Revista Brasileira de
Risco e Seguro

Associating Technical Methodologies of "Multi-Scenario" Risk Analysis to Support The Pricing of Risks: Survey and SIL – Safety Integrity Level

Antonio Fernando Navarro, M.Sc.
Bachelor of Science in Physics and Mathematics, Civil Engineer specialising in the construction of roads and bridges, Postgraduate in Occupational Safety Engineering, Risk Management Specialist with over 30 years experience in Insurances and with Insurance Service Providers, Expert at the Reinsurance Institute of Brazil from 1979 1999, Member of the FENASEG Technical Committees from 1979-2001, Masters degree in Environmental Health, Professor of Actuarial Science at the Universidade Federal Fluminense.
antoniofernandonavarro@gmail.com

Summary

Multi-scenario environmental analysis methodologies are being increasingly used by researchers, mainly because the use of a single method may not be feasible for a number of reasons. In the past, when inspections were carried for insurance purposes, the inspectors or risk survey engineers would assess the facilities looking for perceived problems that existed in the environment. Then, later, employing their knowledge to evaluate the results of these observations and, finally, studying market statistics to identify whether there were similarities between what was observed and similar historical problems. Thus, for a long time, and without specific titles, experts at that time already employed several evaluation methodologies. This article endeavours to present relationships between two methods of technical analysis, namely: *Survey* and *SIL – Safety Integrity Level.*

Key Words

Risk Analysis Methodologies, Utilization of Surveys and SIL, Pricing of losses, Process Reliability, Industrial safety.

Contents

Sinopse

Associando metodologias de análises de riscos técnicos "Cenários múltiplos" como apoio nos preços de risco: pesquisa e SIL-Nível de Integridade de Segurança

Prof. Antonio Fernando Navarro, M.Sc.
Licenciado em Física e Matemática, Engenheiro Civil com especialização em construção de estradas e pontes, pós-graduado em Egenharia de Segurança do Trabalho, especialista em gestão de riscos com mais de 30 anos de experiência em seguradoras e empresas prestadoras de serviços de seguros, perito do Instituto de Resseguros do Brasil de 1979 a 1999, membro dos comitês técnicos da FENASEG 1979-2001, Mestre em Saúde e Meio Ambiente, professor da Universidade Federal Fluminense.
antoniofernandonavarro@gmail.com

Resumo

Metodologias de análise ambiental do tipo "multi-cenários" estão sendo cada vez mais utilizadas por pesquisadores, principalmente porque o uso de um único método pode não ser factível por inúmeras razões. Antigamente, quando inspeções eram realizadas para fins de análises de seguro, os inspetores ou engenheiros de risco avaliavam as instalações procurando por problemas perceptíveis que pudessem existir no ambiente. Então, utilizavam seu conhecimento para avaliar os resultados de tais observações e estudar as estatísticas do mercado para identificar se haviam similaridades entre o que foi observado e problemas históricos similares. Assim, por muito tempo, e sem títulos específicos, peritos já utilizavam diversas metodologías de avaliação. Este artigo apresenta relações entre dois desses métodos de análise técnica: *Survey* e *SIL-Safety Integrity Level.*

Palavras-chave

Metodologias de análie de risco, uso de Survey e SIL, precificação de perdas, Segurança de Processo, Segurançca Industrial.

Sumário

1. Introdução. 2. Formulação da situação-problema. 3. Limitação de possíveis soluções. 4. Objetivos. 5. Metodologia. 5.1. Desenvolvimento. 5.2. Análise de Risco. 5.3. Metodologia de Análise de Risco. 6. Revisão da Literatura. 7. Conclusões. 8. Referências Bibliográficas.

Sinopsis

Asociar metodologías de análisis de riesgos técnicos "Escenarios múltiples" como apoyo en los precios de riesgo: encuesta y SIL-Safety Integrity Level

Prof. Antonio Fernando Navarro, M.Sc.
Licenciatura en física y matemáticas, un Ingeniero Civil con especialización en construcción de carreteras y puentes, post-graduado en seguridad en el trabajo ingeniero, especialista en gestión del riesgo con más de 30 años de actividades celebradas en las aseguradoras y compañía de seguros servicio proveedor, experto del Instituto de reaseguros de Brasil entre 1979 y 1999, miembro de los comités técnicos de la FENASEG 1979-2001, Master en salud y ambiente, profesor de la Universidad Federal Fluminense.
antoniofernandonavarro@gmail.com

Resumen

Metodologías de análisis del entorno del tipo "multi-cenários" están siendo cada vez más utilizados por los investigadores, principalmente porque el uso de un único método puede no ser factible para un número de razones. Antes, cuando las inspecciones eran realizadas con fines de análises de seguro, los inspectores o ingenieros de riesgo evaluaban las instalaciones buscando problemas problemas en el medio ambiente. Entonces, empleaban sus conocimientos para obtener resultados de sus observaciones y estudiar las estadísticas de mercado para identificar similitudes entre lo observado y problemas históricos similares. Así, desde hace tiempo, y sin títulos específicos, expertos en aquel momento ya empleaban varias metodologías de evaluación. Este artículo presenta relaciones entre dos métodos de análisis técnica: *Survey* y *SIL-Safety Integrity Level.*

Palabras clave

Metodologías de análisis de riesgos, uso de Survey y SIL, tasación de pérdidas, fiabilidad de los procesos, Seguridad Industrial.

Sumario

1. Introducción. 2. Formulación de la situación-problema. 3. Limitación de posibles soluciones. 4. Objetivos. 5. Metodología. 5.1 Desarrollo. 5.2 Análisis de Riesgo. 5.3 Metodología de Análisis de Riesgo. 6. Revisión de la Literatura. 7. Conclusiones. 8. Referencias Bibliográficas.

1. Introduction

Scenarios are projected or existing situations where risks are present and can result in the occurrence of loss or damage, and not just to the physical or projected environments. Future scenarios give the most concern to risk analysts, as they may be unforeseen in the establishment of situations projected over long periods of time such as, for example, with engineering projects, the analysis of insurance portfolios and pension plans. Among the multiplicity of scenarios, those that are associated with future policy issues might even be predictable, in countries with solid political bases and a history of stable environments. Economic scenarios, though influenced by a multitude of factors, also can be estimated. For example, a lack of rain can affect agribusiness activities, considered as commodities. Under these conditions, there may be a variation in prices, driven by supply and demand. On the other hand, risk scenarios involving facilities, equipment and even factories are not so predictable.

Insurance activity as a whole operates throughout a wide range of interests and encompasses many types of insurance. Some of these are evaluated not only on defined actuarial statistics and on structures – axioms, but also can be based on scenarios identified through risk management.

Axioms are unquestionable spoken truths, accepted by all as such, and usually employed in the construction of theories or as the basis of arguments. If something is deemed an axiom, this signifies that what is being presented is not a proposal to be studied but, rather, is a fact or truth.

2. Formulation of the situation-problem

The purpose of this article is to deal with the main theme: **Associating the technical methodologies of “Multi-scenario” risk analysis to support the pricing of risks: Survey and SIL – Safety Integrity Level**, for the purposes of indicating the appropriateness of those methodologies, which may be complementary to loss prevention and the pricing of risk; an important activity since it contributes to the operating results provided by insurers and reinsurers.

3. Limitation of Possible Solutions

Not being an academic text but with features for the presentation of themes for dissemination of techniques, some issues that are ancillary to the development of each of the aspects may be cited, so that readers with an interest in continuing their studies may gain knowledge of other texts and methodologies. Moreover, complementary methodologies such as those involving computational analysis will follow the same strategy mentioned previously. Just as an indication, currently the vast majority of projects for industrial activities are developed using computational methodologies, which enable 3D projections to “pass” through projected environments and even identify many of the problems that can occur if the projects were deployed without the necessary corrections. It is important to say that one of the imposed limitations is that association of methodologies cannot always be employed, mainly due to the characteristics of the risks. Specifically, the SIL methodology is appropriate for the analysis of equipment and systems. If these are relevant in the overall context of the enterprise, then certainly the combined results will be better.

4. Objectives

The objectives were divided into three parts: the first objective is to establish and divulge the conditions of understanding with regard to associating the evaluation techniques; the second objective is to present the concepts, which may not always multiple techniques, and perhaps even only a survey or inspection is necessary for the recognition of the risks. In small installations, the use of Survey type methodologies may show good results, as for example with the fast fill reports used in the late 80s for automobile insurance whose insured parties were “women”. Similarly, to evaluate whether a small business is “a good risk” it is not necessary to use computerized applications. However, there are bigger risks, with greater expectations of losses that need to be better studied, since the financial impact caused by the occurrence of an accident can be large. It is also possible to extend this reasoning to the study of insurance portfolios, mainly with regard to the acceptance of the risks; the third goal refers to the conclusions, which can have additional considerations, resulting from continuing studies of the topic by the author. The article follows the concepts of modified Survey methodology, which meets the principles proposed by Judith Tanur (*apud* PINSONNEAULT; KRAEMER, 1993), initially associated with cognitive aspects.

5. Methodology

The methodologies employed will be the revision of the existing technical literature on the subject, texts published by the author, as well as the results arrived through a series of “analysis and research tools”. It will be important go back over time to present how the risks were evaluated with respect to expected losses.

5.1 Development

A Method is a set of actions undertaken in the development of specific activities.

- Set of orderly arranged steps to be taken in the search for truth, the study of a science or to achieve a particular purpose” (GALLIANO, 1979, p.6);

- arbitrary rational procedure of how to achieve certain results (...). In science, methods constitute the basic instruments that ordered the beginning of systems thinking, how the scientist proceeds along a path to achieve a predetermined objective” (FERRARI, 1982, p. 19);

- set of systematic and rational activities that, with greater security and economy, reaches the objective – valid and true knowledge-, outlining the path to be followed by detecting errors and supporting the decisions of the scientist (LAKATOS & MARCONI, 1991).

5.2 Risk Analysis

The use of multi-scenario methodologies seeks to associate the interferences amongst the scenarios that might interact and affect the environment under scrutiny – risks for the insurance industry, evaluating the potential, or not, of these effects, whose end result may lead to an aggravation of loss or damage. This proposal is associated with a qualitative analysis survey model, which may be adapted for quantitative analysis for the SIL model that combines the existence of multiple protection barriers, or redundancy in the security levels, inserted a project for the purpose of preventing, reducing or mitigating the effects of the risks. The barriers are not just solid objects and can be detection systems, sensor elements or fuses, remote-control valves, automatic detection and control of accidents, among many other systems, components or devices to impede the propagation of an accident.

There are historical reports concerning the adoption of risk control measures, notably developed by entities attendant to the insurance business. Two of these actions are still often cited and arguments for the elaboration of hundreds of articles have been developed by Herbert William Heinrich, working for The Travelers Insurance Company, who utilized a triangle to represent the evolution of his concepts, leading to a new presentation model called the Domino Theory. Frank Bird Jr. of the Insurance Company of North America, influenced by these concepts, adopted and expanded the same visual presentation strategy and expanded the triangle from three levels to four levels. In this evolution of the technique of risk analysis, treating them in relation to the reduction in the number of persons injured, other studies were developed. Later, in the 70s, analyses that fundamentally deal with accidents were adapted for studies in other areas, such as safety of facilities and equipment, known as “Reliability studies”.

In this context, technologies, methods and techniques were being aggregated and applied to specific situations, such as the military, aeronautics, rail, waterways, and other diverse projects. It was only logical that the insurance sector accompanied and still accompanies all of this development, since insurance was the precursor for this type of analysis. In the 18th century, American engineers inspected boilers, mainly because these tended to explode and cause injury to a considerable number of victims. Thus, in all sectors, analyses were developed to meet specific “demands”, such as in the 30s, through the work of Heinrich, and the 50s by Bird. Process reliability studies followed the path of analysis based on prevention. SIL methodology, discussed in this article, is a case where various barriers are placed between the multiple risks. A simple example is the circuit breaker that we all have in our homes. This device protects the electrical installations and, in turn, all electrical appliances connected to it. When the Exxon Valdez spilled its oil in Alaska in 1989, the vessel had a simple steel hull. Subsequent to studies following that accident, these types of vessel now have a double hull. Damage to the outer hull can be contained in the second, inner hull. This is an example of a containment barrier.

5.3 Risk Analysis Methodologies

There are dozens of methods of research and risk analysis. Research methodologies designed to identify qualitatively and/or quantitatively the risks[1], and make it possible, among other objectives, for the pricing of the losses and assessment of impacts caused by the materialization of risks. The developed methodology does not always seek knowledge of the consequences of risk but, rather, the identification such risks.

As in other similar areas of knowledge, risks can also be placed in a hierarchy. However, for there to be "frameworks" it becomes necessary to evaluate what is a small or a large risk. The evaluations do not always coincide, since it is not sufficient to utilize only one technique or method of analysis but, rather, an association of techniques and methodologies. Hence, associations have become commonplace.

a) **Survey Method**

The survey is a technique where answers are sought to questions previously posed. To provide a mathematical basis, these evaluations usually apply hierarchies, such as those developed and disseminated by Likert[2]. However, there is nothing to impede matrix associations that take into account aspects related to the gravity, urgency and tendency, known as GUT matrices, or SWOT type matrices (strengths and weaknesses, opportunities and threats, in English). A limited approach is applied in the use of Likert scales, usually adopted in cognitive analyses and attitudes, due to the importance of human actions in the migration chain Danger → Risk → Accident, being large. Matrices supporting the analyses are already employed in the research guidance.

There is no general rule that allows the use of specific methods. There may be situations where it is appropriate for the use of various research and analysis models, including the retesting of the results obtained. Hence, empirical or experimental evaluation methods can be used, based mainly on the experience of risk managers and a database of historical occurrences, complemented by support methodologies that are statistical or mathematical in nature that permit the formatting of the results from the structuring of future scenarios models during the onset of risks. It may seem complex, but it seeks to associate the identification of risks to the behaviour that they can assume in the face of momentary changes during these occurrences.

[1] Random event with characteristics such that by unpredictability as to when and to the extent of the damage needs to be studied so that prevention methodologies can be developed.

[2] The Likert scale is a type of psychometric response scale used in questionnaires, and is the most widely used scale in opinion polls. To respond to a questionnaire based on this scale, interviewees specify their level of agreement to any questions put to them with na affirmation. This scale takes it name from the publication of a report explaining its use by Rensis Likert. [Likert, Rensis (1932), "A Technique for the Measurement of Attitudes", *Archives of Psychology* **140**: pp. 1-55]

Each loss or damage estimate realised during the *Surveys*[3] has a specific purpose. The indication of parameters that could identify levels of losses arising from a fire, for example. Therefore, three levels of evaluation are structured:

- **Normal Expected Loss – PNE**: defines the franchise range to be adopted in the insurance.

- **Probable Maximum Loss – PMP**: is the average of the losses considering that all devices for preventing and fighting fires are triggered, as defined in plan.

- **Maximum Permitted Loss – PMA**: represents the catastrophic loss, imagining that nothing prevents the fire from spreading in the worst possible way and causes the greatest losses imagined. We highlight that this loss may or may not be less than the sum of all the values at risk existing in the environment where the fire occurs.

> Navarro (1995) cited: ... The determination of the Maximum probable damage, for application in insurance rates, especially fire, has always been complex, since its concept is variable according to the degree of knowledge of the estimator, appraiser or risk engineer. Countless times, we find that the values contained in the inspection reports of the reinsurer with regard to the DMP, covering each of the isolated risks, were accepted and reproduced by insurers without any questioning, even if they contain information of the type: DMP of plant 15 = 12%. What is the parameter or methodology used to arrive at that degree of accuracy?...
>
> (NAVARRO, A.F., 1995)

The technique can be adapted so that if the responses are not given freely, but directed, as in closed questionnaires, they can be prioritized and receive scores. In this way, the results will be obtained by adding up the points. When we evaluate the operation of equipment, for example, it must be kept in mind that those who operate and maintain the equipment are certainly people who will tell us everything we want to know about the same. It is worth noting that not always are the biggest losses associated with the largest plants existing in the industrial complex. To consolidate, the results are associated with other analysis procedures and methodologies for obtaining results, such as some mathematical and statistical concepts, so that all the possibilities of analysis are evaluated and not only the main causes. As the present and the past are important data sources, you need to know how to project these results for the future. In these situations, the most varied aspects can be inserted, such as:

1. Operation overload;
2. Lack of preventive maintenance;
3. Action in risk-prone environment;

[3] Survey is a methodology or process of obtaining data or information about a particular environment, through a questionnaire drawn up by professionals who have experience in the matter, who meet to prepare the questions and analyse the results. The greater the experience of the professionals, the better the results will be. The results can be used to indicate dangers, for example, or the incidence of risk, and even how workers in that environment should act with regard to so-called abnormal situations.

4. Improvisation of repairs;
5. Use of different raw materials from that which the equipment is designed;
6. Inexperience of the operator;
7. Fluctuation in voltage or electric current, forcing the electrical equipment;
8. Lack of decision-making control devices;
9. Unsuitable layout for the placement of equipment;
10. Possibility of external impacts due to the movement of materials and or equipment, among other causes.

Freitas *et al*. (1999) clarify this when they present the definition and general characteristics of the method:

> Survey research can be described as obtaining data or information about features, actions or opinions from a certain group of people, indicated as representative of the target population, through a research instrument, usually a questionnaire (Tanur apud Pinsonneault & Kraemer, 1993). Fink (1995a; 1995c) discusses what this method is, its usefulness and when it should be used, as well as key features of the survey research method. Cited as key features of the survey research method: the interest is to produce quantitative descriptions of an entire population; and makes use of a predefined instrument. The survey is suitable as a method of research:
>
> - If you want to answer questions of the type "what?, "why?, "how?" and " How many?", that is, when the focus of interest is on "what's happening" or "how and why this is happening";
> - Has no interest or unable to control the dependent variables;
> - The natural environment is the best situation to study the phenomenon of interest;
> - The object of interest occurs in the present or in the recent past.

In continuity, and quoting Pinsonneault & Kraemer, 1993, this quantifies the purpose of the survey research:

> - Explanatory – aims to test a theory and causal relations; establishes the existence of causal relationships, but questions why the relationship exists;
> - Exploratory – the aim is to gain familiarity with the topic or identify the initial concepts about a topic, emphasis on determining which concepts should be measured and how they should be measured, search to discover new possibilities and dimensions of the population of interest;
> - Descriptive – seeks to identify which situations, events, attitudes or opinions are manifested in a population; describes the distribution of some phenomenon in a population or among subgroups of the population, even making a comparison between these distributions. In this type of survey, the hypothesis is not causal, but is intended to verify the perception of the facts, or not, in accordance with the reality.
>
> (FREITAS, H., OLIVEIRA, M., SACCOL, A.Z., MOSCAROLA, J., 1999)

According to Malhotra (2001), *descriptive research aims to describe something, usually features or functions. Two methods can be employed: survey method and method of observation, where survey (or communication) is the mode of research and observation being personal observation, mechanical observation, content analysis and signs analysis. Therefore, the present research was structured by means of documents, in this case bibliographical research* (MALHOTRA, N.K., 2001).

Gasque (2008) in his introduction to Grounded Theory, first goes against the prevailing concepts practised in the insurance market, where the estimated frequency of events versus the percentage likelihood for damage ends up being a determinant in the setting of risk rates. Both the frequency and the severity or likelihood of damage is usually obtained in the field analyses, here defined as surveys, where the participation of the researcher is critical. Malhotra (2001) also advises against basing the result of the analysis being on a single opinion. These comments make it possible to submit another analysis tool supporting the risk identification process, such as the evaluation of security levels applied to an installation or system.

b) SIL Method – *Safety Integrity Level*

The SIL methodology is more easily perceived, as it is oriented towards the evaluation of the existing levels of protection in an environment, equipment or system, mitigating the losses that occurred. As an example, computers are shipped from the factory with a surge protector, an internal fuse that prevents current or voltage overload. This is the first risk containment barrier. Usually we connect the computer into a multiple outlet, which also has a protection device. The wiring of the environment has a circuit breaker built into the electrical panel. In turn, the electric supply to the building also has a similar protective device. The only import thing that we forgot about is the electrical grounding, that third pin on the socket. Thus, we have multiple levels of electrical supply protection, but we do not have the electric grounding.

6. Literature Review

The forecasting and pricing of risks has always been one of the most arduous tasks for mathematicians, statisticians and actuaries. Risk managers, when inspecting industrial sites, always evaluate the characteristics of the risks and consequences of these, showing proposals or suggestions for the improvement of security levels in their reports. Nevertheless, there is a concern about these professionals projecting future scenarios, since their main concern is with regard to the present moment. In normal insurance, the period of cover is one year. The inspector, because of the risk, assesses the risk at a time that precedes the period of insurance coverage. The risk environment may have changed, even the characteristics of activities developed in the environment.

The definition of what a future scenario is would be an environment or a special situation that is transforming from danger into one or more risks, which, when associated, give potential to the occurrence of accidents. Following one of the axioms determined for risk taking, the future scenario represents a technically structured hypothesis that exhibits a high percentage of certainty that it will occur at that time. Here, too, is another of axiom for risk-taking – to be possible.

a) Human Participation in accidents

Many of the techniques are based on cross-sectional analysis or models of "reverse engineering". In a construction activity, risks are amplified with the presence of workers.

It can be estimated that in approximately 650 accidents, 84% would involve workers in their workplace; 94% of those accidents could be attributed to flaws in assembly, maintenance or performance; 4% of total accidents fall into the category of minimal or no human participation; the remaining 2% can be attributed to various causes, including human contribution to material failure.

Following are two examples that present information useful in the elaboration of risk-surveys. There is no single model to follow and no single motivation. The research initially refers to the analysis of worker's cognitive aspects, before an even deeper analysis of the characteristics of the work and of the equipment and its maintenance plans.

In the magazine Cadernos de Seguro, from FUNENSEG, year V, n. 28, May/Jun -1986, with the title O Seguro e os Riscos do Construtor [Insurance and the Risks of the Constructor] we presented a risk analysis with regard to the expectation of loss, as follows:

Table I – Risk analysis in relation to Damage Expectation

Object of insurance (normal characteristics)	*Expected incidence of Risks*			*Expected Accident frequency*
	Damage to the work itself	*Damage to third party property*	*Damage to people*	
Residential/commercial building	*A*	*C*	*C*	*Constant*
Industrial building	*A*	*A*	*A*	*Occasional*
Large engineering project	*B/C*	*A*	*A*	*Rare*
Large engineering project in urban center	*A*	*C*	*C/D*	*Constant*

Note 1: *Expectation A signifies damage of 0% to 10%.*
Expectation B signifies damage of 11% to 20%.
Expectation C signifies damage of 21% to 30%.
Expectation D signifies damage above 40%.

Note 2: *For the expectation of accidents frequency, their classification meet the following requirements:*
- Rare: an accident occurring in more than 12000 h of continuous work.
- Occasional: an accident occurring between 6000 and 12000 h of continuous work.
- Constant: an accident occurring in less than 6000 hours of continuous work.

In the same article, we dealt with the expectation of damage, more specifically the frequency of accidents, associated with the characteristics of the activities, with the following results:

Table IV – Damage expectation by stage of work

Item (service)	*Average verified accident*
Setting out	*15%*
Rock blasting / mech. breaking	*38%*
Clearing the land	*6%*
Excavation/landfill	*35%*
Shallow foundations	*40%*
Deep foundations	*60%*
Prefabricated structures	*50%*
Conventional structures	*45%*
Bricklaying	*30%*
Installations	*5%*
Exterior finishing	*35%*
Cleaning service	*25%*

In the FUNENSEG Newsletter, year XVI, n. 795, 31/12/1984, under the title: Acidentes de trabalho em instalações elétricas [Industrial accidents with electrical installations] Navarro (1984) presented:

> The vast majority of those accidents occur due to curiosity, carelessness and lack of proper maintenance. However, due to various causes, including a lack of preparation of personnel and lack of knowledge of the equipment, the accidents occur not only in our homes, as in the above examples, but in all sectors of human activity. Note that the following causes generally contribute to the existence of an accident:
>
> - lack of planning and supervision;
> - lack of electrical earthing tests;
> - lack of adequate personal protection equipment
> - operational errors;
> - lack of adequate training;
> - incompetence or oversights;
> - inadequate equipment in inappropriate locations.
>
> In general, the manifestations presented by the victims from electricity are as follows in percentage terms:
>
> - burns (1st, 2nd and 3rd degree) 84%
> - injury to small sections 12%
> - injury to large sections of limbs 9%
> - bleeding through vascular lesions 9%
> - loss of consciousness 8%...

b) Work Environments

In order to glimpse the scenario related to the work environment it becomes relevant not only to have technical knowledge of the environment itself,, subject to studies, but also important are the interrelationships between this and people involved, i.e. situate this in a specific time, which may require, in addition to affective technical questions of the cognitive issues, those issues relating to the environment itself, as to what it represents in a general system, and knowledge to deal with the issue – association – in a way that find common points.

For such sets, in the language of Mathematics (Boolean algebra), what you want to know is if these sets – scenarios – have something in common. From there it proceeds to the following understanding if the commonalities amplify the consequences. In basic studies, A + B can be equal to C. A + B can be equal to A^2, or B^2. For the actuary, the enhancement of the risk represents an increase in losses. In environments considered safe A + B will certainly be C, which is distinct from A and from B, and certainly represents something greater than the sum of A and B. When this happens, the scenarios can be treated in isolation.

Axioms or absolute truths should also be evaluated. For example, if a device does not undergo maintenance, its service life may be shortened. It also presents risks of breaking or paralysis. If there are improvisations on the interconnections between multiple systems of a process, faults will surely arise and hence lead to loss or damage.

RIBAS (2008) apud al, in the article Combinando intuição e objetividade na construção de Cenários Alternativos [Combining intuition and objectivity in the construction of alternative scenarios], published in the Revista de Gestão USP, São Paulo, v. 15, n. 4, p. 1-17, October-December 2008 deals with the question this way:

> The failure to adopt a questioning attitude with respect to the future was one of the determinants in the failure of companies, which, until 2004 were considered unshakable. This is one of the conclusions reached by Sheth (2007), in the synthesis of his exploratory research on large corporations. In an interview with Durance (2004:3), Michel Godet posed the following question about the future: what are the attitudes that we should adopt before it is too late? He answered his own question in the same interview, when he declared that: <u>We often forget to ask about, or have forgotten, the real issues. Let us just clarify two things. Firstly, what will occur is not written anywhere. Second, thinking about the future does not eliminate uncertainty. On the contrary, it better prepares us. Everyone will face the same changes; the real difference lies in the way each of us will react. The elements of success and of failure are underlying. In short, learning how to maximize strengths and minimize weaknesses is much more effective than trying to change the world</u>.
>
> (DURANCE, 2004:4).

This reflection, which expresses the common prevailing sentiment, of the certainty as to the present and the uncertainty about the future, such we were, we are, and are going to be, weak at some point, at which time we will be exposed to everything which may achieve, induce or cause loss or damage, individual or collective, this thinking, that at times becomes collective, follows the path of our preoccupations and uncertainties.

The fact that we look ahead and predict scenarios has no significance if preventative measures are not adopted, or as Godet says in the text above: thinking about the future does not eliminate uncertainty.

c) Axioms

Axiomatic systems have a major role in exact science, particularly with regard to mathematics and physics, being the result of multiple theories usually referred to as theorems or laws. Amongst the various axiomatic systems of mathematics and physics, those that have gained notoriety include the works of Euclid in classical Geometry, the axioms of Peano's Arithmetic, Newton's laws of classical mechanics and Einstein's theory of relativity. Axiomatic systems appear in various other sciences. For example, in the theory of communication, Paul Watzlawick (and collaborators) presented the axioms of communication, which define the behavioural effects of human communication[4].

d) Fundaments of Complexity Theory

In analysing the identification of future scenarios, as mentioned – a theme that is seldom explored in risk management actions – we look to the literary review to establish a new "know-how" on the subject. Credible as it may be, not believing the future is to forget the present, that is, the present is the future of past times. Seen this way, the futuristic vision, fundamental to the evaluation of risk, is not necessarily exclusive to the foundations of mathematics, with the focus on the risk score and the linear regressions required to adapt them to the predictable framework, expanding to other areas of human knowledge, as we will see below, when the complexity theory presents an unusual approach.

ComplexityTheory is a subject often overlooked or little utilized when evaluating the inter-relationships between multiple risk scenarios. According to Estada (2009) in his assessment of the topic highlighted:

> ... The concept of paradigm refers us to the basic idea of Thomas Kuhn (1987), which conceives it as a key assumption among researchers who share it. ... Kuhn's ideas are particularly important as they allow the understanding of the driving and restraining forces of new theories and ideas. Questioning the traditional approach of scientific progress shows that science is in a constant state of evolution. This true evolution or progress of science occurs discontinuously when one paradigm is replaced by another. This is what Kuhn called "revolution". It begins when the established paradigm can no longer give explanations about the phenomena studied.
>
> (SERVA M., DIAS, T. & ALPERSTEDT, G. D., 2010, pp. 276-287)

[4] Text available at http://www.significados.com.br/axioma/, accessed on 04/02/2015.

In these quotes, the main focus of attention is on education. Training programs are undertaken by companies with a view to reducing accidents. Few, however, evaluate the quality of the training programs and how much information a worker manages to absorb and for how long. Repetition of accidents in activities where companies apply training programs can lead us to some conclusions: the first being that the programs are not totally adequate; the second may be a large turnover of personnel; in the third, a low retention rate of the information passed on may be the problem.

There are dozens of methodologies for risk analysis/scenarios and the modelling of the results. A simple relationship of these tools is presented, as an example, in order to inform readers that while there is no shortage of analysis instruments, there is a lack of employment of these methodologies, which most often needs to be supplemented by aggregating the results obtained by other methods. The list, which is not complete, has been drawn up in alphabetical order. FOGAÇA (2010), in an article sent to the 8th Mostra Acadêmica UNIMEP, introducing the theme: Features of the descriptive analysis in studies on entrepreneurship, clarifies the use of tools and methodologies for the analysis of risk and scenarios:

> *The statistics... can be applied in virtually all areas of knowledge and... divided into two broad categories: descriptive statistics and inferential statistics, ... The descriptive statistics... involves the collection and analysis of a set of data with the aim of describing the features of this set (LEVINE, 2000). For the analysis of data, there are several methods that can be used such as:*
> *Relative frequency (frequency division and the total number of the population, in percentage);*
> *Test hypotheses (statistical inference of a population from a sample);*
> *t Test (determines the difference between the arithmetic mean of the sample and the arithmetic mean of the population);*
> *Mann Whitney (non-parametric test used when the objective of the research is to compare two independent groups);*
> *Association (method used when you want to associate two factors that may have some relationship to the determination of such a result);*
> *Classification (consists of dividing the population studied into groups);*
> *Cluster (also known as grouping, is the classification of the object of research into different groups according to the degree of similarity that exists);*
> *Factor analysis (describes the original variability of the random vector);*
> *Fuzzy (type of logic derived from Boolean logic that allows logical values between false and real, for example);*
> *Survey (collection of data or information for a particular sample, generally through questionnaires);*
> *Cronbach's alpha (Computes the reliability of a test) and*
> *Likert scale (type of scale of responses used in questionnaires, especially with opinion polls. o).....*

Analysing what is being employed in technical evaluations for various purposes, we identified the following methodologies, not excluding others not cited:

1. ETA (Event Tree Analysis);
2. FTA (Fault Tree Analysis);
3. AHP (Analytic Hierarchy Process);
4. MCDS (Multi-Criteria Decision Support);
5. Cluster Analysis (a cluster is a collection of objects that are similar to each other according to some fixed similarity criterion and dissimilar to objects belonging to other clusters);
6. Project and Process analysis (analysis that takes into account the possible associations and the results of these projects and processes, aimed at fault elimination);
7. Integrated analysis of scenarios (scenarios are environments or horizons that have high probability of occurrence and that can be associated with others, randomly or not, to change the expected results);
8. Multi-Analysis Scenarios (takes into account that there are inferences between those and those that can be evaluated, with a view to reducing the impacts of occurrences);
9. Multivariate Analysis (statistical methods that analyse multiple measures simultaneously on each individual or object under investigation);
10. Pre-Task Analysis (risk analysis developed prior to the beginning of the tasks);
11. Cognitive Analysis (proposes an explanation for the operation of the mind in three levels: physical, neurobiological; symbolically distinct and irreducible from the physical; and the semantic or representational level itself);
12. AHP (Analytic Hierarchy Process) – complex system of relationships in which there are elements of an objective nature, own actions, and clearly subjective elements of nature, belonging to the value system of the actors. This system is indivisible and, therefore, any methodology to support the decision-making process cannot neglect any of these two aspects Thomaz [2000]);
13. Bayesian Analysis (describes uncertainties about invisible quantities in a probabilistic form. Uncertainties are modified periodically after observations of new data or results. The operation that calibrates the measurement of uncertainty is known as a Bayesian operation utilizing Bayes);
14. Analysis of Uncertainty or Normality of the processes;
15. Integrated analysis of the work;
16. Pre-Task Analysis;
17. Technical analysis of Risks;
18. APR – Preliminary analysis of Risks;
19. Fault tree;
20. Event tree;
21. Accident Barrier;
22. BBS (Behaviour Based Safety – Behaviour-based safety is used widely in industrial processes to improve the safety and environmental performance of the work. The system recognizes that people can’t change, but their behaviour can[5]);

[5] OWOLABI, Babatunde David, QHSE Managing Consultant, SHEMS^{sm} Solutions Consultants Limited.

23. Berliner (study proposed by Berliner in 1964 that classifies human behaviour into four processes of cognitive, perceptive, motor and communication, which when evaluated together define what the worker was doing at the time of the accident) (BERLINER, D.C., D. Angell, *et al.*, 1964, p. 277-296);
24. BPM (Business Process Management – set of information and communication technologies to connect people and systems within organizations, enabling data sharing and integration, rules, information and a single strategic direction [Brodbeck & Gallina, 2008]);
25. BSC (Balanced Scorecard – management indicator presenting the performances required in each process, which, indicates graphically the degree of achievement of the goals);
26. DMAIC (Define Measure Analyse Improve Control);
27. Behavioural Factors;
28. HAZID (Hazard Identification);
29. HAZOP (Hazard and Operability Studies);
30. HFACS (Human Factors Analysis and Classification System);
31. Likert (type of psychometric response scale used in questionnaires, and is the most widely used scale in opinion polls. To respond to a questionnaire based on this scale, the interviewees specify their level of agreement with an affirmation);
32. Risk maps;
33. MASP (Method of analysis and troubleshooting);
34. MCDM (Multi-Criteria Decision Making);
35. MCR (Matix of Classification of Risks);
36. MOC (Management of Change);
37. Monte Carlo (any method of a class of statistical methods based on random massive sampling to obtain numerical results, that is, successive simulations, high repeat number of times, to calculate probabilities heuristically, as if, in fact, actual results were achieved);
38. MORT (The Management Oversight and Risk Tree – technique of thorough investigation that researches work-related accidents and prepares analyses of security programs, employed to improve safety levels in specific activities and organizations);
39. PERIL (Possibility and Impact Classified);
40. PSP (Process Safety Program);
41. QRAM (Qualitative Risk Assessment Method);
42. RAM (Reliability, Availability and Maintainability);
43. SE (Series of Events);
44. SIL (Systems Integrity Level – analysis method based on the sequence of risk mitigation barriers);
45. SR (Risk series);
46. SSPS (Software for Statistical Analyses of Matrices);
47. Survey;
48. SWOT (Strengths, Weaknesses, Opportunities, Threats);
49. Random Techniques;
50. Queueing theory (process of analysis based on production processes);
51. Chaos theory;
52. Domino theory;
53. Graph theory (studies the relationships between the objects of a given set. For this theory, structures called graphs are used, G (V,A), where V is non-empty set of objects called vertices and A is a set of unordered pairs of V, called edges);

54. TIC (Critical Incident technique);
55. TODA (Multi-criteria Decision Making);
56. Triple Bottom Line (People, Planet, Profit corresponds to the results of an organization measured in terms of social, environmental, and economic);
57. Combined Variables;
58. Weibull (continuous probability distribution);
59. FMECA (Failure Mode, Effects and Criticality Analysis).

NAVARRO (2012), in examining the issue of scenario prospection developed and Decision-making Matrix by integrating the different scenarios that could arise in the implementation of the COMPERJ Complex, in the municipality of Itaboraí, Rio de Janeiro State. The implementation of an enterprise can generate employment and income, prestige for the city, qualification of local labour; in short, it can be a factor of multiple positive aggregations. However, the same enterprise may ultimately turn into a serious and future problem for the municipality, through subsequent developments. The proposed model was elaborated by deploying simple tools, such as research through questionnaires and the analysis of the results. There are several reasons for the establishment of an industrial development in a locality or region and some can be listed:

- Fiscal facilities, regional or state;
- Large supply of labour with the characteristics required for the implantation of the enterprises;
- Proximity of loading and unloading that can reduce the cost of transporting raw materials or finished products;
- Ease in obtaining raw materials and inputs for the manufacture or production of the goods;
- Proximity to consumption centres for the products produced, thus reducing the transportation and distribution costs of the goods;
- Other businesses in the vicinity provoking a synergistic effect in the production chain. Under certain circumstances these “parallel” ventures turn out to be complementary to the final production process of the company;
- Topographical conditions favourable to the implementation of industry;
- Ease of obtaining water and electricity, or obtaining benefits for using these resources;
- Public financing policies or strategic partnerships through, among others, development banks, reduced rates, and long grace periods.

After implantation, namely, in the installation phase of the project, and after the euphoria that accompanies the arrival of the company for the region, problems begin to be arise that were not initially perceived by those who saw only the immediate benefits of the project. The first refers to what to do with those employees, or less qualified labour, who originated in other distant regions, in search of a dream job with easy gains, and in not having the minimum level of qualifications required, will no longer be working in the company and are unable to return to their places of origin? How will the city deal with the increase in traffic on the streets, deteriorating the entire transit system and damaging the movement or mobility of the residents? How will older residents survive with the rising costs resulting from the consumption of workers who earn higher salaries?

Such situations become complex and difficult to solve. Solutions exist, but begin long before the industry commences construction. The region should be prepared in the same way as the population.

e) Prioritization of the Scenarios

Some of the most relevant aspects are listed below, with an indication of the impact, which will be discussed. For ease of interpretation, we split the events into four scenarios.

The first scenario covers only the internal environment of the company, namely, the setting, but this is contained within the company itself, with no external considerations. The second scenario has the internal event generating external impacts. In the third scenario, the events are external and can cause internal impacts and, finally, the fourth scenario is represented by an external event that manifests itself only in the external environment. It is logical that the settings interact with each other in some way or form. However, for our studies, we can always observe the greatest impacts and not the consequences arising in the second, third or fourth levels. For a better understanding, we present the table below with a colorimetric indication of the scenarios and their impacts.

Category	Col	Characteristics of events likely to happen during the lifetime of the enterprise*
A		Conceptually possible, extremely unlikely to occur
B		Not expected to occur
C		Unlikely to occur
D		Expected to occur during the lifetime of the installation
E		Expected to occur multiple times during the lifetime of the installation (until decommissioning)

Nº	Scenarios/Risks	Likely impacts on the environment (internal and external)			
		In/In	In/Ex	Ex/In	Ex/Ex
I.	Accidents involving vehicles:				
1.	Against fixed objects.				
2.	Against other vehicles.				
3.	With falling of dangerous cargo or other.				
4.	Involving multiple vehicles.				
5.	By transported cargo falling onto people.				
6.	By transported cargo falling onto vehicles.				
7.	By transported cargo falling onto goods.				
8.	By excessive load with damage to the road surface, underground facilities (water, electricity, sewage, data, signage, and other).				

II.	Multiple accidents that may be caused by:				
1.	Fall of materials being handled.				
2.	During the execution of the works.				
3.	During transportation of workers.				
4.	By food poisoning.				

III.	Accidents occurring during construction by:				
1.	Material or project failure, affecting vital equipment, devido a defeitos de materiais ou erros de projeto.				
2.	Mounting failure of vital equipment.				

IV.	Acts of Sabotage involving:				
1.	Vital equipment, pipelines and external supply of inputs.				
2.	Systems logic or control of vital equipment.				

V.	Diverse accidents that could cause:				
1.	Increased lightning due to metal structures.				
2.	Geotechnical constraints not properly planned causing damage to critical equipment during operation phase.				

VI.	Operational accidents that can have as a root cause:				
1.	Materials fatigue involving vital equipment.				
2.	Explosions during the operation of the facilities.				
3.	Chemical leaks.				
4.	Damage to the environment or personal equipment or facilities, operation, testing, commissioning.				
5.	Exploding gas tanks where blast could affect equipment or any third party.				
6.	Various causes.				

VII.	Environmental damage caused by the enterprise as a result of:				
1.	Dusts, fumes, particulate materials released during the construction phase.				
2.	Dusts, fumes, particulate materials released during the operation of the enterprise.				
3.	Spillage of hazardous cargo near waterways or channels.				
4.	Brush fire, in trash, stockpiles, spontaneous, accidental or deliberate.				
5.	Contamination the watercourses or mangroves.				
6.	Infestations, natural or alien.				
7.	Contamination of water tables by leaking products.				
8.	Products accidentally released into the air, in watercourses, streets.				
9.	Flooding, siltation or obstructions in rivers or estuaries under the responsibility of the enterprise.				
10.	Climate change caused by the implementation of the project, change of temperature, winds, rainfall and moisture regime.				

VIII.	Social damage caused to local society by:				
1.	Asset or personal loss caused to transmission towers.				
2.	Asset or personal loss caused to pipelines or control devices.				

IX.	Damage to the image of the new enterprise caused by:				
1.	Schedule delays due to supply failure due to financial or economic issues that are independent of the Project.				
2.	Dust generated and noise affecting residents in the vicinity of the enterprise.				
3.	Damage to fishermen resulting from leaks affecting areas of rivers and mangroves.				
4.	Accidents that occur in ducts or tracks in transmission lines and which may be attributed to the responsibility of the enterprise.				
5.	Environmental accidents by pipeline leaks and polyducts during the operation thereof or sabotage or ground movements.				
6.	Personal injury or property damage involving third parties that have entered ducts of pipelines or power transmission lines.				

X.	Personal injury caused by:				
1.	Manifestations of infectious or contagious diseases.				
2.	Incurred during strikes, picketing or lockouts.				
3.	Caused to third parties that have, intentionally or not, access to the premises of the enterprise.				
4.	Emergence of chronic respiratory diseases, or not, by chemicals released into the atmosphere surrounding the enterprise.				
5.	Caused to third parties by animals, insects that can be attributed to the responsibility of the enterprise.				
6.	Caused to third parties due to disagreements between the local population and service providers.				
7.	For disputes in lodgings or domains of service providers.				

XI.	Social impacts and/or changes in Social Environments caused by:				
1.	Delay in the work schedule.				
2.	Actions of employees of the enterprise or of third parties affecting people in the community.				
3.	Loss or damage caused to communities due to panic caused by accidents inside the enterprise.				
4.	Increase in begging or prostitution.				
5.	Increased consumption of alcohol in pubs and bars open in the implementation of the project.				
6.	Issuance of bad checks or defaults into the local commerce by enterprise service providers.				
7.	Spread of sexually transmitted diseases, through contact between service providers.				
8.	Rising unemployment on termination of the works.				
9.	Financial and social inequality.				
10.	Increased levels of crime, drug trafficking.				
11.	Urban restructuring in nearby towns (irregular buildings, slums, increased flow of vehicles, congestion).				
12.	Overload of healthcare centres or hospitals in the municipal network.				
13.	Stoppage or reduction of investments for political of economic reasons.				
14.	Reducing the scope of the project for political or economic reasons.				
15.	Delays in the progress of works by late delivery of equipment vital to the process.				
16.	Delays or non-payment of wages by the suppliers.				
17.	Assessments or audits of work hygiene in lodgings or accommodation of contracted workers.				
18.	Delays in the works for reasons of financial mismanagement by contractors or the delay of payments by the enterprise for various causes.				
19.	Permanence of employees of service providers or contractors after the works, on leave or illness or accident.				
20.	Dismissal of employees upon completion of services.				

Notes:

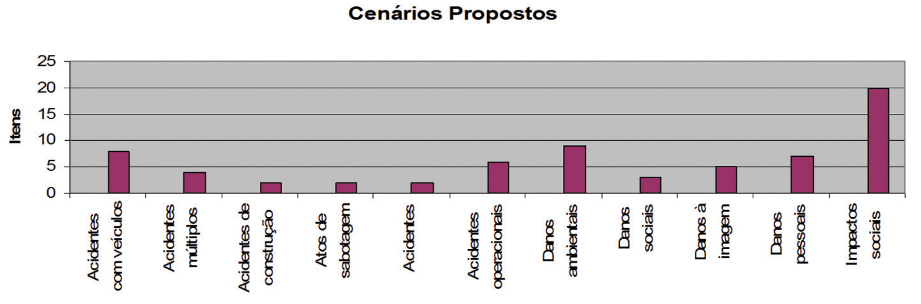
1. In this example, colours can be replaced for values. These values can be obtained through the frequency rate of occurrences or rates related to expected losses. In this case, the analysis of this survey sample is no longer qualitative and becomes quantitative, associating the risk groupings.
2. The time elapsed between the maturation of a project and the final decommissioning and dismantling of equipment must be taken into account;

3. The proposed items and criteria for evaluation of the economic-financial-social impacts should be established by a group of experts who have prior knowledge of the project and the areas of influence, also stating the municipalities that will directly and indirectly benefit from the positive results of the implantation of the enterprises.
4. Special attention should be given to “human migrations”, sometimes “forced” in poorer municipalities. Among the various negative social impacts are those on public healthcare systems for the population and precarious urban settlements, and in areas that are usually inappropriate, exposing these new residents on hillsides to unnecessary risks of heavy rainfall that may cause the landslides.
5. The proposed analysis takes into account the potential impacts of foreseeable events that appear exclusively on the site, occurring in the internal environment of the company and in the expansion of impacts to exterior environment. There are also events that manifest themselves externally which, under certain circumstances, can affect internal areas of the enterprise.
6. Hierarchization due to financial impacts was not considered but, rather, the property and or environmental damage.

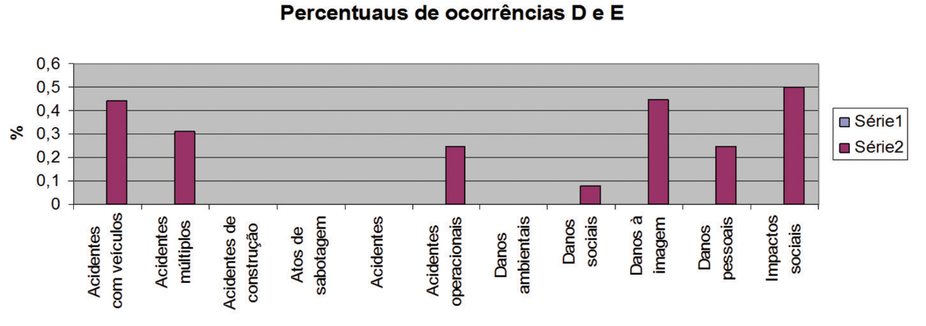
Proposed scenarios in example:
After the preliminary assessment of the enterprise and its environs, the scenarios most likely to suffer negative impacts are considered, as shown in graph I and the quantity of events/accidents/disasters with the category “D” and “E” expected for each specific situation, as indicated in graph II (in this example the sum of the frequencies of classes “D” and “E” and the result is divided by the amount of impact versus proposed scenarios). The hierarchy of the negative impacts can be developed according to Likert scales, or other simple graphic tools. However, the definition of impacts must be performed by means of specific mathematical-statistical programs. Here it is not just about the simple association between the risk and the loss or damage, but additional considerations, which, from the identification of risks and enhancement of their analysis that arrive at the consequences of impacts caused in and around the enterprises, which do not necessarily involve urban centres of municipalities, and the impacts of these being replicated in other locations. Like Dominos, there is a converging risk, or multiplicity of risks, causing damages, which affect other environments, expanding, in this way, this loss and damage.

Actions necessary for the example presented:
Having the proposed scenarios as a parameter, the next step will be the validation of these with possible additions and deletions of negligible impacts about the consequences or the inclusion of new relevant scenarios, and then define the best strategies for each case. For example, an enterprise contracts a number of companies for the execution of services. These, in turn, contract professionals for the execution of the services, as well as companies for the provision of basic supplies. If the enterprise resolves, due to other criteria, to discontinue the works or temporarily paralyze the cash flow, what will be the future impacts? The subcontractors will have the same problems. The municipalities will see their public coffers dwindle. The commitments made by municipalities will also be affected, so there will be an entire cascade with the ability to multiply losses or damage.

Graph I – Quantity of items observed by likely scenarios proposed (AFANP)



Graph II – Percentage of accidents "D" and "E" evaluated for each category of suggested events (AFANP)



Negri & Hulse (2013) in the article A Ferramenta de Prospecção de Cenários no Processo de Tomada de Decisão, publicado na Coleção Gestão Organizacional e Tecnologia em Recursos Humanos do O Judiciário Catarinense na Perspectiva dos seus Servidores [The Tool of Scenario Prospection in the Decision-making Process, published in the collection: Organizational Management and Technology in Human Resources of the Santa Catarina Judiciary from the perspective of its public servants.] – Volume 3, pp 163 to 189, introduces the issue as follows:

> The speed of the increase in knowledge, as well as its application as a form of organizational survival, involves and results in rapid transformations in the environment and is not always predictable, requiring different postures from managers faced with a lot more unstable environments than previously. (MORITZ, 2008, p. 69). In fact, scenario prospection is a scientific effort to fathom the time, through its agents and its variables, in order to reveal trends that should be observed and identified in mankind's effort to better understand and comprehend its future and its fate in this complex universe. (MORITZ *et al*., 2010, p. 2). However, the elaboration of scenarios is not a prediction but, rather, an effort to make plausible and consistent descriptions of possible future situations, showing the conditions of the path between the current situation and each future scenario and highlighting the factors relevant to decisions that need to be taken.
>
> (WRIGHT, 2010, p. 59)

In the literature review, the same authors highlight:

> The chain of reflections and actions that stretches between the time of the perceived need to act occurs and the time when choosing a course of action is called the decision process (ABRAMCZUK, 2009, p. 43). The technique of scenarios, which assists the administrator in the decision-making process, is a set formed by the coherent description of a future situation and the imagined and created routing of events that allow passing from the source of origin to the future situation.
>
> (GODET, 1993 apud MORITZ; PEREIRA, 2005, p. 2)

When dealing with the issue of Methodology the same authors present:

> Studies can be classified as being qualitative, descriptive, and interpretative, whose assumptions are based on the idea that social reality does not exist in a concrete sense, but is a product of the subjectivity and the experience of individuals and organizations.
>
> (MORITZ *et al*., 2010, p. 3).

With respect to the decision-making process, Negri & Hulse (2013), state:

> ... The decision-making process should be focused on the rational point of view, in its stages, its elements and strategies, seeking to give the administrator a position to choose the best approach to manage the decision-making, in order to increase its chances of success in the achievement of objectives. The point is that the options are not binary (0 or 1), in the sense that the decision will be absolutely right or absolutely wrong. All or nothing, as they say. In fact, the decisions are part of complex environments. In these variables arise people, reactions, structure, control, confidentiality, risks, resources, all surrounded by information often uncertain, random and not presumed, without forgetting to consider the existence of chance itself. A good decision takes into account all this, analyses, dissects, establishing alternatives and anticipating consequences.
>
> (YU *et al.*, 2011, p. 9-10)

According to Schwartz (2006, p. 18), however, the scenarios first appeared soon after World War II, as a method of military planning. The US. Air Force tried to imagine what its opponent would try to do and prepared alternative strategies. In the 60s, Herman Kahn, who had been part of the Air Force group, improved the scenarios as a tool for commercial use. He became America's greatest futurist or visionary, predicting that the growth and prosperity would be inevitable. However, the scenarios reached a new dimension at the beginning of the 70s, with the work of Pierre Wack, who was a planner at the London offices of Royal Dutch/Shell, the international oil group, in a new department called the Planning Group.

Furthermore, the first person to employ the word “prospective” was the philosopher and educator Frances Gaston Berger in his book The Prospective Attitude, 1957, establishing how to describe a desirable future for the world, and Berger proposed the use of the term “prospective” to show the need for a targeted approach for the future and because the word “prediction” was too imbued with the sense of prophecy. Intended, therefore, to separate the predicting concepts (build a future in the image of the past) and prospective (where the future is decidedly different from the past) (MARCIAL; GRUMBACH, 2008, p. 28).

According to Amaral & Salancik apud Coelho (2003)[6] a progressive definition for forecasting, related to the degree of precision that these studies present, can be thus described:

i. An indication on the future;
ii. A probabilistic indication about the future;
iii. A probabilistic indication, reasonably defining the future;
iv. A probabilistic indication, reasonably defining the future, based on an evaluation of alternative possibilities.

[6] COELHO JÚNIOR, F.A Suporte à Aprendizagem, Satisfação no Trabalho e Desempenho: Um Estudo Multinível. 2009. 315 p. Unpublished doctorate thesis, Instituto de Psicologia, Universidade de Brasília, Brasília, 2009.

> **Futuribles, La Prospective, Veille Technologique**
> ... Future studies are a field of intellectual and political activity concerning all sectors of psychological, social, economic, political and cultural life, that wants to order and master the complex causal chains, through concepts, systematic reflections, trials, advances and creative thinking.
> In the construction of scenarios, Zentner, affirms that:
> “the scenarios constructed must meet the criteria of plausibility, usefulness and intelligibility”. Therefore, the process of elaborating scenarios involves research and a qualified search of information. Within this vision, developing scenarios, in theory, requires three distinct stages and inter-related phases: A sector phase, seeking a diagnosis containing the contours, limits, parameters, logical and essential elements of the problem. This phase is based on research and study of the current situation; An analysis phase, when it will be built or identifying the various alternatives...[7]

Perestrelo & Caldas (2000), in analysing the methods of scenarios under the optics of the strategic actor, citing the Cluster methodology:

> 1. The Strategic Actor method.
>   ... The specific objectives of the strategic actor are as follows:
>   - Identify and characterize the different key actors;
>   - Understanding how conflicts arise and possible alliances between the various actors, and how they can guide the evolution of the system;
>   - Contributing to increased participation/involvement and strategic reflection on the part of the different actors;
>   - Confronting the projects at hand and evaluate existing power relations;
>   - Elaborating a series of strategic recommendations and specify the conditions of viability for its implementation....
>
> (PERESTRELO, M. & CALDAS, J. M. C., 2000)

The Ministério do Desenvolvimento Social e Combate à Fome [Ministry of Social Development and Hunger Alleviation[, through the Secretariat for Evaluation and Information Management in the Technical Study No. 21/2013 which addresses the Introduction to prospective studies and scenario building methodologies, deals with the Prospective Study in a very didactic way, returning to the time of informing – SAGI (2013):

The first approaches to prospective studies occurred after the Second World War, with the adoption of usage scenarios techniques in the 1950s by the RAND Corporation. ... Among the best-known examples is that of Shell, from prospective studies conducted in 1969, anticipating the rise in oil prices in 1973, which initiated their extraction process in the North Sea ahead of its competitors. A global prospective study was developed by the so-called the Club of Rome in 1972, entitled “The Limits to Growth”, about prospecting the future, indicating the population, economic and technological trends and the social, economic

[7] Zentner, disponível em http://www.strategia.com.br/Alunos/2000-2/Cenarios/135/construcao.htm, acessado em 29/9/2014. Citado por Ribas, J.R., Combinando intuição e objetividade na construção de cenários alternativos, Revista de Gestão USP, São Paulo, v. 15, n. 4, p. 1-17, October-December 2008.

and ecological consequences for the world. ... The proposal was considered in the preparation of the Economic Model of Long-Term Simulation adopted by the United Nations and the training of technicians of the Centro de Estudios del Desarrollo (CENDES) in Venezuela, and the Instituto Nacional de Planificacíon, in Peru.

SCHENATTO *et al*. (2011), present a critical analysis to the question of scenario prospection and results in some important considerations such as:

> Expanding mental models, so that future conditions may be interpreted and shaped more efficiently, constitutes a constant strategic challenge for social, economic, political and institutional agents. ... The original generic approach has been replaced by more specific views, related to proper methods of research and building the future, gaining greater relevance, coherence and replicability.
>
> (SCHENATTO, F.J.A., 2011, p. 739-754)

7. Conclusion

The first conclusion, more a reflection, arises from a simple question: why are we concerned about events that, when they occur, will be in the future? In this vein, a child does not worry about death, nor passes judgment or makes an assessment of value about that fact. He justs want to play. However, for a large company, for a Country, for a Municipality, impactful events can disrupt or destroy dreams, claim lives, cause wars, cause the extinction of environments, drown companies in debt that will never be paid, cause suicides, increase the number of unemployed, ultimately, there is a whole socio-economic, financial, environmental and cultural context, which cannot ever be forgotten when dealing with the planning of enterprises. Thus, to be concerned with the issue is the same as thinking about solutions other than the long term, as in the case of water, for example. In our country, where there is a micro society that depends on and thrives on politics, looking to the future is not a common practice. Investments calculated by a bad Government will only commence during the next Government. This is not just a current state, and has occurred for centuries. Nevertheless, with the effect of the conurbation, the creation of industrial hubs, which started at the time of the Brazilian dictatorship, with Camaçari (BA) and Triunfo (RS), with dozens of companies grouped, with high risk of fire or explosion, it was forbidden to talk about disasters. In 2010 there were projected disasters, with landslides on the slopes of hills occupied entirely by housing and thick layers of garbage, and furthermore, without any type of urban planning. All these facts lead our thoughts to the fact that it is not a common practice to study the future. Yes, because the analyses of the multi-scenario type make it possible to focus the binoculars of much farther research. Yet, we can leave this vision 360º aside and assume postures that are more realistic.

Arriving at a simple conclusion when it comes to Multi-Scenario analysis or Multicriteria, is not an easy task. We are dealing with prospective analysis, carried forward into the future, which may or may not involve a multitude of situations. This is not an analysis that leads quickly to an equation of the first degree type: $a + bx = c$, in which the parameters “a”, “b” and “c” are known, leaving only to know the value of “x”, our unknown. From each unfolding scenario may arise distinct variables. Logic demands that the experience of the group of analysts and the study of similar cases can influence the speed of analysis. Nothing is impossible.

The importance of the topic and what is presented in this article, simple basic tables of the “first degree”, because they do not extend to subsequent impacts, is due to the approximate sizing of the expected damages, or commercial or operational strategies, expectations on investments, planning of global actions, industrial accidents, and other innumerable questions, since multiple scenarios can lead to multiple consequences, each with multiple impacts..

One has to question that, unfortunately, not all likely scenarios may be covered, and we not have calculation “tools” available that allow us to deal the interaction of these same scenarios, or expectation of changes in environments that can be called hostile; environments where there minimally exists the possibility of changes outside the normal course of political environment, economic and financial, social, technological, apart from other environments that can cause investor apprehension, such as the lack of uptake by consumers, for example, or the enterprise, due to an accident, that is likely to cause serious environmental damage and thus damaging the company’s image. In these cases, more limited predictions and those covering the short term are still needed.

On social security issues, it is known that the stability of the plans depend not only on the amount of new participants or contributors, but also on the life expectancy of the insured being not longer than the current beneficiaries, the correct application of funds guaranteeing the future benefit payments, maintenance of fiscal policies that enable the definition of costing plans, maintenance of social policies, to mention only a few scenarios. Recently is has been reported that the population is decreasing, such as in Japan. This means a lower inflow of contributors in the near future. Aside from that, the beneficiaries are living longer, that is, in a very short time the plans will have to be revised or the government will have to change the conditions of these plans. It is a very simple example, but it denotes the need to project results. This projection is termed analysis of future scenarios. Talented professionals for these analyses and the availability of computational resources in support are always welcome. The human being is beginning to explore the surface of the planet Mars, perhaps to make a rapid journey when the Earth, our P3, is already decaying and no longer able to support so many people destroying it. Scientists have structured their research in stages, starting with the search for water, no coincidence, since the oxygen that we need can be contained in water. Thus created the first of the scenarios, thereafter comes the conclusions, such as other forms of life.

Another aspect that presents great difficulty is the understanding by risk managers of the intertwining of the various future scenarios, which may enhance the effects of negative scenarios. This interrelation between the scenarios is quite complex, but not impossible to be accomplished.

The use of computer technologies or adapting specific methodologies requires the risk manager to have effective knowledge about the main events are being contemplated, among which, those with potential to spread the damage beyond the limits of the enterprises or geographic regions, those with potential to be lethal and that can impact the entire production process. Thus, it is important to use specific measurements of these impacts. Databases for the study of the general impacts can and should be used, or the reports of past facts.

Currently we question the lack of “metrics” in many of the activities. Actuaries do not have the main argument for elaborating them, which is the existence of reliable information, or upgraded databases. The absence of that pillar affects the balance of all other evaluation actions. A well-practiced resource is the reduction of analysis parameters. It may be interesting when the predicted risks are not large, or at least the expectation of these occurring is low. This is a solution that ends up being widely practiced, mainly because the calculations always add technical loading or “security” to prevent the occurred results departing too much from those contained in the range of expected results. For those who are accustomed, as a rule, the safety loadings are in the order of 30%.

Another issue, which should be reviewed and studied in greater depth, is the interrelationship between the scenarios. This is a proposal which has become interesting, since it is practiced most is the employment reliability methods for the integration of future scenarios, assuming that the enhancement, or not, of these scenarios as the amplification of specific losses arising from claims.

Ultimately, it is a subject that deserves more work in all its aspects, and be better divulged, as it can certainly advance the search for solutions, as was the case with the issue of “the time forecast”.

In summary, we sought to justify the need to study the environments at various times. In times past through statistics. In present times through field inspections or risk management measures. In future times through the application of methodologies or processes that lead us to “imagine” what the scenario will be. The importance of all of this should be clear. Knowing the risks enables the pricing of losses, with regard to insurance. As for companies, they can better invest their resources.

Finally, it was demonstrated that Survey methodology can be an interesting way to identify risks. The concept of identification becomes more robust to the extent that it aggregates complimentary analysis methodologies. SIL is one of these, and becomes important in knowing know how well prepared a company is to meet the challenges or contain risks, with the interposition of multiple barriers. The simplest, and the one offers immediate results, is the communication barrier and training people. Trained staff tend to be involved in fewer accidents. It can be said that a considerable amount of accidents are caused by human participation and the people involved did not have the training required to perform the activity. It is believed that these issues can be better exploited, individually or together in order to have a lower expectation of accidents (claims).

8. Bibliographical References

BERLINER, D.C., D. ANGELL, *et al.*, Behaviors, measures and instruments for performance evaluation in simulated environments. Symposium and Workshop on the Quantification of Human Performance. Albuquerque, Novo México, EUA, 277-296, 1964.

BLAIR, P. Technology assessment; current trends and the myth of a formula. 1994. CGEE – Centre for management and strategic studies, available at http://www.cgee.org.br/prospeccao/index.php?operacao=Exibir&serv=textos/topicos/texto_exi b&tto_id=2&tex_id=1, taken on 26/9/2014.

BRODBECK, A.F.; GALLINA, D.B. Practices of the Project Management to Redesign Business Critical Process: The Case of a Multinational Electronic Company. In: Anais do IV CONTECSI, CD-ROM, São Paulo, 2008.

COATES, J. A 21st century agenda for technology assessment. Technology Management, Sept.-Oct. 2001.

_________. Foresight in Federal Government Policy Making. Futures Research Quartely, 1, p.29-53, 1985.

_________. Why Study the Future? Research Technology Management, May/June 2003. COELHO, G.M. Prospecção tecnológica: metodologias e experiências nacionais e internacionais. Rio de Janeiro.

COELHO JÚNIOR, F. A. Suporte à Aprendizagem, Satisfação no Trabalho e Desempenho: Um Estudo Multinível. 2009. 315 p. Unpublished PhD thesis, Instituto de Psicologia, Universidade de Brasília, Brasília, 2009.

ESTADA, A. A fundaments of the complexity theory in edgar morin. Akrópolis Umuarama, v. 17, n. 2, p. 85-90, abr./jun. 2009.

FOGAÇA, Marília de Oliveira, Características da análise descritiva em estudos sobre empreendedorismo, orientadora: Maria Imaculada de Lima Montebelo, 18º Congresso de Iniciação Científica, 8ª Mostra Acadêmica UNIMEP, 26 a 28/10/2010.

FREITAS, H., CUNHA Jr., M., and MOSCAROLA, J. Aplicação de sistema de software para auxílio na análise de conteúdo. Revista de Administração da USP, São Paulo, v.32, n.3, p.97- 109, Jul. 1997.

FREITAS, H., OLIVEIRA, M., SACCOL, A.Z., MOSCAROLA, J., O método de pesquisa Survey, Revista de Administração, v.35, n.3, p.105-112, São Paulo, Jul/Sep 2000.

GALLIANO, Alfredo Guilherme: O Método Científico – Teoria e Prática. São Paulo, Harbra, 1979.

GASQUE, K. C. G. D. Teoria fundamentada: nova perspectiva à pesquisa exploratória, Métodos para a pesquisa em Ciência da Informação I, Chapter 4, Universidade de Brasília, p83-118, available at http://repositorio.unb.br/bitstream/10482/9610/3/CAPITULO_TeoriaFundamentadaNova.pdf, taken on 24/02/2015, Rio de Janeiro/RJ.

HAMEL, G., PRAHALAD, C. K. Competindo pelo futuro: estratégias inovadoras para obter o controle do seu setor e criar os mercados de amanhã. (trad. Outras Palavras) Rio de Janeiro: Campus, 1995.

HEMARD, J. Theorie et pratique des assurances terrestres, Paris, Recueil Sirey, 1924. HORTON, A. Foresight: how to do simply and successfully Foresight, v. 01, n. 01, 1999. JAKOBIAK, François. Veille technologique, l'approche française. In: Seminário Internacional sobre Gestão Estratégica do Conhecimento. (1997, Rio de Janeiro). Anais. Rio de Janeiro: SENAI/CIET, 1997.

INT/Finep/ANP Projeto CT-Petro Tendências Tecnológicas, 2003.

KUHN, Thomas S. A estrutura das revoluções científicas. Trad. por Beatriz Vianna Boeira. São Paulo: Perspectiva, 1962.

_______________. La tensión esenciai. Estúdios selectos sobre la tradición y el cambio en el âmbito de là ciência. Trad. por Roberto Hclicr. México: Fondo de Cultura Econômica, 1987.

LAKATOS, E. M.; MARCONI, M. de A. Fundamentos de metodologia científica. São Paulo: Atlas, 1991. 270 p.

LEVINE, D. M.; BERENSON, M. L.; STEPHAN, D. Estatística: Teoria e Aplicações. 1. ed. Rio de Janeiro: LTC, 2000. 811 p.

LIKERT, R. A Technique for the Measurement of Attitudes. Archives of Psychology 140: pp. 1-55, 1932.

MALHOTRA, N. K. Pesquisa de Marketing: uma orientação aplicada. Porto Alegre: Editora Bookman, 2001.

MARTIN, B. R., ANDERSON, J., MACLEAN, M. Identifying Research Priorities in PublicSector Funding Agencies: Mapping Science Outputs onto User Needs. Technology Analysis and Strategic Management, v. 10, 1998.

MARTINO, J. Technological forecasting for decision-making. New York: Elsevier Science Publishing Company, 1983. MASINI, E. & SAMSET, K. Recommendations of the WFSF General Assembly, WFSF Newsletter June 1975, p.15. 38 to 39

MORITZ, G. O. *et al*. A prospecção de cenários nas universidades: variáveis portadoras de futuro e a trajetória estratégica da UFSC para 2022. 2010. available at:< http://www.inpeau.ufsc.br/wp/wp-content/BD_documentos/coloquio10/233.pdf>. Taken on: 6 Jan. 2012.

MORITZ, G. O. *et al*. Aplicabilidade da prospecção de cenários como ferramenta de auxílio na tomada de decisão em gerenciamento de eventos. 2009. Taken on: 25 Dec. 2011.

MORITZ, G. O.; NUNES, R.; PEREIRA, M. F. Os métodos de prospecção de cenários e sua aplicação nas organizações: um estudo de caso no Período 1998-2008. Revista de Administração FACES Journal, v. 7, n. 2, p. 68-83, Apr.-Jun. 2008.

MORITZ, G. O; PEREIRA, M. F. Planejamento de cenários: a evolução do pensamento prospectivo. Revista de Ciências da Administração, v. 7, n. 13, p. 1- 20, 2005.

NAVARRO, A. F. Análise integrada dos Cenários dos Riscos de Implantação de Empreendimentos Industriais, available at http://pt.slideshare.net/AntonioFernandoNavarro/anlise-integrada-dos-cenrios-riscos-de-implantao-deempreendimentos, 22/09/2012.

_______________. Os seguros e os riscos como compreendê-los – SlideShare, available at pt.slideshare.net/.../os-seguros-e-os-riscos-como-compreendelos-3398196, publicado em 27 de abr de 2014.

_______________. Acidentes de Trabalho em Instalações Elétricas, FUNENSEG Newsletter, year XVI, n. 795, 31/12/1984.

_______________. O Seguro e os Riscos do Construtor, Revista Cadernos de Seguro da FUNENSEG, Ano V, n. 28, May/Jun-1986.

_______________. O Efeito do Dano Máximo Provável sobre o seguro: Utilização de Softwares Específicos, Revista Cadernos de Seguro, ano XII, nº 78, 19, Mar/Apr, Rio de Janeiro, 1995.

NEGRI M. & HULSE, W. H. A Ferramenta de Prospecção de Cenários no Processo de Tomada de Decisão – Coleção Gestão Organizacional e Tecnologia em Recursos Humanos do O Judiciário Catarinense na Perspectiva dos seus Servidores – Volume 3, pp 163 to 189, Florianópolis/SC, 2013.

PERESTRELO, M. & CALDAS, J. M. C. Instrumentos de Análise para o Método dos Cenários, Revista Dinâmia Centro de Estudos sobre a Mudança Socioeconómica, Fundação para Ciência e Tecnologia, Portugal, in March 2000.

PINSONNEAULT, A. e KRAEMER, K.L. Survey research in management information systems: an assessement. Journal of Management Information System, 1993.

RIBAS, J. R., Combinando intuição e objetividade na construção de Cenários Alternativos, Revista de Gestão USP, São Paulo, v. 15, n. 4, p. 1-17, outubro-dezembro 2008.

SAGI – Secretaria de Avaliação e Gestão da Informação, Ministério do Desenvolvimento Social e Combate à Fome, Estudo Técnico No. 21/2013, Introdução aos estudos prospectivos e metodologias de construção de cenários, Brasília, v1, 24fls, 2013. 39 of 39.

SALLES-FILHO, S. L.M. (Coord.); BONACELLI, M. B. M.; MELLO, D. L. Instrumentos de apoio à definição de políticas em biotecnologia. Brasília: MCT; Rio de Janeiro: FINEP, 2001.

SCHENATTO, F. J. A.; POLACINSKI, É.; ABREU, A. F. & ABREU, P. F. Análise crítica dos estudos do futuro: uma abordagem a partir do resgate histórico e conceitual do tema, Gest. Prod., São Carlos, v. 18, n. 4, p. 739-754, 2011.

SERVA M., DIAS, T. & ALPERSTEDT, G. D. Paradigma da complexidade e teoria das Organizações: uma reflexão epistemológica, ©ERA, São Paulo, v.50, n.3, Jul./Sep.2010, pp. 276-287, ISSN 0034-7590.

THOMAZ, J. P. C. F. Concepção de um modelo multicritério de apoio à decisão. Dissertação de Mestrado apresentado à Universidade Lusíada. Lisboa, Portugal: 2000.

TRUJILLO FERRARI, Afonso. *Metodologia da pesquisa científica*. São Paulo, McGraw-Hill,1982.

VÁSQUEZ, J. M. Manual de prospectiva y decisión estratégica: bases teóricas e instrumentos para América Latina y el Caribe, CEPAL – SERIE Manuales, nº 51, Instituto Latinoamericano y del Caribe de Planificación Económica y Social (I LPES) Área de Proyectos y Programación de Inversiones, CEPAL, Naciones Unidas, 2006.

ZENTNER, R. Scenarios, Past, Present and Future. *Long Range Planning*, v. 15, n. 3, p. 12-20, 1982.