Towards an analytics and an ethics of expertise: Learning from decision aiding experiences in public risk assessment and risk management

Myriam Merad, Nicolas Dechy, Michel Llory, Frédéric Marcel, Alexis Tsoukiàs

Laboratoire d'Analyses et Modélisation de Systèmes pour l'Aide à la Décision
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Myriam Merad[1], Nicolas Dechy[2], Michel Llory[3], Frédéric Marcel[1], Alexis Tsoukias[4]

myriam.merad@ineris.fr

[1]: *INERIS, Parc technologique ALATA, BP2, 60550 Verneuil en Halatte, France.*

[2]: *IRSN, BP 17 - 92262 Fontenay-aux-Roses Cedex, France.*

[3]: *Senior scientist, France.*

[4] : *Université Paris Dauphine. Place du maréchal de Lattre de Tassigny, Paris, France.*

Abstract

Public expertise in safety, security and environment is a process that is increasingly submitted to control and transparency. It therefore requires an oversight, a monitoring and an aiding approach on its conduct and its governance. Difficulties learned from experiences in framing risk problems and sharing expertise conclusions and recommendations are pointed. Our practice of expertise has made clear to us that "expertise is a decision aiding process for a decision-maker which contains other decision aiding processes for the experts involved. To overcome this paradox, we argue on the need of a generic integrated framework for expertise that allows framing a valid and a legitimate expertise process and conclusions. Public expertise is then defined and main concepts are explicated and discussed to frame what we have called an expertise analytics and ethics.

Keywords

Expertise, risks, analytics, ethics, safety, security and environment.

Introduction

Majors technological disasters and accidents around the world, like for example Minamata in the early 1950s and 1960s or more recently AZF in Toulouse (France) in 2001or Fukushima in 2011, regulation such as Aarhus convention in 1998, controversies and societal mobilizations have contributed to discuss the limits of public decision-making in Safety, Security and Environment (SSE). Public expertise, as a decision aiding process and as a part of the decision-making process in SSE, is nowadays questioned by public opinion and subject to doubts and criticisms.

Decision aiding process has already been discussed by Roy (1993), Bouyssou et al. (2000, 2006) and Tsoukias (2007). A decision aiding process implies the existence of at least a Client (that can represent the DM and other actors) and an Analyst. This process makes sense with respect to one or more decision processes (Tsoukias, 2007). SSE decision processes are mainly public because they deal with "public objects or goods" with respect to Ostrom (2005) definition: *goods or objects with low subtractability of use and a high difficulty of excluding potential beneficiaries*. These objects are of interests for different actors that are for some of them public actors (e.g. Ministry, local administrations …) (Ostanello and Tsoukiàs, 1993). These public actors are, in a large majority of situations, responsible and accountable of the decisions that will be taken in SSE.

Expertise in SSE is a public decision aiding process according to the above definition. The complexity of situations in SSE, the intrinsic uncertainty on the public objects and the variability of interaction situations between the Expert, the Client, the DM, the other actors make the process of Expertise and the impact of expertise conclusions difficult to predict. That is why the Expertise process in SSE is also a "Public decision process" that needs a decision aiding process. In this last situation, the Client can be a set of experts and the Analyst can be a member of the expertise team. The Analyst must excel in methods on the conduct and the governance of expertise and on one or different domain in SSE.

In (Merad, 2010) we discussed about the concept of public expertise as a link between the scientific and the political worlds. For some people, public expertise in SSE is limited to the *mastering of scientific knowledge* without being influenced by the ongoing regulations, socio-economical, political and technical contexts. The objective is to provide a technical and scientific expertise that is strictly independent from the decision process. For some others, the expertise is an Art based on experiences and intuitions which can only be recognized by peers. In that sense, it is extremely difficult to describe the underlying mechanism of expertise. For others, the expertise in SSE is the development of know-how in the application of the standards and rules in practice. For some others, expertise is a *function* defined by the administration (in the sense that if a member of a public expertise agency is performing an expertise then he is an expert) and not a *characteristic* (someone is involved in a public expertise because of his methodological and/or scientific knowledge and experience)[1]. So to speak, public expertise depends on specific *endogenous characteristics*, such as for example neutrality, competence, the ability to negotiation the capacities of communication, and on *exogenous* characteristics, such as for example the function, the mandate and peer recognition. The reader can complete this discussion *in* Favro (2009) and Merad (2010).

In this paper, we argue that public expertise needs a decision aiding to experts. We then propose an integrated framework for an analytics and an ethics of expertise in its conduct and its governance. Conducting a public expertise in SSE consists in describing the context of expertise, in formulating and modeling the expertise issues and problems and in framing consistent conclusions. Governance of public expertise in SSE refers to decisions-making, actions, processes, regulation, traditions, organizations and institutions that characterized the way expertise is organized, regulated and SSE conclusions are taken into account, accepted, negotiated with stakeholders and implemented in SSE decision process. This integrated framework is submitted to two mains conditions: validity and legitimacy.

In section I we will describe some open questions about legitimacy and validity of expertise in SSE. First answers will be provided and the state of the art will be discussed and an integrated framework for an analytics and an ethics of expertise will be introduced. Section II will be dedicated to define more precisely public expertise and main concepts will be explicated and discussed. Section III is dedicated to precise the way the integrated framework is structured based on engineering of decision aiding process to support expertise in SSE experience feedback.

[1] This distinction seems to be trivial. The reader may argue that the function is obtained by the experience and the scientific/technical knowledge. It is not always the case.

I. Early contributions to study the validity and the legitimacy of expertise in SSE

A. *Learning from experience: open questions and first answers*

Given a long experience working on the field of risk prevention within the public domain on natural and on technological hazards, we have always been facing along the road with what some will consider as being "ethical considerations". We have then faced questions such as "Expertise is separated from Decision: Why do you feel so concerned by the potentials outcomes of your recommendation?" and "What can you possibly learn and give as added values by investigating the decision and governance context and re-questioning the usual expertise methods?".

Nowadays, these ethical considerations are numerous following the continual sliding between what is a *science conclusion* and what is an *expertise conclusion*. Of course, nor "science" nor "expertise" are neutrals. But expertise, as a decision aiding tool to giving insights to public decision-making, must capture our vigilance. Michaels (2008) and Oreskes & Conway (2010) have provided significant contributions that show, in our point of view, how expertise (*and not science*) is exploited to defend private or self-interest with huge impacts on health, safety, security and environment (eg. cigarette manufacturers strategies or the use of bisphenol A), producing doubt biasing scientific controversy and discrediting the value of *public expertise*. It may create a discredit on the value, the credibility, the legitimacy and all others considerations that are expected from public expertise.

Considering these first basic questions and observations, what can be our answers?

Our first answer is that, if validity, robustness, legitimacy and coherence of expertise process, methodologies and conclusions when dealing with Safety, Security or Environmental (SSE) issues are not often patent and direct causes of major accidents and disasters, experience feedback shows that they are in-depth and structural vulnerability factors of public policies in this field. Learning from accidents, means sharing more than a "safety and/or a risk culture" but a "culture of accidents" (Dechy et al., 2010) that help Expert and Analyst in materializing the outcomes of theirs studies that are rarely accessible for in-lab safety or/and risk prevention theoreticians.

The second answer would be that our concern is of course about an "ethics of expertise" but not about a "*morality*" of expertise (what should or not be done according to absolute rules?). An ethics of expertise should provide answers about "how to conduct and organize an expertise process? Who should or have to be involved and consulted? When and how should the process be done? What should be done and organized when facing deep uncertainty, dilemmas and opposite, fragmented or contradictory expertise conclusions?".

Our last point is that questioning the way expertise is performed in SSE has an immediate link with the public policy assessment issues. Expertise is a process that produces outcomes or results and is often summarized or assessed according to them. Some others way of paying attention to expertise is to focus on the legitimacy of *the expertise process* or on the *expert' status.* In fact since SSE issues are public and can be collective or common concerns, it is necessary for the public arena to assess and analyze the impact on SSE of the conduct and the governance of the expertise. Testimonies about how expertise is in practice organized and governed in context is a powerful tool to bring to the forth the underlying limits and advantages. Let us notice that the idea of assessing expertise is attractive but difficult to implement operationally speaking. Indeed, there is a need for both *an analytics examination to both methods to implement and the context* of expertise and also for *an ethics that act like a monitoring system or an introspective approach on expertise in SSE*.

Decisions, policies and actions in Safety, Security and Environment (SSE) seem in our times to be driven by science where experts are considered as being neutral by the fact that they are not involved in a decision process and follow scientific codes. They should be scientifically robust in the sense where they frame and they resolve problems according to best and up to date scientific knowledge.

B. *The state of the art: from fragmented contributions to an integrated approach*

The scientific literature in this field, that will be presented hereafter, shows that this question was studied in a fragmented way. In SSE, the problem of the consistency of expertise was studied by the engineering community. Expert judgment is considered as separate from "value judgment" and the main objective is, according to specific case studies, to be able to develop procedures to elicitate expert judgment and to select experts to be a part of a collective expertise process (Goossens et al., 2008). Many protocols and methods were developed to deal with problems such as post accident investigations or risk prevention. Major contributions were done in the field of nuclear safety (see for example Lannoy and Procaccia, 1996) and for chemical and petrochemical plants (see for example Cooke and Goossens, 2000).

Other authors have focused their attention on the issue of transparency, validation and how to frame more democratic expertise and decision making processes when dealing with risk analysis and risk management processes (*see* for example Renn, 1998; Reid, 1999; Assmuth and Hilde, 2008; Rosqvist, 2010). Indeed, since stakeholders' opinions where considered, by a large majority of the engineering community in SSE as none consistent and too emotional, the main issue was to fight against these ideas. In fact, stakeholders are impacted and affected by the decisions and the conclusions of expertise; they should be consulted and involved in the decision aid and in the decision-making processes. Guidelines and contributions such as Renn (1991), IRGC (2006) and Renn (2008) were central for the SSE' scientific and practitioner community.

Complexities of systems and of decision contexts and situations have also captured the attention. Main contributions were given to deal with these issue and support experts on choosing the right models (Gertman et al., 1996; Horlick-Jones, 1998; Lagergren, 1998; Amendola, 2001; Fairbrother et al., 2007).

The characteristics of the accidents investigation domain in SSE has enlighten the difficulties faced when dealing with tricky and strategic decision situations such as attributing responsibility (or even blame) for juridical needs. Analysts/Experts are often under political and administrative constraints in their process of determining causal links. In these circumstances, it is often advocated that they should be independent from Justice, Authorities and Businesses but competent enough which set a stable dilemma (ESReDA, 2009, Dechy et al., 2012 – a, 2012-b; Dien et al., 2012). In the same subject, Llory (2000) has explored some engineering ethical questioning when performing a risk analysis in socio-technical systems and has given some insights based on experience of major accidents.

More largely then in the field of SSE, many authors have focused their attention on the issue of how to make choices and decision and how to reduce biases.

Strategies to prevent perception biases were suggested: see for example the four strategies proposed by Fischhoff (*in* Kahneman et al., 1982)[2] or the works done by Stanovich and West (2000)[3]. Epstein (1994) and Slovic et al. (2002) have suggested a way to move from an intuitive mode of reasoning to an analytical one where Kahneman and Lovallo (1993) have suggested strategy that consists in taking into account the point of view of an outside actor. Other strategies were suggested that encourage the actors to take a contrary view to allow them to reconsider their choice conditions or understand the process of cognition and what follows in terms of biases to be able to reduce them (see Slovic and Fischhoff, 1977 and Fischhoff in Kahneman et al., 1982).

In Merad (2010) and Merad et al. (2011) we proposed a methodology to support the conduct of expertise in risk analysis and risk management based primarily on the idea that the fact of putting into perspective the expertise driving conditions enabled to reduce biases. Even if the expertise can be regarded as public decision aiding (Figure 1), the expertise process itself needs a support in the sense of a decision aiding.

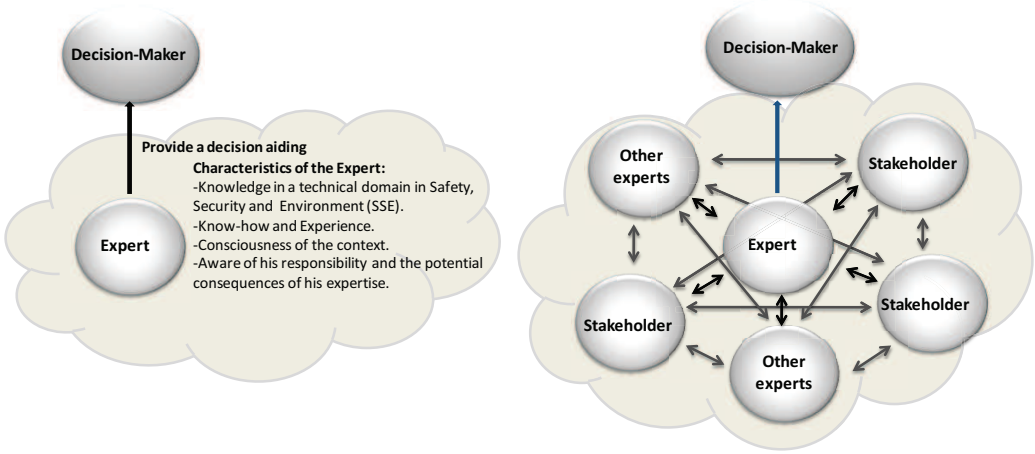

Figure 1. Expertise in SSE as a decision aiding process for Decision-Maker (Left- Situation of expertise in SSE with an Expert and a Decision-maker; Right- More complex situation in expertise)

We have then proposed a methodological approach to fill out the conditions of a participative and deliberative model of expertise (*see* Merad, Dechy and Marcel, 2011) (*see* section I, A). We have

[2] (i) implement the alerts on the possibility of bias, (ii) describe the direction and the sense of the bias, (iii) provide feedback, and (iv) implement a training program with experience feedback, coaching and other interventions in order to improve the judgment.

[3] The authors suggested distinguishing the system 1, which refers to an intuitive system that is fast, automatic, effortless, implicit and emotional, from the system 2 more reasoned, slower, more aware, more explicit application efforts and is regarded as logic. The great difficulty is to switch the actors of the system 1 to system 2. Different strategies are then possible.

considered that the expert performs in a conscious manner or not, in his work of expertise a set of choices, based on his level of knowledge, his level of experience, his culture, the context of its intervention, etc. The expert is therefore, in the process of analysis, individually or collectively, in a manner akin to a decision-maker (in the sense where he has the power to define the framework and the terms of the expertise process and is responsible for the technical credibility of its findings) (Figure 2).

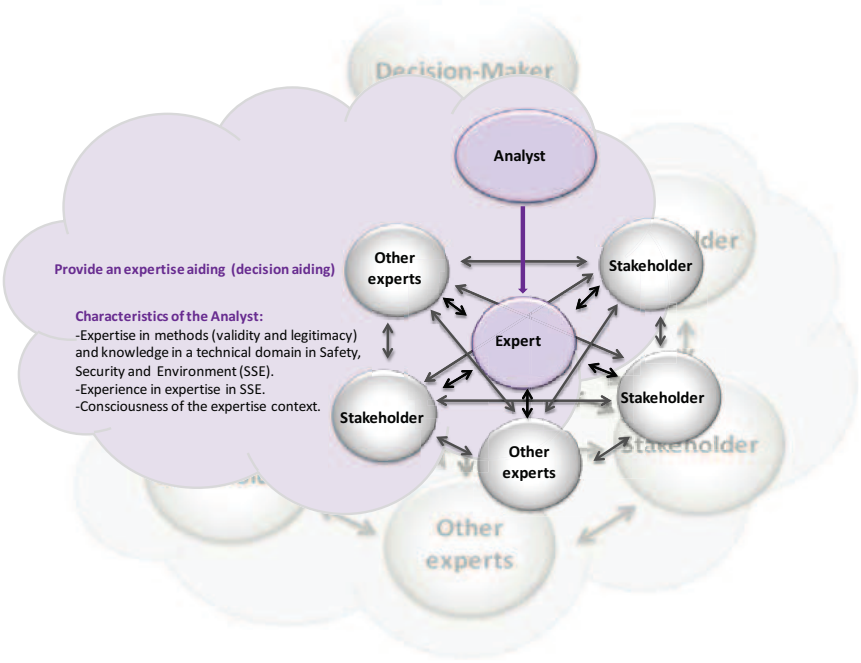

Figure 2. Expertise in SSE: A need for a decision aiding process for Experts

In this paper we suggest that there is a need for an integrated framework of *expertise analytics* and *expertise ethics* (see Figure 3) that should be based on: (1) experience feedback about practical experiences of the practice and governance of expertise in SSE in order to explicit the lacks and the *good practices* that were identified and developed *in context*, (2) explicit observations and recommendations. This last point must be distinguished from procedures. In fact, we do not want to develop norms about expertise such as the NF X 50-developed by AFNOR (2003). Our purpose is to provide, for both public expertise practitioners and stakeholders a framework to assess and appraise the conduct and the governance of a public expertise in SSE and develop a critical lecture of aptitudes and attitudes before, during and after an expertise process. Indeed, we would like to provide an integrated framework that is endogenous to the public risk decision world and not only exogenous like norms use to be.

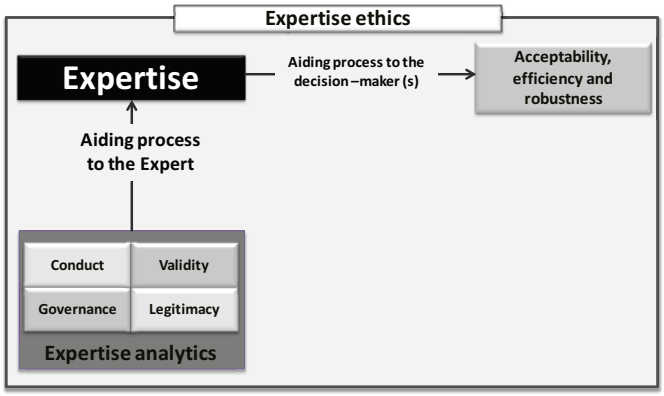

Figure 3. Analytics and ethics of expertise: an integrated framework

Sharing good and bad experiences on expertise in SSE is fundamental but not easy to get. This can have many explanations depending on the culture and the regulatory constraints within a country. In fact, expertise is a part of the regulatory system in SSE; and SSEs are common and public concerns. So, pointing such as potential lacks or biases in the governance or the conduct of expertise can be considered as critics to the public decision makers. Let us consider for example the disparity of practices when coming to the sharing of experiences about accidents investigation, some countries are more transparent

than others and are more prone to provide easily documentation to the general public (Llory et Montmayeul, 2010; Merad, 2010).
When being involved in and/or conducting a public expertise in SSE, experts and analysts are not facing a theoretical simplified *in vitro* situation but are imbedded *in vivo* in complex situations with a multiplicity of constraints and components that cannot be easily isolated. They are discussed on section II.

II. Public expertise: organization, problems and conclusions

When dealing with high risk industries or natural hazards with potential catastrophic outcomes, they often become more regulated after major accidents and disasters (see for example post AZF Toulouse disaster in September 2001 in Dechy et al. (2004) and the promulgation of a risk law in France in July 2003 in Merad and Dechy (2010)). Safety, security and environment (SSE) are public common goods. Depending on countries, the State organizes, according to his administrative and local culture, a way to protect the citizens and their goods from short, middle and long terms potential harms. Public expertise is then institutionalized and organized in order to explicit and assesses the risks induced by a technology (e.g. implementation of a chemical or petrochemical plant) or induced by natural hazards (e.g. flooding, earthquake). Let us share an example on how the public expertise is schematically organized in France.
In France, public expertise in SSE is divided into different agencies. Each agency has a specific field of competence (ex. nuclear, health, chemical and petrochemical, etc.) and is under the supervision of one, two or several ministries. These agencies are funded by the public sector and can have different legal status that allow them carrying different activities (such as public expertise, research and commercial activities) and can be balanced by private and public funds. Public expertise agencies support ministries in framing laws and national risk prevention guidelines, anticipating future problems and developing solutions by conducting research activities. Depending on their status, public expertise agencies can have the possibility to self-referring (auto-mandate) when a SSE problem occurs in the public arena (Figure 4). But, in the large majority of cases, these agencies are mandated by the State, or by the ministry that supervises the agency, or by the inspection (that is in charge of auditing and controlling that the regulation is well applied in SSE). If a private stakeholder (ex. Industrial operator) asks for an expertise to a public agency, this is done in the context of a *business contract*.

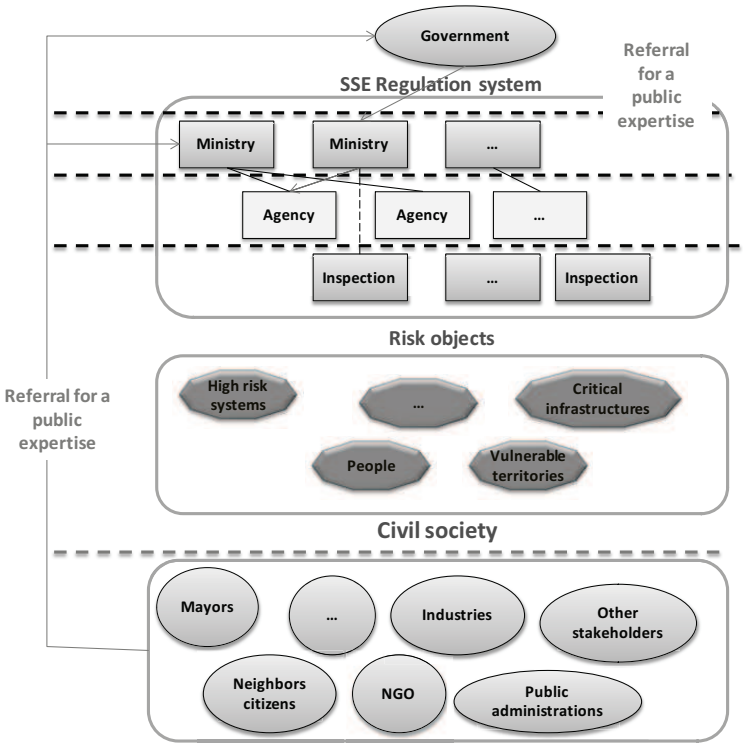

Figure 4. SSE public expertise in France

In UK or in the USA, public expertises in SSE are not always similar to the French context. Research is sometimes separated from main expertise done for the regulation activities. Inspection and expertise can be grouped in the same organization (see for example in the UK, the HSL and the HSE, the EPA and the NRC in USA).
Public expertise institutes or agencies can perform individual or collective expertise to give a decision aid support to the public authorities. Let us notice that agencies differ from institution by the fact that they

have objectives in terms or risk reduction and prevention, and institutions must contribute to risk prevention. The expertise is called an *individual* one when a member of the agency is requested for his/her scientific or technical knowledge to inform solely the public decision making. The knowledge mobilized for the expertise is in majority in one or multiple SSE scientific and regulatory domain and/or it is the case also for methodological knowledge on the way to organize risk assessment, risk management and/or risk communication processes. The large majority of situations, the expertise is called a *collective* one. That means that multiple domains and/or methodological experts are mobilized to enlighten the public decision-making in SSE.
As a part of the SSE public decision process, the expertise process is a decision aiding one that is nor linear nor static. This last process is under the influence of public decision makers, scientists, industrial operators, NGO, mayors, citizens, other expertise organizations and to other set of stakeholders.

C. Three models of expertise and situations of interaction between actors

In Merad, Dechy and Marcel (2011) we suggested four levels of stakeholder participation (information, consultation, association and deliberation) according to the impact level of stakeholder participation on final decision making and to the level of equality between the decision-maker (DM) and other stakeholders. This allows to distinguish three models of expertise that can give an interesting insight on the way public expertise is organized in different countries.
Model I is based on an information model of public participation where there is a strict separation between risk assessment, risk management and risk communication. This model was and is still dominant in France and in several other countries. In this model, we faced classical interaction situations in SSE that consists in bi-actors situation: a Decision-Maker (DM) (and/or his contractor) that come with a formulated issue or problem and an expertise agency that is asked for bringing a practical technical solution.
The model II is based on a consultative framework of public participation where specification of the way risk is assessed is given by explicating the underlying arguments and the collectives' rules of risk framing. In this second model, expertise should provide a possibility to be audited and should be transparent. Procedures must then be traceable and experts must be independent. Since the ratification of the Aarhus on the Access to Information, Public Participation in Decision-making and *Access to Justice in Environmental Matters* that was adopted on 25th June 1998, public expertise agencies aim at following this model of expertise. In France, this model was re-transcribed in a more proceduralization of expertise: institutionalization of quality assurance system, set up of deontology committees and promulgation of deontology procedures and booklets, involvement of NGO in the board of director and scientific board meetings and promulgation of charter of "opening of expertise to civil society"[4]. This tentative of transformation of expertise towards more openness to civil society was strongly influenced by the Canadian model such as Environment Canada. However, the proceduralization of expertise is more due to the French administrative culture and also mostly influenced by the application of the ISO 9001. This model presents different interaction situations in SSE that included the situation presented in model I and the following ones:

- DM is in interaction with the Expert (Analyst). Other actors/ stakeholders are concerned and impacted by the SSE issue. The Expert, or the DM, is in charge of considering their opinions, preferences and their expectations. The Expert can be expert in a specific domain in SSE or a methodological expert (ex. facilitator). The expert is asked to bring a practical solution, or/and to reduce the level of uncertainty and/or ambiguity on a specific situation
- DM and different actors present an issue to the Expert (methodology, domains). Expertise agency is asked to frame SSE issue and sometime to slide from giving recommendations to making the decision.

In the model III, expertise is based on a participative and deliberative framework of public participation that includes the Model II of expertise. Questions such as legitimacy and validity of procedures and experts knowledge are raised with respect to their limits and to the way they were produced. Until now, this approach has not faced a big success. Maybe due to the fact that it is difficult to find a way that makes it technically and organizationally operational, effective and efficient. In this paper, we will give a contribution to this model.

[4] See for example the charter signed by the expertise institutions such as IRSN, INERIS, CEMAGREF (IRSTEA), IFSTTAR and ANSES: http://www.irsn.fr/FR/Actualites_presse/Communiques_et_dossiers_de_presse/Pages/20110909_Charte-ouverture-societe_expertise_inter-instituts.aspx.

D. *What is the problem?*

Studying how public problems are framed in SSE is not a trivial task. Some problems are explicitly raised by a DM after an event (e.g. Accident investigation after the explosion of an ammonium- nitrate chemical plant in Toulouse (France) in 2001) or due to new regulatory constraints (eg. Land-use planning around Seveso Plants due to the application of Seveso II directive and the French national law on risks prevention 30th July 2003), some others are the result of a social dynamic following controversies, conflicts or whistleblower alerts (eg. Asbestos, nanotechnologies or bisphenol A). These problems are risk problems that can be simple, complex, uncertain or ambiguous (IRGC, 2006; Merad and Mazri, 2007; Merad, 2010). They can have an impact on a local, regional, national or extra-national scale; they can involve and/or impact a few actors or a large set of actors. In fact, expertise problems in SSE are delimited in an explicit or implicit contract between the expert/analyst and the DM (Figure 5). In the contract, the DM gives his appraisal of the perceived risk problem. The Analyst must give his recommendations according to the perceived risk problem fixed in the contract.

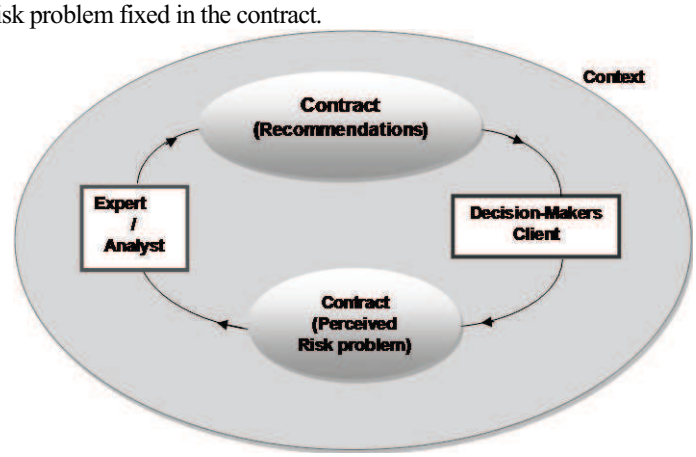

Figure 5. How the risk problem is framed? A contract between the Expert and the Decision-Maker (DM)

The main starting difficulty for the expert/analyst is to be able to frame a co-perception of the risk problem. This is not always the case (Table 1). When perception is identical (Situation C, Table 1), the contract is well framed that means that the resources are adjusted according to the constraints. When the gap in perception, denoted $\Delta_{\text{Risk perc}}$, is significant, the constraints and stakes on the contract can be over (Situation A, Table 1) or under estimated (Situation B, Table 1).

Table 1. Gap of perception ($\Delta_{\text{Risk perc}}$), between the DMs and the Experts of risk problem

Perceived risk problem by the DM		Perceived risk problem by the expert			
		Simple	*Complex*	*Uncertainty*	*Ambiguity*
	Simple	**Situation C**	**Situation B**		
	Complex	**Situation A**	**Situation C**		
	Uncertainty			**Situation C**	
	Ambiguity				**Situation C**

In situations A or B, experts will have to take more time stating and framing the contractual expertise context with the DM and the underlying impact on the conduct of the expertise process. Let us remark that even if the contract between the DM and the expert is a preliminary condition to start the expertise, the interaction all along the expertise process will make the problem evolving with time and even change in nature. Indeed, the expertise process is a *diachronic* process that should be traceable.
Framing adapted, sound, accepted and robust conclusions of expertise will then depend on two major conditions: validity and legitimacy. These two conditions will be explicated hereafter.

E. *Conclusions and recommendations: What can be the outcomes of the expertise process?*

Public SSE expertise is a decision aid process. In that sense the outcome of the expertise process is neither a *decision-making* action (e.g. Expropriation when houses are in the red hazard zone at the vicinity of a hazardous plant and submitted to explosion phenomena) nor a *scientific evidence*. Outcomes are *recommendations*, *conclusions* that can be *prescriptive* (eg. according to these observations, the set of measures that should be considered to improve safety) or *explicative* (e.g. Accidents database provide heterogeneous information, the method used to assess the probability of accident scenarios is different from a plant to another) that could have impacts on different territorial, social, economical or

environmental scales, which could then concern variable number of actors. As risk problems, expertise conclusions can take different aspects:

- *Information*. That can be for example a level of probability of the occurrence of a dreaded event such as explosion of an industrial plant for example or the impact distance with lethal effects. That can also be an observation such as for example conformity or not to ongoing standards in safety within a chemical plant (conformity or not).
- *Diagnosis* or/and *analysis*. Post-accident investigations are an example (see examples *in* Dechy et al., 2011 and Dechy et al., 2012-b).
- *Approach*, *methodology, method, process, procedure or tool*. That can be for example the development of a national guideline for land-use planning around Seveso High Threshold plants (see for example Merad et al., 2008).

These expertise conclusions depend on the nature of the risk problem (see Table 1). The less the risk problem is perceived as simple by the DMs, the more the public expertise process is piecemeal framed and the final conclusion is based on *fragmented* sub-expertise conclusions that are seldom connected.

III. Toward a generic integrated framework to an analytics and an ethics of expertise

Being involved in SSE public expertise and sharing experiences on SSE expertise have helped us to address several kinds of issues. That is why we suggest a generic integrated framework (Figure 6) aiding at: (i) *expliciting* the way expertise is conducted and governed to be able to identify a set of biases and constraints, and (ii) *suggesting some prescriptions* to frame valid and legitimate expertise conclusions. We mainly framed our approach by being strongly influenced by the *grounded theory* (Martin et al., 1986; Allan, 2003; Kelle, 2005; Thomas and James, 2006) and by the works done by David (2001) that has contributed to provide a theoretical basis to the conception-task.
Figure 6 provides an overview of our proposal of necessary aspects to consider when dealing with expertise issue.

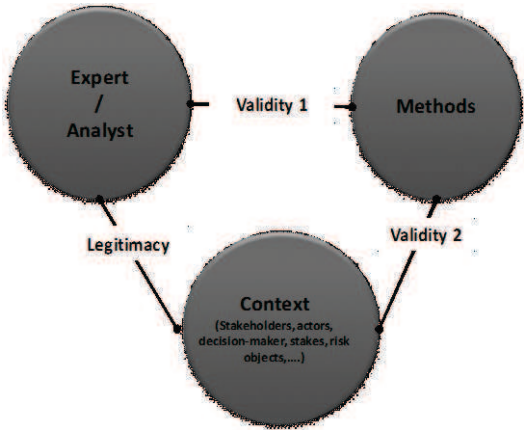

Figure 6. Integrated framework for SSE' expertise analytics

To understand the way expertise is conducted and governed, it is useful to explicit three mains aspects that define expertise:

- The *expert characteristics*: who is mandated (a group, an institution …)? What are their scientific and technical cultures? How expertise is organized and managed? …
- The *context* and its characteristics: who are the actors involved including the DM? What are the sets of stakes and constraints (scientific, technical, economical, regulatory, media…)? ...
- The *methods*: what kind of approaches, models and tools are used? What kinds of disciplines are mobilized? What are the limits of their approaches? ...

The triptych defined by the interactions between [Expert (Analyst)-the context -the methods] fixes the conditions of *validity* and *legitimacy* of expertise. When dealing with SSE, analysts are not often free to reframe their mandate or their contractual conditions even if it is necessary. In fact, strong contextual and internal constraints like regulations (e.g. laws) and procedures (e.g. good practices) should be respected. Moreover, the legitimacy and the validity of the expertise process and of the conclusions depend not only on the precision of the technical data and knowledge, but are also directly or indirectly influenced by a multitude of other dimensions such as financial, social, legal aspects, etc. These interacting dimensions are sometimes difficult to predict, to explicit and it remains hard to qualify their impacts.
Thus, experts have, before, during and after a study, to explicit what were their choices, their assumptions and preferences knowing the set of limits and constraints they were subject to, what are the uncertainties

about their data and what are the robustness of their conclusions. Let us say that expertise is submitted to a *constraint field* (see Figure 7) with a large set of constraints that must be considered.
In what follow, we have made a distinction between the *conduct of expertise* and the *governance of expertise (see* Figure 8*).*

Figure 7. SSE Expertise under a constraint field

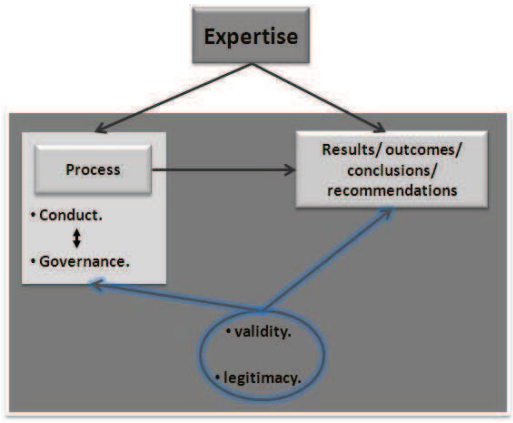

Figure 8. Conduct and governance of public expertise process in SSE under validity and legitimacy oversight

A. *Some insights about validity and legitimacy conditions*

As we have previously stated that identifying, fixing expertise problems, choosing an expertise method and framing conclusions are critical issues. Indeed, there is a need to pay now attention to the way problems are framed and to the way methods are chosen to frame recommendations.

- *A.1. About validation*

Insuring the liability, the consistency, the robustness or let us say the *validity* of expertise means that there is a need *to explicit the context of the conduct of expertise, the biases on the framing of expertise and the ones induced by methods* that are chosen and the limits and robustness of expertise conclusions. The decision aid literature has contributed to give interesting insights about the *validation process* that should be used by the Analyst (*see* Landry et al., 1983). Four aspects are suggested:

- the *conceptual validation*,
- the *validation of the logical* consistency of the model,
- the *experimental validation* by using data coming from real life situations, and
- the *operational validation* that consists in following the daily life of the model.

When dealing with SSE and risk problems, what can be transferred and adapted about validation? In what follow, we have distinguished two categories of validation:

- validation of category 1 (*Validation 1*) that includes the conceptual and the logical validations (see Figure 6), and
- the validation of category 2 *(Validation 2*) that includes the experimental and the operational validations (see Figure 6).

Expertise conclusions must effectively contribute to reduce risks for health, environment and goods. The DMs and other impacted and/or involved stakeholders should understood both the process of expertise, but also the conclusions in terms of added value and in terms of limits. This operational validation can be obtained only *ex post*. On the other hand, organizational measures can be taken *ex ante* and during the process of expertise to ensure achieving this kind of validation. Such measures can be to better understand the context of expertise and to learn from experience feedbacks from *good practices* or *successes* or *failures* in SSE expertise processes. This experience feedback can be of different kinds: sociological and quasi- ethnological descriptions, such as for example the description of the Challenger launch decision by NASA as described in Vaughan (1996), or some more compact and resumed descriptions such as for example the organizational investigations of accident in Llory and Montmayeul (2010). This last point can also contribute to the *experimental validation.*

But, it is never easy to benefit from the sharing of *failures* in SSE expertise processes. First, because there is a reluctance to point these aspects and then because there can be some significant juridical/legal,

political and societal impacts. More discussions can be found on Dechy et al. (2011 and 2012-b), Llory and Montmayeul (2010) and Cicolella and Benoit-Browaey (2005). Let us for example point the AZF Toulouse expertise (Jacob and Seillan, 2012) and the way risks induced by Asbestos were recognized (Chateauraynaud and Torny, 1999).

Norms, rules, regulation, good practices,… are numerous in SSE. They depend on the nature of risk, the sector of activity (eg. Chemical and petro-chemical, nuclear,…), the national and/or organizational culture.

Indeed, conceptual validation can be subdivided in two categories: validation to fixed concepts and validation to consensual concepts (*soft laws*). Let us illustrate our last point by a French example on the way land-use planning was defined on territories above mines. A risk zoning was done by an expertise agency on 1999 based on an ongoing definition and conceptualization of risk of mining subsidence such as: a function of probability of occurrence of a subsidence and of an expert judgment (meaning qualitative assessment) on the sensitivity of the stability of the configurations of mining exploitation. Three years after, the consensus on risk definition has changed. Risk was then defined as a combination between hazards (eg. Collapse and subsidence) and the vulnerability of stakes. More precisions about the example can be found on Merad (2010). Risk is in this example a consensual concept that changes during time that makes the conceptual validation difficult to obtain for the whole expertise process.

Of course, some references of this conceptual validation can be obtain in looking to some aspects of the expertise process that are based on some mathematical, chemical or physical stabilized concepts. Indeed, conceptual validation is hardly applicable to public SSE expertise process. Let us finish with the last but not least, the *validation of the logical* consistency of the model. Experience feedback show us once again that it is complicated to find expert that excel in "*methods based expertise*" or in "*system based expertise*" but it is very hard to find expert that both excel in knowing *systems and methods*. Let us give for example the systematic errors that are done when assessing the probability of occurrence of accident scenarios during the framing of safety studies for chemical plants (see Merad, 2011). Indeed, the problem of logical validation could be tackled by framing adapted training programs that help framing a culture of methods and systems at the same time.

- *A.2. About legitimacy*

Now, how about the *legitimacy* of public expertise in SSE? This aspect is considered in the way analyst will:

- try to consider the contextual and the organizational condition of the problem' emergence as stated by his client. Tsoukias (2007) suggested that the way the problem is stated can be consider as a *pretext* to start the decision aid process;
- take care in building a relationship between the client and him, making parallel with the relation between a patient and his doctor, by the fact that the relationship between the two of them is legitimate by the time that is invested by the doctor in an active listening;
- take care of the impact of the recommendations after all.

Considering contextual and organizational aspects seems to be of equivalent importance in both validity condition and legitimacy condition. How about risk problem? Let us point that in public expertise in SSE, the risk problem is, in the majority of cases object to a *contractual agreement*. If this one is verbal, it is possible to consider the risk problem stated by the DMs (or his representative) as an *attention-catcher* or *introduction* to the expertise process. This is rarely the case. The contractual agreement is more often written, expert is directly or indirectly more or less subordinate to the DM (eg. Public authority) and, even if it is possible to discuss the limit of the problem in a research project or in some *ad hoc* committees and commissions, reframing the limits of the risk problem had better to be one of the given conclusions to the DM, in addition to giving an *answer* to his stated risk problem, then a starting point of the expertise process. Let us say that we do think that considering contextual and organizational conditions and reframing the risk problem will be useful for the expert/analyst considering deontological and practical expertise concerns.

Investing time in building a relationship between the expert and the DM is of course fundamental. Mainly because it will help to arrive at a convergence in the perception of the risk problem (see table 1); and it will also help in establishing a common vision of the stakes, the means and the constraints that will occur during the expertise process. But this relationship must not be limited to these two parties. Other stakeholders should and must be included in this time framing. Firstly because that will help to consider other aspects of the problem that were not identified and pointed, deliberately or not, by the DM. Secondly, due to the fact that even if the client is the DM by himself or by his representative, the SSE public expertise real client is neither tangible nor immediately visible but is the main thing in *public services* "*working to prevent risks for citizens/peoples and ensure health, safety and security with respect to environment*". Therefore, other actors and stakeholders should be, or let us say must be, involved and consulted. Let us finely point a limitation produced by the interaction between an Expert and a DM (like Analyst and his patient) that consists on an *imposed* one or a co-framed (*simultaneous)* blindness on the

framing of problems and on the consciousness of the potential impacts of expertise conclusions. In SSE public expertise, many examples can be done that have an influence on the limitation of the risk problem framing, organizing the expertise process and framing conclusions. The story of the *Minamata disease*[5] which is the most severe methyl mercury poisoning and one of the most severe health disaster of the history of chemical industry that occurred in the 1950s and 1960s and caused by man-made environmental pollution is an illustrative example. Many other lessons can be of course learned from the Minamata disaster.

Taking care of the impacts of expertise conclusions can be obtained by considering the context of expertise and decision-making in public SSE risk problem. Unfortunately, let us point that some ongoing norms (see NF X 50-110 of AFNOR) in expertise don't seem to be prone of this idea. Why? Because it is a common argument to presuppose that strict separation between expertise and decision and their impacts will increase neutrality and then legitimacy of expertise conclusions.

After all and in other words, what can we suggest to increase the *quality and the reliability* of both the conduct and the governance of public SSE expertise? Let us resume our discussion here after (see Table 2) on how to incorporate the two major principles such as validity one and legitimacy one.

Table 2. How to implement the validity and the legitimacy principles for expertise analytics and ethics

Principles	Characteristics	Key questions
Validity	*Robustness*	Are risk problem well stated? Are the conclusions framed using consistent methods? Are the biases considered and reduced?
	Effectiveness	Will the risks be reduced for people, goods and environment?
	Efficiency	Is the expertise process taking into consideration contextual constraints? Are conclusions context-effective?
	Sustainability	Will the conclusions remain consistent in the medium and the long terms?
Legitimacy	*Transparency*	Are the expertise process and the conclusions clearly communicated to all actors and stakeholders?
	Accountability	Are responsibilities for expertise and liability of expertise clear and accepted?
	Legality	Are the expertise conclusions compatible with national / international laws?
	Fairness	Are risks and benefits distributed equitably?
	Participation	Have all actors with stakes been consulted and involved?
	Responsiveness	Have actors/stakeholders and shareholders views been taken into account?
	Ethical behaviors	Do the expertise process and the conclusions meet moral and deontology standards?

In what follow, we will give some insights on a crucial task that was pointed in this section: how to explicit the context of expertise to improve the quality of risk problem framing and conclusions framing but at the same time to ensure the quality of the expertise process as a whole.

B. Understanding context, facilitating expertise process

The decision aid literature has given a large contribution on this subject (see for example Vincke, 1986; Al-Shemmeri et al, 1997; Georgopoulou et al, 1997; Guitouni and Martel, 1998; O'Keefe, 1989; Roy, 1985; Tsoukias, 2008). Some references focus on the way to make the decision process more coherent by looking at the methodological and deontological aspects of decision aid (David, 2001; Tsoukias, 2008). In SSE however, the role and the difficulties faced by the expert/analyst in practice are not well detailed. A different perspective was considered by looking at the research done by Wisner (1982, 1995) in ergonomics. Ergonomic focused on the way the work is done in a given situation. Indeed, by looking at Wisner works, we have to look at the "*real working situations*" of the Analyst/expert (that means to the context and the methods that he uses) to be able to understand the work done by him. In fact, in real life situations, expertise problems do not preexist with one possibility of using methods and framing conclusions. There is a multitude of problems with a multitude of possible solutions and conclusions. The expert should build compromises between contradictory objectives and should develop what Wisner calls an "*understanding and intelligibility of practices"*[6]. Extrapolating the Wisner' proposal to expertise

[5] To learn more about this disaster, the reader can refers to Mishima (1992) and Sakamoto et *al*. (2010).

[6] " *Une intelligence de la pratique et avoir recours au concept de la mètis*".

contexts means that making explicit the context of expertise is done by identifying regularities and laws that can organize the appearing untidy of the analyzed' situation or problem. According to these proposals, we have made the hypothesis as practitioners of expertise in SSE that the difficulties faced by an Expert/Analyst can be due to a misconception of the constraints on the subject of expertise process or "decision aid" process. In fact, each SSE problem is a project under constraints fixed by the Organization and its direct environment (context). These constraints are aspects that help to frame the SSE problem.

At this stage, if we admit that "e*xpertise is a decision aiding process to the DMs*" and that "*expertise is also a decision process that needs a decision-aiding process to expert(s)"*, it is then useful to consider some contribution to analysts in designing its process.

Tsoukias (2007) has suggested a multiple step process. The first step of this decision aid process consists in the framing of the *problem situation* P. Where P = < A, O, S>. The set A is the set of actors of the decision process; O is the set of stakes that actors want to introduce in the decision process and S the set of resources that the actors introduce in the decision process. P is framed during the interaction process between the DM and the analyst. We do think that when dealing with SSE expertise process, P should not only be the result of an interaction between the DM and the Expert mainly for problems of *neutrality/partiality* (even if DM can be the public authority), *responsibility* and more largely due to problems of *legitimacy*, but mostly a larger interaction between the Expert, the DM and the other stakeholders.

Then, we propose an adaptation with $P=<C_{cont\ Exp}, \Delta_{Risk\ perc}, B>$ where $C_{cont\ Exp}$ is the set of contextual characteristics identified by the Expert; $\Delta_{Risk\ perc}$ is the gap in risk problem perception between the expert DM and the Expert (see Table 1); and B is the set of cognitive, collective or organizational biases and factors that influence risk perception.

- *B.1. The five contextual characteristics ($C_{cont\ Exp}$) that influence the conduct of expertise*

In what follows, we have identified five contextual characteristics that influence the conduct of expertise (Figure 9).

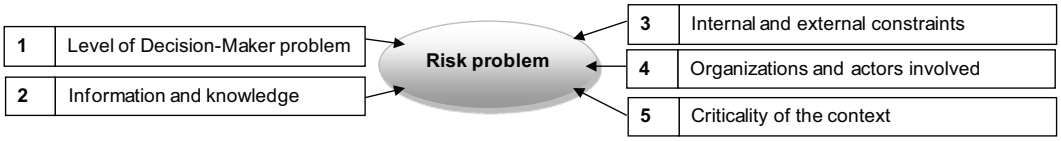

Figure 9. Five contextual characteristics that influence the conduct of expertise ($C_{cont\ Exp}$)

1 *The level of the decision-making problem.* Expertise is a process in a SSE public decision process. Expert have to identify the level of decision where his Client and the DM are involved in and what are their constraints. We have identified three levels of public decision making concerns: strategic, tactical and operational levels. These levels are distinguished according to the available level of information and to the impacts of the actions taken following the recommendations (Merad, 2010).
In cases where risk problem extend over long periods, the decisions reached are often found to be cross-functional in nature compared with the three levels of public decision making.

2 *Information and Knowledge.* The way both the decision-making problems and the expertise problems (risk problem) are formulated is the result of a cognitive construction where the actors and shareholders involved in the process attempt to draw on their own experience and their own knowledge. Indeed, both the expert/analyst and the other actors involved, including the DM, are in a continual learning process; so we admit that the risk problem is context related.

3 *Internal and External Constraints: Space, Time and Strategic Aspects.* Considering the assumption that an expertise is managed like a project within an organization, we observe that it is subject both internally and externally to constraints of time (e.g. deadlines) and resources (e.g. the number of people involved in the study, computer, technical, budget resources, etc.). It is then essential to explicit these conditions that can vary across the time. What we point out here are the well-known constraints of project management. Besides, an expert should pay much attention to consistency between the risk problem and cultural practices within the Organization in terms of *"project management"* that can be a *sine qua non* condition for the acceptance of the Expert's approach.

By the term culture we mean "*all of the beliefs, behaviors and assumptions shared by a group and resulting from past experience*". For Mintzberg (1989), every Organization has its own way of organizing itself to manage a project and he states that "*[culture is] a rich, highly developed and deeply engrained system of values and beliefs that distinguishes a given organization from all others*". The word *culture* is applicable for an Organization (e.g. Expertise agency) that means that people may share common objectives (i.e. context of debate). However if we consider the organization as a part of society, the

problem could become more complex, because people may have opposite concerns and are likely to disagree with objectives (i.e. context of negotiation). The problem remains tractable as long as people are open to negotiate.

As pointed out above, Organizations such as expertise organizations do not have the resources to collect all information to reach an optimal expertise conclusion. But the problem is even deeper. Even if this information was available, experts and decision-makers would not be able to process the whole amount of information. This is what H. Simon called "bounded" rationality that constraint the decision-makers to envisage the finality of decision-aiding differently. It also constraints the analyst to start from a naïve and "positivist" vision of the "best solution".

4 *Organizations and the actors involved in or impacted by the expertise process and/or the SSE public decision process.* An expertise is conducted in interaction with those who are called actors (Roy, 1985). Various categories of stakeholders and actors are involved and impacted by the risk problem and the expertise conclusions. These actors may be the one who asked for the expertise, the person or the organization in charge of the expertise, the experts individually and also various corporate entities or private actors directly or indirectly involved. It is interesting to note that the concept of an actor is neither absolute nor neutral; this presupposes the presence of an observer (expert/ analyst) who, based on their problem framing, produces a representation of the explicit or implicit distributions of roles to all of the actors.

Actors can be grouped in five categories depending on whether or not they hold any power or stake over the final decision (decision makers), whether their intervention directly influences the expertise (stakeholders), whether they are subject to or intervene indirectly in the expertise (affected by their conclusions), whether they intervene indirectly but are not affected by the consequences of the decision made (ghost or latent actors), or whether they are intermediaries (expertise' requesting party or customers, expert or analyst, advisor, negotiator, referee, informant). Whether for affected parties or stakeholders, it is important in the expertise process to be aware of and explicitly define the roles, responsibilities and interactions between the actors. Based on this observation, the stakes of both the finality and the conclusions of expertise can become clearer to the Analyst/expert.

5 *The criticality of the Context.* Based on our experience feedback as practitioners (Merad, 2010), expertise process will be influenced by the degree of criticality in the environmental context:

- *Pre-crisis or pre-accidental*. The expertise during this phase must be performed from a preventive point of view. This means identifying and detailing the responsibilities (meaning who will do what) of the various actors involved and identifying and analyzing context related factors.
- *Crisis or accidental situation*. This phase is characterized by a highly dynamic context where effective measures which need to be taken urgently come together with precautionary principles. We feel that here, the expertise aims more to act on the risk than to understand it. To this end, the methods used should take into account the significant influence of political stakeholders and their impact on modeling the situation. It is also necessary to organize the communication process around the expertise' conclusions towards an audience that is not necessarily a specialized one in order to meet a social demand and protect the various stakeholders involved in risk management.
- *Post-crisis or post accidental*. This phase must necessarily take into account the need to implement measures for repairing and compensating for damage as well as the need to understand and draw conclusions from the events. To this end, expertise performed during this phase aims more to identify, estimate and evaluate risk.

The five aspects above can give an enlightenment to an expert/analyst and can help him to have a reflexive approach on the relationship (the contract) that he has with the Client (who can be the decision-maker) and thus before proposing a method or a tool, to give recommendations (Figure 7).

- *B.2. Some insights about the set of cognitive, collective or organizational biases and factors that influence risk perception (set B)*

The set B has captured the attention of many in decision science but also in safety and risks sciences. Significant contributions were provided by Kahneman, Slovic and Tversky (1982) on the way actors frame their choices when facing uncertain events. Fischhoff, Lichtenstein and Slovic (*in* Slovic et al, 1980) have significantly contributed to the identification of a set of explicative factors, or biases, between technical and none risk assessment. The reader can find more information on Kahneman and Tversky (1974), Sandman (1993) and Recchia (2001). These factors can roughly be grouped in a category called "*individual cognitive or behavioral factors that influence the perception of risk problem*" (*see* Merad, 2011). Examples can be the elimination of the cognitive dissonance that happens when new information, proven or not, is in contradiction with the values of an actor; in this situation, the information can be deliberately ignored. More examples listed in Merad (2010 and 2011). In Douglas (1982), Douglas and Wildavsky (1986), Renn (1991), Kasperson et al. (1987) and Walker et al. (1998) significant contributions

are given on the "*contextual such as cultural, collective and social factors that influence risk perception*". These factors can be founded in Merad (2006) and Wright et al. (2006). Last but not least, the category of "*organizational factors that can influence expertise in SSE*". Many contributions can be found in Llory and Montmayeul (2010), Dechy et al. (2011), Dechy et al. (2012-a and 2012-b), Merad (2011) and Dien et al. (2012).

These biases can significantly impact the expertise process. As illustrations, let us for example point the one case in nuclear domain, with the declaration of Jacques Repussard, in the journal Le Figaro, few months after the Fukushima disaster in 2011 that assumed an underestimation of the probability of major accidents of about 20[7], and another one in safety cars engineering with the decision on production of the Ford Pinto during the 1970s (that became notorious for its tendency in rear-end collisions to leak fuel and explode into flames) that was considered as an only business decision and was based on a cost-benefit analysis badly and roughly done.

In this section, we wanted to avoid giving a jumbled list of the set B mainly because we think that it is necessary to have adapted list illustrated with examples according to the expertise organization experiences and SSE activity. Let us notice that explicating factors or biases that will influence the validity of expertise process is one strategy to avoid their inconvenience. Other strategies were proposed in the introduction section. Looking at safety measures, authors like Kervern (1994) or more recently Morel (2012) have tried to suggest strategies. Morel (2012) has proposed to increase systems safety by what he named *meta-rules of high reliability* and that he grouped in two distinct categories such as: *collective meta-rules* and *cognitive meta-rules*.
The step "*issue situation*" should take an end when both the DM and the Expert converge toward a common vision of the risk problematic (see table 1).

The others steps suggested by Tsoukias (2007) such as the *formulation of an issue*, the choice of an *assessment model*, the *framing of final recommendations* can be transposed to the expertise process given the limitations point in the previous section.

Conclusion

We have argued in favor of a general integrated framework called an analytics and an ethics of expertise in the field of safety, security and environment, all along the paper, based on our experiences of risk problems. We have suggested that some guiding aspects, models and methods should be helpful to allow more validity and more legitimacy to the expertise process. These guiding aspects can have an explicative value to enlighten whether or not expertise process is robust and credible but have not *a causal validity* even if they are based on experience feedback.

Aspects such as, on one hand, contextual and organizational conditions and on the other hand cognitive and collective biases/factors, impact both the framing of risk problems and the framing of expertise conclusions and recommendations. Learning from failures on public expertise shows that these aspects are nor *fortuitous concomitances* nor *apparent pretexts* for generalizing rules on the validity and the legitimacy of expertise.

The thesis that we have defended is that "*expertise is a decision aiding process for a final decision-maker but is a decision process by itself that needs a decision aiding process*". This paradox about a "*helping process that needs help*" shows that there is a need for framing both *deontological and logical rules* on the conduct and the governance of the public expertise process in SSE but also a need for s*upporting the creative individual or collective process* that expertise represents in practice. For this purposes, we have proposed in this paper a guiding process for expertise when facing risk problems based on experience feedback. This process aims to provide elements of guidance for experts/analyst to implement a decision aiding process. A first theoretical and practical question which is "how to guide the framing an "issue/problem" situation in safety, security and environment?" is so far partially solved. We have then pointed out a second issue that is: which kind of decision aiding should the Expert/Analyst provide to the DM or his representative considering the nature of risk problems in SSE? This question was partially answered by ensuring the respect of classical intrinsic properties of expertise recommendation and conclusions (e.g. Effectiveness and robustness) and then by explicating and making explicit the contextual conditions.

[7] Accident nucléaire : «Il faut imaginer l'inimaginable». Le Figaro17/06/2011. Actualité-Science. See: http://www.lefigaro.fr/sciences/2011/06/17/01008-20110617ARTFIG00610-accident-nucleaireil-faut-imaginer-l-inimaginable.php.

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