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Knowledge Management &Risk Management

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***Abstract*—**Knowledge Management methods, techniques and experience can bring a considerable help in preventing all kind of risks. The current economic context amplified the existing risks and introduced new ones such as environmental, political and social. Among the most critical risks of this century is this of lost of knowledge and "memory" in particular in industry involved in long-term activities.

After listing the principal risks and recalling of main approaches and techniques of Knowledge Management and its application for risk management an example of nuclear industry is given. Discussion follows in final conclusion and some perspectives are presented.

I. Introduction

HUMANITY have always been exposed to all kinds of risks - natural, industrial and those related to human activity and human nature, including motivations and passions. While the management of "soft" industrial risks is well established, the serious, unpredicted and rare risks are managed after the disaster.

Knowledge management approaches powered by artificial intelligence techniques can bring considerable help in risks prevention and management, but they are not sufficiently used.

This paper presents a broad spectrum of today risks and main works connecting these two topics. A short recall of principal knowledge management methods and disciplines follows. Some techniques for risks prevention and fixing are mentioned. These purposes are illustrated by a case study in the field of nuclear energy management. This paper ends by conclusions and perspectives for future work.

II. Typology of Risks

Among the industrial risks we can distinguish those caused by a malfunction or by the "human factor".

Risks resulting from human activity such as air and water pollution, destruction of natural ecosystems and global warming are the consequence of the ignorance of natural ecosystems, that we are the part, of the context and motivations as selfishness and desire to become rich quickly.

The pride and power can also lead to irresponsible decisions at high political and management levels, as for example wrong choice of strategy.

Other risks arise from human nature and motivations, such as sabotage, crime and cybercrime, wars, and lack of communication or of compromise. Risks arising from ignorance, obscurantism or indoctrination can cause unwanted destruction, bombings and wars.

The perpetuation of the same mental patterns is a risk of not finding the right solution when solving problems, which is a strong barrier for innovation. For example, onboard car computers are programmed using traditional decision trees and the user wanting to go to a given place has to choose step by step instead of making a direct voice request. Some of them are still equipped with a mouse and using such a system when you drive may lead to accident.

The recent risks are related to the use of technology, digitization, virtualization, security of sensitive data on clouds, the unexpected impact of biotechnology, nanotechnology and others [1, 2]. The precautionary principle, very strong in France [3], is applied in some cases when the impact is not known or not considered. An alternative of applying systematically such a principle is the understanding and simulation of the potential impacts by a multidisciplinary and experienced team possessing the related knowledge.

Another risk could come from the lack of management of the intellectual capital. Consequently, knowledge and know-how are not explored because little known at the strategic level.

A simplified ontology of risks is presented in Figure 1.

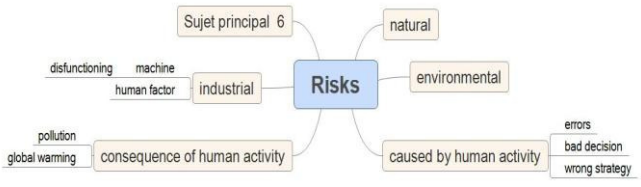

Fig. 1. Simplified ontology of risks.

The ISO 31000 norm considers as a high risk a theft, loss, obsolescence, no recovery and the lack of the use of knowledge. All have the negative effect on the achievement of objectives.

III. Related Work

The industrial interest in risk management is not new. We can find numerous work devoted to managing risks in energy [5, 6, 7, 8], in chemistry and pharmaceutical industry [9, 10, 11, 12] aeronautic and space [13, 14], automotive [15] and recently those related to the use of information technology [16, 17]. Other fields are also concerned, such as finance and banking [18], insurance and health [19].

In France there is a long tradition of managing industrial risks using statistic methods, recently extended by Bayesian and some data mining [20, 21]]. The Institut pour la Maîtrise des Risques (IMdR) groups research and industrial actors involved in this area and organize Lambda Mu, scientific conference and other events aiming in sharing experiences and solving problems collaboratively [22].

The approaches and techniques of Artificial Intelligence such as experts systems, case-based reasoning and multi-agent systems have been successfully used for managing risks as well for prevention as for fixing [23].

The development of methods for risks management and operating reliability, based on probabilistic networks from 1990 has been complementary to expert systems.

The bayesian networks, belief networks and Valuation Based Systems provide graphic representations of knowledge, more comprehensive by the user. These techniques are well suited to the uncertain context and in particular to epistemic uncertainty and are a part of toolbox currently used by engineers of risk control or operational safety, such as fault tree and Bayesian network [21]. These tools are currently used after collecting related data.

The professionals of risk management and operating reliability are used to apply known methods to existing data, opposite to the "knowledge thinking" approach based on problem understanding and collecting or mining the related knowledge vital for solving a given problem [23, 24]. The risk related to intellectual capital such as loss of knowledge and of competency, know-how is still weakly managed [4].

Globalization and hyper-competition has increased the risk in business. Political push to create start-ups should be associated with adapted policy, which is not the case today. The collected feedback from these experiences will be very helpful to improve the innovation policies.

The recent collogue of French Ministry of Defense pointed out the influence of climate changes on the raise of criminality [25]. Over twenty presentations with various points of views demonstrated the cause-to-effect dependence of delinquency and terrorism with climate change. But it is not only influence; the others factors such as unemployment and lack of the clear vision for the future and professional perspectives for young, low educated people, enhance the probability that they may choose Jihad.

To anticipate and manage such risks, it is necessary to gather and manage the related multidisciplinary knowledge and skills and use the right approaches and tools.

IV. Role of knowledge in risks management

Globalization, reinforced by the development of various modes of transportation, Internet and other information and communication technologies has changed the way we learn, work and do business and have introduced other risks. In search of cheaper workforce, companies relocate production and customer service taking a risk of knowledge loss and of customers' deception.

Production of spare parts in low cost countries may entail a risk of quality caused by the lack of conformity with the specifications and the use of alternative materials that can degrade the performance of given equipment.

Internal transfers, retirements, turnover and cross-competition generate impacts such as loss of know-how, loss of time to reinvent and remake what has been already done, additional costs, loss of competitiveness, responsiveness, security/safety flaws, which are the factors determining differentiation in an open economy. The knowledge transfer "at time", the use of decision support systems, knowledge base of products, projects and customer relations, managing the feedback from experience, e-learning and m-learning systems integrated to the overall knowledge flow connecting may help the involved actors in preventing and managing the risks.

The relocation may also lead to other risks, such as loss of employment and exclusion in developed countries.

Faced with the economic crisis in developed countries, governments consider innovation as the only remedy that can improve growth and boost the job creation. But entrepreneurship requires risk taking and know-how of managing a start-up for success cannot be acquired only in school, but mostly by doing or with an experienced mentor.

Innovation needs multidisciplinary knowledge to succeed and many products and services are knowledge intensive. Sometimes ignoring ergonomics and the real needs of users and customers may lead to the risk of non acceptation of given software or other products. Such products will not be used and may cause a company fail.

Computers and other technological devices and applications, currently used in industry are now present in all fields and their development accelerates. Computers, sensors and other electronic devices are more and more embedded into products. The products such as IoT, conceived according to the designers' vision only, autonomous devices, M2M communication and fully automatic client support systems raise the risk of elimination of human from the decision making.

If the machine thinks instead of us, it may influence the progressive lost of human cognitive capacity.

Can we trust the perfect operation of fully automated systems?

Internet is considered by many as a source of knowledge, but what is the reliability of information found on the web?

Decision taking based only on information found in various wikipedia, forums, and social networks maybe risky.

Can we find a reliable knowledge or information only in such results? Is it helpful and sure to avoid risks in the future? Is it efficient for knowledge discovery?

The prevention and management of all kinds of risks require an understanding of all facets, contextual knowledge and a method that fits to these components while the most of risks managers use the data and statistics.

A. *Prevent or fix?*

The industrial risks management methods include preventive maintenance, annual and five or ten-year controls of nuclear power plants, aircrafts and other complex equipments and feedback. The feedback is usually recorded in a large database conceived for all related professionals. The data processing after collection uses mainly statistics and the results are available to those concerned. Data is often missing because the persons that should record then do not understand what they have register because of weak adapted interface; sometimes we can find errors related to the data value such as missing comma, shifted, wrong or missing data [35].

In a few critical cases we manage the crisis after it happens (Tchernobyl, Fukushima, AZF Toulouse and others - http://www.aria.developpement-durable.gouv.fr/).

This involves repairing of the effects, as in Western medicine, but how to prevent these accidents using efficiently existing knowledge and expertise?

Practical experience demonstrates that sometimes a given problem, i.e. terrorist attack, may be detected considering weak signals often ignored. It is vital to collect all related knowledge including contextual and check consistency, especially when it comes from several sources.

While industrial maintenance is usually well managed, the related knowledge is often not organized and poorly managed. Nevertheless, knowledge plays a central role in our activities. But what is the necessary knowledge to collect and preserve in aim to avoid and control risks? What to preserve, how and why? It depends on the organizational/company strategy, that decides about the key knowledge and strategic competencies to maintain develop and preserve. Than the best adapted approach and tools will support the realization of this task.

V. KNOWLEDGE MANAGEMENT

In the early 1990s we saw the emergence of a new management method - Knowledge Management or business based on knowledge [26]. It has been a foundation of a new economy of knowledge [27].

The term "Knowledge Economy" is not new. Although it was proposed in the 1980s, such economy has always existed. It is about generating value from knowledge, know-how and experience. This is a radical change for companies that must now recognize and manage this intangible capital.

In this context, knowledge management can be defined as "*an integrated system of initiatives, methods and tools designed to create an optimal flow of knowledge within and throughout an extended enterprise to ensure stakeholders success"* [28, 29]. Stakeholders are partners, distributors and customers. Success includes among others leadership, industrial performance, efficiency, quality and safety.

The purpose of this approach is to organize and manage knowledge applicable or applied by the company or organization, for its activities related to current or future business.

Our research focuses on critical knowledge and know-how of experts, which in majority of cases is not formalized. While knowledge transfer has always been the scope of the trainers, we often ignore that knowledge can also be "transmitted" to the computer using something else than traditional databases [7]. Artificial intelligence has invented very early methods and techniques for knowledge acquisition, discovery and processing by computer. They have been tested successfully for over 50 years and are now encapsulated in tools.

Many decision support systems have been designed to assist users through expert systems, help in process control, in medical and industrial diagnostics, to provide design assistance, solve complex problems with constraints such as logistics, scheduling, planning and others. AI techniques are also useful for intelligent e-commerce, effective matching of offer and demand, very useful for recent platforms. All these applications should be organized as a Knowledge Flow. Knowledge modeling methods such as KADS for conceptual modeling, ontologies and other models [24] should be adequate to the nature of given knowledge. Graphical interface will facilitate their collection for preservation and sharing, but also reusing for a variety of applications.

The development of methods based on probabilistic networks in risk management and operational safety in the early 1990s also focuses the use of expertise. Bayesian networks, transferable belief models (TBF), the Valuation Based Systems use a graphical representation of knowledge which facilitates the understanding of data. These techniques seem well adapted to the context of uncertainty (including epistemic uncertainty) and generalize the methods commonly used by traditional engineer in risk management or operational safety, such as fault tree and Bayesian network. Current applications include risk analysis, reliability analysis, and analysis of the human factor [21].

Deep learning, born from the experience and the need to explore appropriately gigantic amounts of data connects several automatic machine learning techniques (machine learning) as data mining, natural language processing and image mining, among others.

At this stage a distinction between thinking "data" and "knowledge" must be considered. While the first focuses on the collection of data, the second focuses on the collection of

knowledge, essential for knowledge-based problem solving.
Knowledge transfer from human to computer via different knowledge models is now mastered and should be generalized. Many knowledge bases exist, but the knowledge capitalization process is not widespread. It is very often postponed, due to lack of time and underestimated by many companies. But it is a false excuse, because they continue losing time using still "data approach" which generates huge amount of data that should be "cleaned" and analyzed.
"Knowledge approach" may seem difficult for those who are used to work with data, because it requires changing a mental schema. However the trend of knowledge management and a necessity to preserve knowledge of retiring experts handed capitalization up to date.

For over two decades, companies and organizations have experimented Knowledge Management, beginning with their motivations and perspectives - as integrated in a company strategy, by managing of Intellectual Capital, Business Intelligence or by industrial applications [23].
Many companies have taken steps, but for the most part, without considering the feedback from Artificial Intelligence. Internal networks of experts (communities of practice) are among the "easy and quick" initiatives aimed at mitigating the risks related to the loss of knowledge and experience, allowing the sharing of "best practice", such networks requires a facilitator, who can progressively become Chief Knowledge Officer.

Two major factors hindering the implementation of KM as a management method are following:

- is the necessity of demonstrating the utility of this approach and its ROI,
- misunderstanding of the role the Chief Knowledge Officer must play; it is not a social position, but a cross communication and facilitation.

The initial objective of Knowledge Management remains improving of the innovation capacity of enterprises and organizations by better use of talents, knowledge, detection of opportunities, integration of feedback and use of the best fitting technologies.
As Knowledge Management involves stakeholders, the respect of ethics and trust are vital to achieve a common goal – to be successful together.
It is not easy to implement because it involves spending time to understand before doing, thinking "knowledge" and to change attitudes: listening instead of push, collaborating instead of competing, collecting and sharing experience and feedback, evaluating the benefits in terms of tangible and intangible values.

The knowledge to preserve includes not only this associated with long life technical equipments, such as nuclear power plants, but also the ability to solve problems. This is an art to gather individual and collective knowledge serving to solve a specific problem, but also the know-how in considering the various contexts that influence decision taking.

If we consider the risk of crime and cybercrime, solving this problem is not just to find the guilty and put him to jail, but to understand the real causes and motivations of involved persons and their environment. As mentioned before, the study of French Ministry of Defense has demonstrated the link between climate change and crime. For example, the drought caused by deforestation and intensified cultures lead to the depletion of the earth, causing famine and pushed more vulnerable to selling drugs or stealing.

The risk prevention requires awareness of their existence and their possible consequences, the ability to solve complex problems, holistic and system thinking and to select the necessary knowledge to prevent, minimize the causes, and impact. If this approach had been applied in the case of German Wings the company could have prevented the accident because the knowledge on the health of employees and their relations are part of the overall approach.

Finally the KM approach producing the best results is those that starts with an application addressing the real needs, developed with an incremental approach "do small and think big".

VI. EXAMPLE: NUCLEAR INDUSTRY

In France we have 18 nuclear plants, as shown in Fig 2.

Fig. 2. Map of French nuclear power plants [30].

Some of them have been built over 60 year ago. Nuclear plants represent three main risks: loss of initial knowledge, ageing of component materials and management of pollution at the end of life. Designers of these plants are retired. The initial knowledge and context of the whole lifecycle related to plants has been transmitted through documents and reports. There are still some elements lost because all details of lifecycle, replacement of elements, minutes from meetings, verbal experts' exchanges are not transmitted. Reports from the programmed control also exist, but it is a known fact that everything is not written [7]. Related database contains only data. Some expert systems have been

developed in specific critic fields, such as ageing of materials and their consequences on maintenance [36], mastering of ageing,

Last year Paris has been hosted the COP21 and the strong international lobbying claims to stop the oldest power plants. On the other hand, the management of nuclear waste is a long term process and requires an updated long term memory. ANDRA (Agence Nationale pour la Gestion des Déchets Radioactif) involved in managing nuclear waste is aware of the problem and has initiated a Knowledge Management activity [31]. As there are not only one organization involved in the whole nuclear plants cycle of life they initiated with ANR (Agence Nationale de Recherche) a collaborative program supposed to bring together all stakeholders in aim to organize and manage the related knowledge [33]. The task is not trivial, because the majority of involved actors retains knowledge and do not realize the consequences of such an attitude. We expect their awakening.

Despite a global awakening on planet and living protection the most of industrial people focus on quick business and do not assess the multiple impacts of their activity on our biosphere [34].

VII. Conclusion

Facing the systemic risks generated by globalization, quick business, vertiginous progress in technology and replacing human by machines requires different way of thinking and problem solving. Preventing and management of such risks require the "knowledge thinking" and considering the multidisciplinary knowledge and the related context. Deep problem understanding will guide the choice of Knowledge Management method and well suited tools. AI techniques support the managing the flow of knowledge by systematic collection and exploration of related knowledge and experience and knowledge. However a global awakening and change of attitudes is required. It can be done using i.e. serious games and various simulators. The future work related to risks management focus on the risks prevention by understanding the key factors through the games.

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