How integrated should risk management and quality management be?

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ABSTRACT: This paper argues that risk management cannot be subsumed into quality management. First we recall quickly some important empirical and theoretical results on risk and risk taking. Then we suggest basic risk management principles, and we show that the major presently used methods of risk management do not meet these requirements due to the erroneous amalgamation between quality management and risk management. Thus, risk management differs from quality management because they do not share the same basic concepts, diagnosis method and solutions.

1 INTRODUCTION

Most project managers are proud to announce that they have an integrated system of managing quality and risk as well as safety. Such an integrated vision rests on classical technical engineering determinism. One can quote the famous Laplacian genious :

"An intelligence which at a given instant knew all the forces acting in nature and the position of every object in the universe – if endowed with a brain sufficiently vast to make all necessary calculations – could describe with a single formula the motions of the largest astronomical bodies and those of the smallest atoms. To such an intelligence, nothing would be uncertain; the future, like the past, would be an open book". Project's life is too uncertain; engineer and manager's brain too bounded to acknowledge practically this metaphor. Did you actually experience such a perfect control on construction projects? Facts are simple on costs: Flyvbjerg & alii (2002) in their historical study of 258 big projects find significant over costs for 9/10 projects. It is easy to find extraordinary cases like Sydney's Opera (the final cost is 15 times the initial cost) or Boston's Central Artery tunnel (Big Dig) ; ... Catastrophic experiences like the spectacular Gong Badak stadium roof collapse are not unusual.

A study of 1627 finished projects counted delays from 50 % to 809 % (Piwattanapiwong, 2004).

Thus, actually, ex-ante plans on delays, costs and quality are not completely executed. They can over or under perform expectations. Full conception determinism (Taylorism engineering) or systemic frequency determinism (TQC : Total Quality Control) are not sufficient to manage construction project.

Risks (positive and negative sided) exist and can't be denied because they impact results. Their management imposes new principles and methods that cannot originate from quality management or classical determinist management.

2 DENIAL OF RISKS, OVERCONFIDENCE AND HINDSIGHT BIAS

Sociological studies in the fields of managerial naïve cultures and practices on risk and psychological researches in laboratories should first be considered.

2.1 *Managerial perspective on risks and risk taking*

The first empirical studies have been carried on in the mid eighties and surveyed in a seminal paper by March & Shapira (1987). Managerial definition of risk differs from risk as it appears in decision theory (Savage, 1954). Managers do not assess risk as a distribution of all possible outcomes. Only the negatives ones are considered (80% of Shapira's respondents sample (1986)). Possibilities of gains are important in assessing the attractiveness of alternatives but are not associated with risk (MacCrimmon & Wehrung, 1986).

They prefer consider uncertain prospects using few key values like "the worst outcome", or "the best plausible", or "maximum exposure" than compute statistics grounded in ideas of probability. Thus it could be descriptively more appealing to model their behavior in terms of loss or regret aversion than risk aversion (Kahneman & Tversky, 1982)

Most managers do not like reducing risk to a single quantifiable parameter. They account it as a complex multidimensional phenomenon whose quantification is not easy even if it is desirable.

They describe managerial attitudes toward risk as varying across individuals and contexts, depending on their experiences and incentives. If there is a part of individual personality, the most important factors to explain differences are prescribed behavior and motivations. Some critical reference points structure their risk behavior: if they underscore their target they would be more risk taker, but if the target is expressed in relation to survival they wouldn't.

Because of their reputation capital they express a surprising paradox: on the one hand they value risk taking but only in order to win and succeed, but on the other one they depreciate gambling that turn out to failure or bad outcomes.

2.2 *Misconception of chance - Overconfidence and hindsight bias*

There is a huge psychological literature on decision biases facing risky situations (Slovic, 2010 ; Gilovitch, Griffin, Kahneman, 2002 ; Kahneman, Slovic, Tversky, 1982). To survey it exceeds our present objectives, but few consensual facts among many others should be reported. Misconception of chance can be evoked with this situation (from Bazerman, 1994): "You are about to hire a new project manager for the fifth time this year. You predict that the next director should work reasonably well since the last four were "lemons" and the odds favor hiring at least one good project manager in five tries."

Most people judge correct this foregoing logic. But they are wrong because the performance of the first four project managers will not directly affect the performance of the fifth. Based of your intuition and the representativeness heuristic you wrongly compare this situation (the probability that the fifth is a lemon) with the probability of getting five "lemons" in a row, which is very low. But you are missing two antecedent facts:

a - you already experienced four "lemons"

b - the performance of the fifth is independent of the performance of the first four.

This error is explained (Kahneman & Tversky, 1972) by the inappropriate tendency to assume that random outcomes (successes or failures) should balance out.

Overconfidence is an old fact demonstrated for the first time by Alpert & Raïffa (1969). The experiment consists to list 10 uncertain quantities. Subjects have to answer the ten questions in putting a lower and upper bound around their estimates, such that you are 98 percent confident. 42,6% of the quantities fell outside 90% confidence range. People overestimate its knowledge and undervalue the response range. This pattern has been observed in many experiments since this original study (reviewed in Lichtenstein, Fischoff, Phillips, 1982 ; Gilovitch & alii, 2002). A lot of arguments have been suggested to explain overconfidence, and its aftermaths still remain controversial. Some esteem it has probably given you the courage to attempt options that have stretched your abilities. But it is easy to critic this setting in many circumstances: medical decisions, nuclear regulation, innovation, …

Every organization should manage its risk taking policy, and hence its overconfidence to improve its professional decision making.

Last but not least, suppose you asked a group of skillful managers to decide between two options in the following context (inspired by Russo & Schoemaker, 1989):

A is a new project having 50% chance to succeed.

B is a new project having 60% chance to succeed.

If A or B succeed, your firm expect 1M€ profit; 0 if you fail. Naturally, without any piece of extra information every manager chooses B.

But then, assume B fails and A succeeds. How do you evaluate this decision on a scale from 1(lowest) to 7 (highest)?

As a factual paradox, managers note decision's quality only at 4.4, whereas they all should note it at 7.

This paradox exemplifies hindsight bias. Human brain is inefficient to recall the way an uncertain situation appeared before finding out the results of the decision. We tend to overestimate and distort what we knew beforehand based upon what we later found. Knowledge of an outcome increases our belief about the degree to which we would have predicted that outcome. It's easier to predict the football score after the match than before! I knew it all along!

Hindsight bias is very important because it reduces our ability to learn from the past and to evaluate decisions (our's as other's), because you cannot forget their results.

Facts from psychological laboratories studies and sociological field inquiries are bright. Human brain capacities are not skillful evaluating and managing risk and risk taking.

3 SOME LESSONS OF THESE FINDINGS

The last section, and a huge literature on decision making suggest managerial naïve intuitions about risk and uncertainty deviate from rationality. In this research tradition unaided intuitive judgment and decision-making facing uncertainty cause systematic flaws. That's why medication problematic arises: How aiding decision maker to avoid these deviations from simple rational principles?

The first classical approaches to decision aid prescribe analytical and systematic method to asses problems, values, probabilities and derive from it an optimal course of action. It is called Decision Analysis (Raïffa, 1968) and Multi Attribute Utility Analysis (Keeney & Raïffa, 1976). Decision makers are encouraged to create a large range of options, identify attribute for evaluating them, assign weights for each criteria, assess the probabilities of the uncertain option's outcomes, rate the options, and compute the scores to find the best option.

An other research tradition – naturalistic decision making (Lipshitz & Strauss, 1997; Klein, 1993; Cohen, 1981; Cohen & Freeman, 1997) – challenges prescriptive decision theories and tools. Real decision-making conditions, they argue, are featured by ill defined goals and tasks, uncertainty, ambiguity, missing data, time stress, multiple players, and dynamic and continually changing conditions.

In such an environment you just can't apply decision analysis. Their starting point is not normative decision theory, nor statistical axiomatic. It is grounded on descriptive account in field settings of experienced decision maker.

They find that practice did not fit into a decision tree framework; decision makers are not choice maker, creating options, assessing probabilities and modeling consequences. Actual professional, saw themselves as acting and reacting on prior experience, rarely deliberating about the advantages and disadvantages of different options. They rely on recognition, and once they know which case they confront, they fit an adequate solution from their experience. Then, simulate the ongoing mentally to search for flaws and discover workable adaptations.

In the first case, the research program rest on normative axiomatic, based on intuitively appealing tenets, as transitivity, invariance or consistency. In the second case, the research program rest on observed experienced skillfulled decision maker.

One can suggest two obvious critics to this "naturalistic" research program:

- Hypothesizing actual behavior with optimal behavior is equivalent to mix "is" with "ought to": descriptive arguments and normative arguments. Even if the decision maker is sincerely "certain" to choose the best given its proficiency and experience. One can always question its efficiency using facts and logic. Those resort implicitly to the first research program because a normative benchmark gives evidence. But which one? Proficiency and experience are too vague and messy concepts to set up convincing cases.

- Moreover error, in this frame is ill defined in reference to more or less proficient decision maker, or deviation from successful real world tasks. In this view, errors come from unadaptive fitness between internal capacities and the requirements of complex dynamic tasks to overcome. Thus adaptation is at the heart of the process: "decision-making errors are better understood against a pattern of generally successful adaptation to real world contexts, rather than as deviations from a largely irrelevant abstract standard." (Cohen, 1993). But such a claim, about adaptation is unfalsifiable, since the post hoc invention of successful adaptive consequences is all too easy.

To conclude, we share the call of Brown (1989) toward a prescriptive science and technology of decision aiding. Prescriptive decision science says how people should make up their minds including descriptive results on how they do make up their minds, but also normative results on how ideal people would make up their minds in context free situations.

4 CONSENSUAL PRINCIPLES ABOUT WHAT SHOUL'D BE DONE ABOUT PROJECT RISK MANAGEMENT

Two important sets of references (ISO 31000, 2009; COSO II, 2004) converge in common concept definitions, procedural propositions and methodological requirements.

4.1 *A shared risk and risk management concepts*

In the new ISO 31000 standards, risk is defined as "the effect of uncertainty on objectives". The change is important in comparisons with the AS/NZS 4360, published in 2004 which defined risk as : "The chance of something happening that will have an impact on objectives". It shifts emphasis from the events "something happens" to the "effects on objectives". Both emphasized the context, but the last one set not only negative side of risk but also positive side. Risk is directly linked to all decision making and thus management of change.

COSO II (2004) define the risk concept as a negative impact on the achievement of objectives and opportunities as a positive impact. They formulate enterprise risk management as "a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives".

Common procedural and transverse prescriptive propositions could be designed from these definitions. Risk management is

- framed by a risk management strategy (risk appetite, ethic, …)
- effected all across the organization from top management to operational levels

- based on valuation method that enables policy tradeoff and coordination

4.2 *Tools requirement for risk project management*

Project risk should not be considered as being only detrimental because it overlooks most of the time residual risks and hence assurance cost.
Project risk evaluation methods should enable to compare different risks on a single dimension providing an operational approach to manage tradeoffs between project actors at all project stages. It should therefore refer to some practical metric (interval scale).
To create such a project risk governance, one need also a person in charge of organizing all this sensemaking (Weick & Sutcliffe, 2001). It should remain on the direct authority of the project chief and has to coordinate all along the project lifetime risk taking behaviors in accordance with an project risk appetite framed by the project owner.
It is easy to note differences between these three fundamental requirements of risk management and quality management quoting the famous 14 principles (Deming, 1982) and its fundamental premise: understanding past variations. Quality rest on a notion of error, designed in reference to a set of ex-ante specifications. Quality improvement could result from two different processes: a- reducing the variance of error's level by eliminating specific variance causes. It's named stabilizing the system; b- as you satisfy this precondition, error's level is produce by the system, that's why quality improvement needs system's change to decrease error's level. Thus, all quality improvement actions rest on frequency information about past errors (called by Deming "statistical control").

Table 1: Deming's 14 principles

1.Create constancy of purpose toward improvement of product and service,…
2. Adopt the new philosophy …
3. Cease dependence on inspection to achieve quality … by building quality into the product in the first place.
4. …Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service to improve quality and productivity and thus constantly decrease costs.
6. Institute training on the job
7. Institute leadership …
8 Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments.
10. Eliminate slogans, exhortations, and targets for the workforce asking for zero defects and new level of productivity. Such exhortations only create adversial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.
11. a. Eliminate work standards (quotas) on the factory floor. Substitute leadership. b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.
12. a. Remove barriers that rob the hourly worker of his right to pride o workmanship…
13. Institute a vigorous program of education and self improvement.
14. Put everybody in the company to work to accomplish the transformation.

The 14 points (p 23, 24, Deming, 1982) are also very different from risk and risk management concepts and the procedural requirements derive from it. The most important differences come from point 7, 10, 11, because objectives are a basic concept in risk definition and because trust don't rely on duty but on explicit risk taking policy.

5 TRADITIONAL PROJECT RISK MANAGEMENT TOOLS DO NOT FIT THESE REQUIREMENTS

5.1 *Failure Mode and their Effects Analysis*

The dominants methods used have been derived, as already suggested above, from quality management or manufacturing reliability tools, basically FMEA[1] for discontinuous processes, HAZOP for continuous processes with 'nodes' (i.e. crucial reactions in a chemical process) and quality management procedures, among which, of course, the idea of a multi-hierarchical level committee to spot defects in the production process. FMEA looks at the different ways a product may fail, their frequency (F) gravity (G) and detectability (D), from which it infers a "risk priority number" (RPN=FxGxD) based on the subjective measures given on a scale for each factor. There are, beyond these basics, innumerable versions of FMEA, yielding as many 'different' methods, all relying on the same principles. For more than a half century, engineers had indeed distinguished between (technical) functions and tried to ascertain, as a matter of safety and quality management, what might go wrong within each of them. The FMEA procedure, e.g., had been established by the U.S. Army in the late Forties to provide a simple frame of reference to this way of

[1] *Failure Mode and their Effects Analysis, a management tool developed by the Army in the U.S. in the late Forties, to deal in particular with the inventory left from World War II and the 'surpluses' therefrom.*

thinking and keep it within some reasonable bounds as much as possible.

To mirror these functions within engineering systems, 'business analysts' have claimed that organizational processes could be determined. They have claimed that proceeding in the same manner with organizations was the simplest and most effective way for dealing with industrial risk. They have incorrectly pretended that quality and safety analyses were akin to risk analysis. 'New' techniques resulting from the application of these basic ideas may have been oversold to companies and – worse – to many good minds. For example, one distinguishes between 'essential' business processes (impacting directly customers, such as producing, servicing, delivering, etc.) and 'management support' processes (helping to perform effectively and efficiently the former, such as information management, communication handling, etc.) in the firm. These 'business processes' may have 'failures', as engineering functions and processes, and these failures constitute the risks the enterprise faces. Cases similar to engineering FMEA can then be established, adjusting for items subsumed and vocabulary used in the different columns of the corresponding table. One of the present authors has witnessed quite a few such cases in corporations, both in Europe and the U.S.[2] Stylized examples can easily be provided.

Fault tree analysis (FTA) resulted from an extension of FMEA analysis, when studying possible failures of launching minuteman missiles, a work performed at Bell Labs (Watson, 1961). FTA relates initial events or causes (hence the alternative name of tree of causes) to some potential failure through intermediary events, using the mathematical structure of a tree. Fault trees have since the 1970's become handy tools to help compute the probability of the events mentioned on the basis of the presumably known probabilities of the elements in the tree. Such fault trees have been used to think in similar terms – sometimes with some lack of rigor. They have been extended by E. Paté-Cornell to include some of the organizational and management factors affecting the probability of the event under scrutiny (called also the "feared" event).

[2] *One prominent company which used this risk management model was Enron, which was quoted as the epitome of companies within the "leading edge" following this 'sound' risk management practice.*

5.2 *Bow-Tie models*

The concept of *in depth defenses* was put forward in 1960 by the IAAE (International Agency for Atomic Energy). The original concept could be considered as the interpretation in security terms of an event tree (tree of the consequences entailed by one event). The reinterpretation known as the "Swiss Cheese Model" by social psychologist J. Reason (1990) has generally been received as a tool of "organizational" quality or safety management, with some variations in the interpretation of the metaphor (Perneger, 2005). In this model, failures result not only from "active failures", but also from "latent conditions" allowing bearers of dangers to come inside the system and cause losses. Active failures or latent conditions can be represented as holes in successive slices of a Swiss cheese through which a straight needle representing some intruding danger can penetrate the system. "In-depth defenses", whether they be actions, equipments or procedures in the organization, aim then at filling the holes in some slice(s) of the cheese.

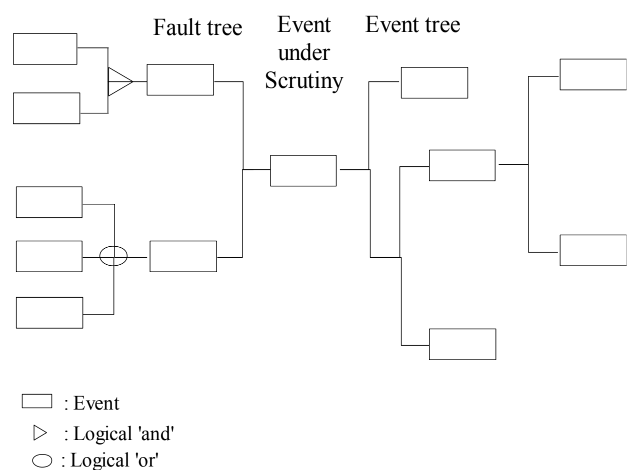

Figure 1. the organizational 'Bow-Tie' Model

While originally designed to provide the nuclear industry with a non probabilistic way of mitigating the potential impacts of a nuclear accident, the concept of "in-depth defenses" was then extended to include the probabilistic approach of preventing causes of failures. The Swiss cheese metaphor turned then out to be insufficient. A new graph emerged as the "organizational bow-tie" (figure1). Such a graph is a combination of a fault tree leading to some event, on the one hand (left), and of the event tree emerging from that event on the other hand (right). Mitigating defenses are to be posted on the event tree to the right, while preventive defenses should be posted on the left tree (in the language of insurance, the latter constitute a "self-protection" policy).

5.3 *Risk matrices – tables mapping frequency and severity ratings to corresponding risk priority levels –*

Other views and techniques have emerged. These views are more risk or uncertainty management focused and are clearly alternatives to the main-stream which we are considering here.

This mainstream leads to a generally accepted method which is again similar to the usual quality procedure which engineers follow, i.e.:

-Identify and detect the origins of possible threats to quality (set equivalent to risks)

- Assess significance of such risks as FMEA does with threats to quality and decide on steps to handle the issues, in the hope to hit targets of failure minimization
- Assess the gains obtained through such steps.

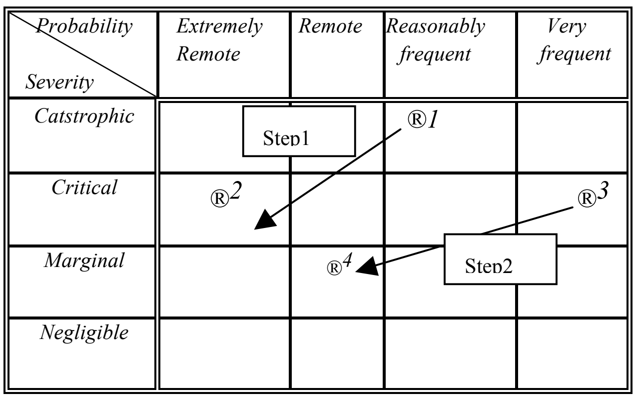

Figure 2: Stylized Risk Map or Matrix

To this last end, the matrix in figure 2 is used by all four current sets of methods described above under the name of a "risks map". Such a matrix aims at representing three dimensions: Frequency and severity are explicitly mentioned, but control capacity is only implicit. To each identified 'risk' ®^{i}, (i=1,..,n) - one assigns a square within the matrix. The assignment is generally performed by some committee, as in quality management, which looks for the largest possible consensus. Consider the two arrows represented on figure 2, from ®^{1} to ®^{2} and from ®^{3} to ®^{4} respectively. By some adequate step(s), the committee agrees that it could be able to shift the corresponding risk from the square where the arrow begins to the square in which it ends.

While we know that current methods help as a first discovery of the span and importance of risks in the corporation, we also know that they are tragically insufficient and give way to mistakes. Five reasons support this view.

1) *Current methods fail to correctly specify the fundamental goal of risk management.*

In this still dominant view, accidents happen, like defaults in manufacturing, because something has been done inadequately and should be corrected. Hence the idea that risks should be minimized. However, while a zero default course of action can be legitimately sought, a zero risk course of action makes no sense. In fact, as experience has shown since early history, mankind is trying to get the best out of nature by its ability, but has to take risks to that end. What risk management is at is not at minimizing risk, but at optimizing risk taking.

2) *Current methods fail to integrate any probabilistic view of the world.*

March and Shapira (1987) found that managers do not believe really in probabilities in the sense where modern statistics defines them, because managers are unconsciously convinced that they can "master" the cause(s) of dysfunctions and hence of risk. This pays tribute to the old deterministic view of the world, which most scientists think that it has to be abandoned. Our own experience shows that some major accidents tend to happen in places where high ranking managers assert that nothing in terms of unexpected events can happen within their company "because they tested everything" (an engineer in the spatial activity, 1968) or because "only their company has got ready for the really complete checklist" (an engineer in an oil company, 1998). The reason is that these persons forget that what happened could have been a different course of the world. In other words, they have been lucky, not 'mastering risks'! This, of course doesn't mean at all that any prevention would be useless.

3) *Current methods fail to yield correct evaluations of the risks at stake*

The level at which risk measures (probabilities or other measures) are understood certainly constitutes a good proxy of the effectiveness of risk management (Chapman, 2006). The same is true for gravity measures.

The verbalization of frequencies/probabilities is a source of considerable misunderstanding between actors in the corporation. Beyth-Marom (1982) has shown that an individual within a group of people agreeing unanimously to assign the same verbal probability to some given risk thought, as a matter of fact, of that risk as describable by a probability which could stretch, from an individual to the other, between .36 and .77! When it comes to extremely small probabilities, the issue can become way more critical: a 'negligible' value of probability could by then stretch from 10^{-4} to 10^{-2}, depending on the issue, etc.

A similar result can be obtained regarding the severity dimension. Morel (2003) showed that an individual within a group of people agreeing unanimously to assign the same verbal severity to one given risk thought in fact about a severity which did vary considerably from one individual to the other in the group.

Furthermore, impacts are shown by technical models to be multidimensional in industry (contrary to what happens in finance). On risk maps, all these dimensions boil down to some "gravity" level, by some mysterious, unmentioned and a fortiori unexplained, mechanism. Most people interpret it as intuition, but this may be a simplistic explanation. Clearly, this is a source of appalling mistakes, as shown just above.

Clearly, frequencies should be mentioned, but with the qualification that they are rarely available under any significant form in risk management, while they are prevalent in statistical quality control. Instead of the qualitative scales used in risk management, techniques of subjective probability elicitation and of subjective significance scores encoding have to play the main role here.

4) Current methods fail to provide any effective tool of communication and therefore any effective tool of coordination

As a consequence, and to the contrary of what has often been claimed, a risk map cannot serve any purpose in coordinating actors within a group or a corporation. Even when people within the group agree unanimously, they believe to agree, while they in fact disagree on the real values they think of for the corresponding probabilities or severities. They do not violate Aumann's theorem (Aumann, 1976): The issue is simply that words do not define, in the mind of individuals, in a sufficiently unambiguous way any of the risk dimensions. To be sure, one can assign 'bounds' to each column and to each line: Within the bounds, the issue will not be settled and the conclusion can be slightly softened, but certainly not overcome. To be sure also, we can make rows and columns much more numerous: By then individuals will never agree even after days of discussion and will probably settle on some classification by being worn out rather than out of conviction. And the same conclusion will hold.

5) Current methods fail to allow making efficient policy tradeoffs

Efficiency cannot result from the reasoning and risk maps used by the methods mentioned above. Even assuming that risks are neither correlated nor interdependent and assuming that steps to be taken have only an impact on one risk at a time, we are not in a situation to decide whether step A or step B is more important, because the scales used do not have any well-defined measurement property which would be necessary to claim anything of this sort. This is true as well of any of the ways we might decide to combine the measurements such as the 'RPN' (Risk Priority Number or criticality in the FMEA method). Furthermore this index has no experimental foundation and a very weak theoretical foundation: Rather, it is, in fact, arbitrary.

6 CONCLUSION

The five significant and in practice far reaching remarks above apply as well to FMEA, FMECA, HAZOP, etc. as to their innumerable derivatives and variants like MADS-MOSAR or the sixty two 'methods' listed by some authors (Tixier, Dusserre, Salvi, Gaston, 2002) etc. A clear revision is called for. The recently published norm ISO 31000 may be a relevant guide toward such a revision, as it lays down principles of risk management.

The issue, however, goes beyond principles and encompasses the question of the tools to use. If current tools do not fit the requirements presented above, are other tools available and do they comply with the principles put forward in this paper? It is particularly impressive that the norm ISO 31010 lists 31 tools which, by far, are not all in compliance with the principles put forward by the mother norm ISO 31000. It is always more difficult to produce new techniques than to enumerate the rules with which they ought to comply. Some, however, are, and deserve to be developed. We are not helpless; we just don't use the right tools for the risk management problems. The reasons for such a paradoxical behavior would constitute a substance to our next paper.

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