1.5 billion euros of which 1.2 billion euros** are for urban planning/land reform measures as mentioned in [22]. This justifies the rising interests of the territorial stakeholders in the industrial risks themes and illustrates the price of reconciliations between the industrial facilities and their neighboring residents in urban areas. Also, between 2008 and 2010, the investment of the operating companies has increased from **one hundred million euros to 200-300 million euros per year** resulting in a one billion euros saving and 350 saved km² due to the avoidance of the land reform measures as estimated by the MTE. Thus, the role of the PPRT is not limited to the process of risk assessment and transcriptions, but it also includes the (i) important role of different actors in its elaboration and the induced decisions at each stage of the procedures and (ii) PPRT’s by-product role in pushing the operating companies to invest in the safety of their facilities to avoid the extra cost related to urban property management and protection measures [22]. This is associated to the “deconfinement” of the industrial risk questions beyond the sphere of expertise (i.e., the operating companies and the State services) to further include mayors, local representatives, etc.

C. How was CLIC/CSS mentioned and used during the Lubrizol accident?

CLIC/CSS was mentioned 17, 2, and 1 time (s) in the Tome I, Tome II, and LFE reports, respectively. Additionally, there are nine mentions of a committee for transparency and dialogue in the LFE report.

Based on the commission inquiry, launched through the Senate platform, the conclusions regarding the information and inclusion of different stakeholders in these committees are the following:

- 62% of the mayors have declared a lack of information regarding the industrial risks and 78% have declared to be not/little associated to the civil safety exercises.
- The social demands of the public appeared to be unsatisfied as revealed by the commission inquiry.
- The structure of the CLIC appeared to be unbalanced as more State services representatives were present.
- Also, the process of informing the public lacked local and national animation.

Thus, there is a need to transform **the CSS into a tool for the residents/public** and consider operating facilities as a participant with a consultative role [11, p. 17]. Also, the **over-representation of the State services** in the CSS was mentioned my *France Nature Environnement (FNE)*. This is besides the critique that the CSS Rouen had an **inactive status** between 2014 and 2016 as stated in [11, p. 209] with a lack of coordination between the local and national scale.

Additionally, sharing the ICPE inspection reports with the CSS members and the public was encouraged to be able to communicate with the company. “*The risk of an industrial accident does not inspire the public to take action unless and until it affects their daily life*” - [24]. The lack of the citizens’ participation in public inquiries and public consultations is not a recent issue despite the continuous efforts of the relevant authorities and the operating facilities to include them [24]. This was related to several reasons: (i) the abstract nature of risks for the residents until an accident occurs, (ii) the psychological protection that euphemizes risks, (iii) the perception of risks as being a familiar element of the daily life, and (iv) the need to defend certain socio-economic interests, etc. as discussed in [24, p. 22]. There is hence a necessity to reinforce (i) the understanding of how risk is perceived by the residents and (ii) the role of local media in enhancing the knowledge around both acute and chronic risks.

The participation process is as rewarding as challenging for not only the public/civil society but also project managers and policymakers. Thus, in order to serve the assessment purpose and build a better understanding of the outcomes of this public participation, [24] has called for the necessity to introduce indicators to measure the impacts of the citizens’ expertise on the public action quality by measuring (i) the exercise of the democratic demonstration (considered as the main goal besides the following benefits); (ii) the capacity to counterbalance stereotypes and preconceived ideas about others (rather than denying them); (iii) the capacity to make conflicts explicit; (iv) the education of the stakeholders about risks to reduce their amplifications or distortions of risk analyses; and (v) the fostered mutual understanding, social learning and cooperation.

D. What are the relevant effectiveness assessment indicators related to the EDD, PPRT, and CLIC?

Drawing on these analyses and discussions related to the 2019 *Lubrizol – Normandie Logistique* accident, the following indicators (Appendix - Table 3) are identified as essential to complete the holistic assessment framework.

E. General discussions

Various tools are mobilized to explicit and manage risks induced by and around high-risk industrial sites, also called Seveso Upper Tier (UT) sites. They include the EDD, PPRT, CLIC/CSS, POI, PPI (specific intervention plan), DICRIM (municipal information document on major risks), PCS (communal safeguard plan), and many others as shown in Fig. 1. This study assesses the first three tools by reviewing what is prescribed and by analyzing what is applied in practice through the inquiry and REX reports.

Firstly, despite having each of these tools/documents elaborated by different entities at different scales as summarized in TABLE II, they are inter-related as illustrated in Fig. 1 where some are elaborated based on the outputs of other tools. For instance, the EDD, elaborated by the operating company, constitutes the main input to the other tools including the PPRT as illustrated in Fig. 1. This

highlights the importance of the EDD based on which other planning documents are conceived. This must guide the assessment chain to be able to point the “deeper” effectiveness problems (i.e., that go beyond the ultimate outcome assessments) when it comes to the implementation of the various tools.

As shown in this study, the required information related to each tool was not always sufficient; for this, the socio-economic-political considerations of these tools are essential. Stakeholders’ interests and perceptions have proven to be an important component when addressing the effectiveness of these tools in practice where each phase appears to rely on a certain tool rather than the other as shown in Fig. 2. The proposed indicators/indices in this study aim to address the multidimensionality of the “effectiveness” of these tools by shedding the light on the encountered challenges in practice rather than on paper to guide future policy improvements.

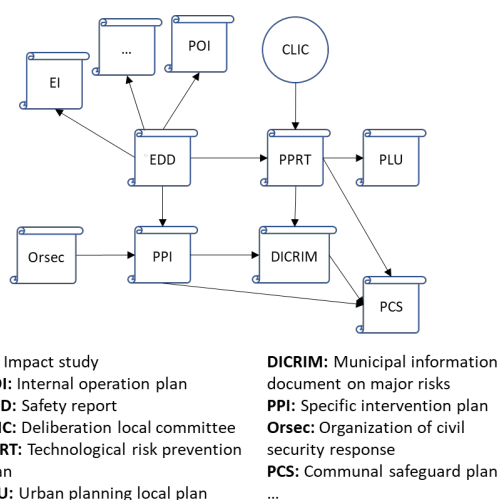


Fig. 1. The interrelated risk prevention and crisis management tools.



Fig. 2. The main reliance on each policy tool for each phase.

TABLE II: SUMMARY OF THREE RISK PREVENTION TOOLS AS APPLIED TO THE SEVESO UT SITES.

Tool	Scale	Scope	Created by	Lifespan	Cost	Tool Type and Status for UT	Legal Text	Related to policy principle
EDD	Facility level	Risks inside the facility	Operating facility	Updated every 5 years at most or 3 years as per art. 6 (or when changes are planned to occur on the sites).	No studies are available	Risk management tool and a requirement for authorization/licensing request. Applied for facilities subject to the Authorization regime, sometimes for the ones subject to Registration, or upon a particular request of an administration (DREAL/DRIEE for example). Compulsory for Seveso UT or facilities with AE.	Risk Law – art. 4	Principle 1: knowledge about risks and hazards phenomena
PPRT	Municipal / Inter-municipal by considering the worst-case scenario perimeter around the facility	Risks outside the facility	The State. PPRT is defined by the Prefect.	It takes 18 months (extendable once) to elaborate it. Yet, it takes 4 to 10 years in practice.	1.4 – 1.5 billion euros over the 10-year effective PPRT launching.	Land-use planning and vulnerability reduction tool. Compulsory for Seveso UT sites.	Risk Law – art. 5	Principle 4: risk consideration in urban planning and urban management
CSS (Ex CLIC)	Industrial basin	Deliberation regarding risks in general	Prefect	Not specified	No studies are available	Informational and dialogue tool. Compulsory around Seveso UT.	Risk Law – art. 2	Principle 3: preventive information and education of the population

VI. CONCLUSION

The motivation of this study is in line with the citation highlighted in the inspection strategy “*If the procedures related to the documents and the technical analyses of the processes and the results of measurements constitute a powerful tool for action by the State, they must be supplemented by actions as close as possible to the field which makes it possible to provide competences and guarantees additional information on risk and pollution control*” [28]. Thus, this raises the following question: did the regulatory and methodological evolutions integrated by the Risk of 30 July 2003 bring improvements to the risk prevention and crisis management policy in France? This study addresses the policy tools’ effectiveness question by reviewing what is prescribed by the Law of 30 July 2003 and what is practically applied through the inquiry and REX reports related to the *Lubrizol – Normandie Logistique* accident that has occurred in Rouen (France) in 2019. The scope of this study includes three of the many mandatory tools/instruments needed around Seveso UT sites: EDD, PPRT, and CLIC/CSS. In order to answer the need to develop assessment indicators to track the effectiveness of these tools, the results highlight: (i) the necessity to consider the undefined notion of technico-socio-economic acceptability to

cope with the trade-off between the risk prevention and the local economy balance sheet; (ii) the limitations of defining the probability approach as an improvement while, in some cases, it is hiding the weight of some scenarios especially when transferred to other tools such as the PPRT; (iii) the necessity to introduce the indicators concept to check the effectiveness since the beginning of the process so stakeholders know the formality of the assessment; (iv) the need to have a better proportional number of representatives of different stakeholders within the elaboration of different tools (e.g., CLIC) to avoid transforming the risk prevention tools into legitimacy tools for the industrial actors; and (v) the need to get closer to the inspection to collect some evidence on whether these shifts (e.g., moving towards the probabilistic approach) have eased their work and simplified the communication with the other actors or not. Finally, many indices and indicators are indirectly raised in the debates as noted in the inquiry reports. They necessitate to be framed, grouped, and translated into explicit indicators to ensure their consideration and tracking in the following discussions. The outcomes of this study fall in line with the need to define these raised issues and transform them into trackable indicators to put “effective” tools in practice. Future interviews aim at addressing the completeness of these indicators to develop a holistic assessment framework.

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Appendix - Table 3: List of the proposed assessment indicators for each of the three tools: EDD, PPRT, and CLIC.

Assessment criteria	EDD-related assessment indicators	PPRT-related assessment indicators/indices	CLIC-related assessment indicators/indices
Impartiality	NA	NA	- Knowledge about stereotypes and preconceived ideas regarding others to have the capacity to counterbalance rather than deny them. - Information symmetry by sharing the inspection reports with the CSS/public to be able to communicate with the operating facilities.
Transparency	- Accessibility/presence of an updated digital and/or physical list of the stored materials.	- Side effects of the PPRT include pushing the local urban development towards an “industrial ecosystem” by having intervention at various levels as follows: <ul style="list-style-type: none"> • Numbers related to the prescribed maintenance work at the level of housing or sites • Numbers related to the reduction of vulnerability at the level of a neighbourhood • Numbers related to the preventive procedures leading to a relocation at an industrial site level - Side effects of the PPRT that push the operating companies to adopt alternative strategies to avoid the costs of the land reform measures: <ul style="list-style-type: none"> • Numbers related to the strategy of declassification from Seveso UT to Seveso LT • Numbers related to the strategy of activity transfer by relocating the sites to fewer problematic sites • Numbers related to the strategy of site reorganisation by relocating the facilities to the most far location from the neighbouring residents • Numbers related to the strategy of adding safety barriers to reduce risks (these barriers can be added without taking into account the major accidents scenario). 	- Expose the arguments that lead to conflict.
Pluralism	NA	- Time of the elaboration of the PPRT depends on (i) amount of information needed and the variety of the stakeholder values; (ii) the balance between the measures for risk reduction at the source for the sake of the industrial sites’ safety and urban planning measures for vulnerability reductions; and (iii) the implementation issues faced by the on-site actors. - Recognition of the present stakeholders’ interests to better articulate the technical judgement criteria - Evolvement (via active roles) of different territorial stakeholders and responsibility shifting/expansion - Aggregating the objectives related to the neighboring residents’ safety, the local urban management options, and the industrial development perspectives. - Shares revealing the involvement of the five groups of actors in the PPRT - Insurance companies’ potential inputs in the PPRT might be relevant	- Foster mutual understanding, social learning, and cooperation - Consider the CLIC as an exercise of the democratic demonstration - Percentage of mayors informed about major industrial risks (of the ones involved in the PPRT at least) - Percentage of mayors involved in the civil safety exercises - Representatives’ share of the CLIC - the ratio of the number of public-representatives over operating company-representatives to express the power representativeness - Having the operating companies as consultative role and make the CSS a tool for the public - The ratio of the number of public-representatives over State services-members.
Competences	NA	- Applicability of certain land reform measures (i.e., expropriation and abandonment) as they remain difficult - Sufficiency/problems of the know-how and competencies of the actors responsible for the risk assessment (i.e., especially at the operating facilities and the DREAL) - Verified communication chains in all the involved municipalities in the PPRT	- Improving stakeholders’ risk culture.
Exhaustivity	- Sufficiency of the accident scenarios considered in the EDD. - Completeness/impartiality of the effects included in an EDD - Possibility to be exempted from the EDD (flexibility/holes related to the “obligatory” status of an EDD) - Consideration of the intersection of the scope of EDD (i.e., it concerns risks and measures within the perimeter of the company) with the scope of other tools such as the PPRT (i.e., it concerns risks and measures outside the site; it has recently started to include some risk reduction measures inside the company).	- Multiplication of the discussion points around PPRT (sometimes considered negative/ineffective) - Pertinence, acceptability, and applicability of the measures prescribed by the PPRT. - Easier visualization of risks (including its four technical criteria) and user-friendly hazard maps intended to be involved in decisions relative to urban management.	NA
Trackability	- Easiness to access and verify real-time information (e.g., have the main essentials listed in few pages to be consulted in case of an accident)	- Data on land reform measures: number of expropriation procedures and number of abandonment measures	- Active status updates of the CSS (i.e., by setting some required organized meetings with their full minutes)
Proportionality	NA	- Mutualization between the different operating companies and the fire departmental services of the same industrial basin of a PPRT - The gap between the voted credits by the finance law and the effective credits used in practice - Property price changes in function of its distance (in km) from an industrial site.	NA