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A NEW APPROACH TO RISK ASSESSMENT BASED ON THE SEMANTIC VALUE OF EXPRESSIONS

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Abstract
The framework takes into account non-quantifiable decision variables and dilemmas, and uncertainties related to input data. The RISKMAN model scheme consists of process description and a range of suggested evaluation criteria as well as guidelines on how is possible to perform the evaluation. In addition to guidelines on prioritizing and evaluating the different criteria, the interpretation and use of the numerical results is discussed. The framework also shows the follow-up management strategies based on the outcome of the evaluation. In short, it describes a possible way of following up the output of security risk assessments and the identified size of security risks. It involves different stakeholders and offers a transparent process for prioritizing, and finally, selecting security measures. In its simplest form, the whole evaluation should be conducted by security experts within the decision making procedures, making qualitative assessments according the offered criteria. This can be necessary as a first screening for choosing capacities for further decisions. The use of and the strengths and weaknesses of the framework should be pre-tested within the stage of planning process and simulation of predictable threats.

Key words: *CASTL, risk map, insurance, risk management, risk assessment*

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I. INTRODUCTION

The management of large-scale emergencies is a complex activity. There are a diverse range of possible emergency scenarios, including terrorist attacks. This paper presents a risk-based framework for debating and evaluating of a new approach to risk assessment based on the semantic value of expressions. The article sets out our approach to modelling and illustrates, by example, how sematic models can be useful within the risk management.

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The possible approaches how to understand the risk management

Crisis management as an expression has developed from a number of academic fields, focus on to the different areas and threats, describing the different of activities that occur in response to unexpected and symmetrical or asymmetrical events. **Error! Reference source not found.** has famously argued (in terms of accidents) that crises are inevitable in complex, interactive and tightly coupled organizations, a fitting description for modern societies dependent on a range of inter-related critical infrastructures.

The dynamism of risk management research substantiates (Beck) thesis that a characteristic of late modernity is to be obsessed with risk. A comprehensive body of knowledge on the management of risk that is

both sensitive to contextual contingencies and amenable to integrative efforts (Renn, 2006) has emerged from the study of activities that involve the possibility of spectacular accidents, such as mining (Sauer, 2002).

Scholars from many disciplines have devoted careful attention to depicting how organizations can identify, manage or communicate risk. An array of risk regulation regimes (Hood, Rothstein, & Baldwin, 2001) has been mapped, together with the national differences that exist between how public authorities behave to mitigate risk aversion and enjoy trust among the public (Löfstedt, 2005) Business leaders are invited to develop an understanding of the changing nature of risks in a global era (for example by (Cleary & Malleret)). For this purpose, there exist numerous procedures to identify, analyse, evaluate and classify risks (see (Renn, 2006) for a synthesis), inclusive of systemic risks (OECD). There also exist a range of managerial tools to decide whether and how to avoid, transfer, mitigate or accept risks, both general (for example, (Reason) and industry-specific (for example, (Crouhy, Galai, & Mark, 2006) for the banking sector).

Risk management is a strategic activity (Andersen, 2006)that does not only consist in models, algorithms, checklists or programs. The cultural dimensions of risk (Douglas, 1992) and its management have been repeatedly emphasized. Risk is acknowledged as a situated knowledge mode that actors can adopt or leave at will, depending on needs and circumstances (Boholm), to deal with the uncertainty of the future in a quantitative manner (Reith, 2004). Professional patterns of communication which use different expressions and relations between them and the further coordination are the cornerstones of work safety routines. Likewise, successful risk communication depends as much on communicating values as it does on providing technical information (Palenchar & Heath, 2007), but the others too, which can comprehensively describing the situation.

Man-made disasters (Turner & Pidgeon, 1997), normal accidents (Perrow, 1984) or high-reliability organizations (Roberts, 1990) are examples of risk management concepts that have entered standard managerial vocabulary.

Managerial vocabularies are important traits of an organization's life, but they do not cover actual managerial practices in all their richness. Practices have layers that the terms used to render them do not necessarily render. This is why to understand the nature of risk management, it is necessary to go beyond what managers tell about what they do. There is a need to unfold their practices in the face of hazards and uncertainty, inclusive of what these practices reflect in terms of organizational learning, ideological options and organizational power games, even in organizational contexts in which people do not openly use a risk vocabulary to deal with contingencies (Corvellec, 2009).

Risks such as the 'new' forms of terrorism, pandemic flu and the recent economic collapse within the financial sector, along with the consequential global economic crisis, serve to illustrate the borderless nature of risk in a renewed, but in several respects, significantly different manner. Moreover, they present several challenges to conventional approaches to risk management: (1) they often lack the *a priori* evidence that would render them predictable to any degree; (2) they are sufficiently large, in terms of the damage that they cause, to trigger further hazards or crises further down the timeline and (3) their origin, evolution and final scale and form are frequently unknown, such that they represent an emerging, ill-understood and ill-defined set of risks that need to be dealt with. As a result, they often require mediation by technical experts in an attempt to provide an evaluation of the likely failure modes and effects (Smith & Fischacher, The changing nature of risk and risk management: The challenge of borders, uncertainty and resilience., 2009).

As a consequence, and on the basis of these characteristics alone, many emergent forms of risk often do not yield to conventional forms of risk assessment and management or indeed to conventional policies at an institutional or Governmental level. These new forms of risk also illustrate the interconnected nature of 'risk', 'crisis' and 'disaster' and the manner in which discrete events can serve as triggers for other problems within an all too often nested system. In addition, the mitigation and response to risks in the broadest sense is increasingly a function of interagency and networked forms of management and organization. Although such approaches are essential for dealing with risk, they invariably represent a 'double-edged sword' as they can also be important factors in inhibiting or complicating risk communication and early warnings of failure. The question remains as to what role such networks play in allowing risk potential to contribute to the 'incubation' (Turner & Pidgeon, 1997) of risk and what techniques are available to deal with this process. As governments, practitioners and academics increasingly engage in debate around the nature of these threats, along with their mitigation and future impact, and then a particular note of caution needs to be given on how these events are understood, and the ways in which different communities of practice define, conceptualize and seek to address them. Of particular salience here is the growing use of, and importance attached to, the policy concept of resilience (Smith & Fischacher, The changing nature of risk and risk management: The challenge of borders, uncertainty and resilience., 2009).

The potential range of issues arising from these new forms of threat, and from the response of these various communities of practice, is beyond the scope of this editorial. Here, we seek to address three particular aspects of the challenges that face academics and practitioners associated with risk management, and to set out some directions in which we hope that debates might develop. The first of these is the particular difficulties that arise from the ways in which risk transcends the natural and artificial borders that surround institutions, nations, cultures and bodies of knowledge. The second is the way in which we understand the notion of resilience in

terms of both theory and practice. The third relates to the spatial interactions that take place within a networked society to generate what we term 'spaces of vulnerability' and, ultimately, 'spaces of destruction' (Smith, Making accidents happen in the imagination - Simulation, fitness landscapes and the management of crisis, 2009).

II. „RISKMAN"– A NEW APPROACH TO RISK ASSESSMENT

Thinking is the highest form of reflection on objective reality, consisting of systematic, intermediated and generalized learning of substantial dependencies and relations of objects by a subject (human being), of creating new ideas and of predicting events and human actions.

Mathematical thinking is based on knowledge of mathematical terms (for example, definitions, theorems, axioms, assumptions and statements, and proof of theorems and propositions, sets, relations, operations, equations and inequalities), on knowledge of mathematical theories (mathematical logic, set theory, statistics, probability, theory of equations, geometry, theory of algebraic structure, etc.), mathematical terms and definitions, mathematical phraseology and knowledge of mathematical symbols. Mathematics is the study of quantitative status and relations and of the spatial forms of the objective world.

Thinking and language are interlinked phenomena, where ideas reflecting the objective world are expressed and realized via language. Both thinking and language are physiologically preconditioned by the second signalling system and are used for cognition of the world and communication among people. Language is a way of expressing thinking, the physical agent of thought.

Why not approach risk assessment from the perspective of language, and use the knowledge of semiotics and semantics? The oldest known definitions of the theorem originated in antiquity: Oratio est ordinatio dictionum sententiam perfectam demonstrans; that is, a sentence is a coherent word combination expressing a complete thought. In our case it expresses an actual event: a risk scenario. This scenario in the form of a sentence, which is the basic instrument for communication and display, has its own structure, elements and logical links. If all relations are found and described, it will be possible to somehow mathematize the risk scenario and so express the numerical value of the risk significance. Such an approach has several advantages, such as using actual specified scenarios; this is demonstrated on an example from the insurance sector. It appears that in order to achieve more accurate values when assessing risk it is not possible to define the risk in general, but it must be defined exactly and in all the possible variants enabled by the broad group of "librettos".

Another advantage of this new semantic approach over standard (theoretical) mathematical expression of risk by a simple equation is that each and every new word in a scenario represents a criterion having an impact on a negative event. Therefore, each word in the sentence system is taken into account when making the final scenario/risk assessment. The number of factors influencing the creation, progress and impacts of a negative event is free and unlimited.

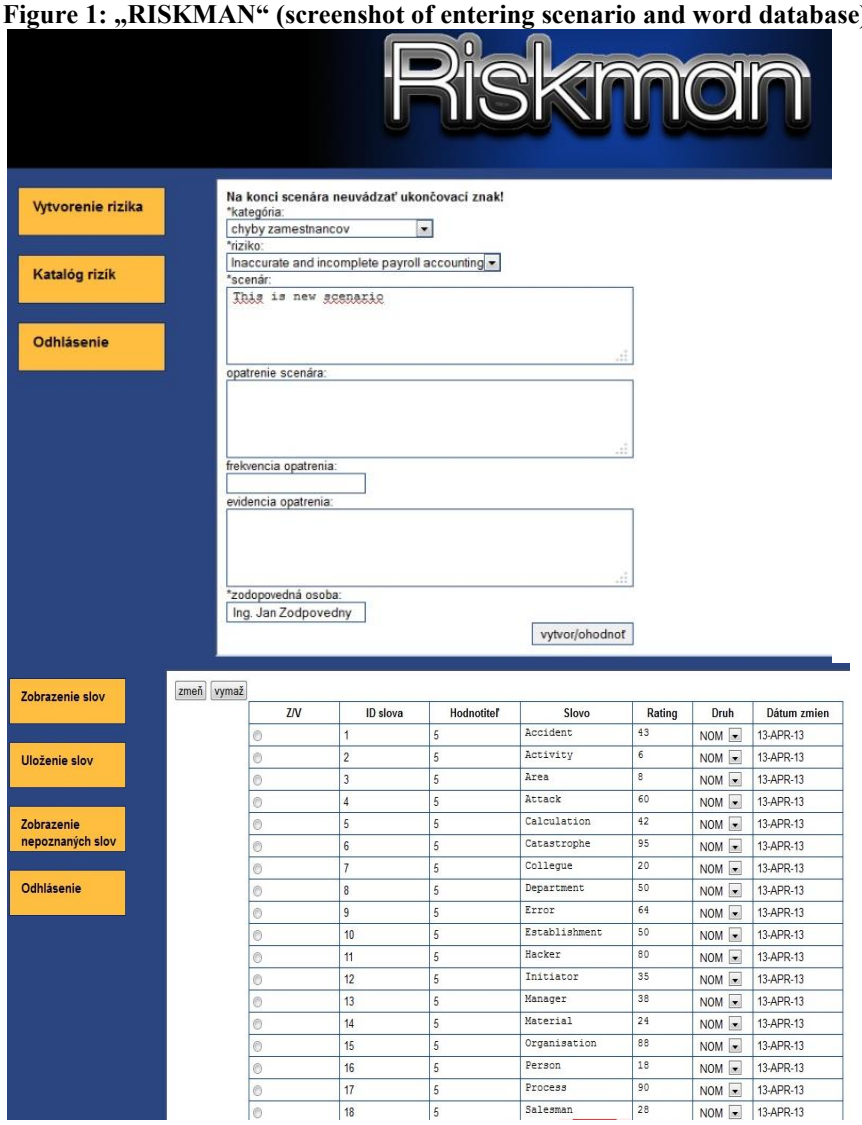
At the beginning a scenario is not assessed by an expert as a whole (eg, via the qualitative or quantitative risk map method); this reduces the level of subjective assessment. In parallel, it neither insists on the basic frequency assumption (occurrence probability) of a negative event, which can be neither determined nor estimated for several risks (eg, natural disasters or new, as yet unidentified, risks), nor mitigates the impacts (life and property loss). The basic assessment principle of this new approach is the vulnerability and impact level, which should then be influenced by the measures taken on the basis of the assessment output.

An indisputable further advantage over the commonly applied risk map method lies in the creation of an accurate ranking list of all scenarios, instead of limiting only to a simple statement of whether or not a risk is acceptable, as in the case of the qualitative risk map. This classification then allows the decision of which risk is more serious than other ones (has higher ranking value) for accurate planning of measures and scarce economic resources.

A significant point in the presented method is the rating evaluation of individual words functioning as the basic scenario criteria. An expert's assessment is desirable in such case. This assessment is done only once, namely upon creating the basic words database, from which further various librettos may be created.

The above innovative procedure of risk assessment, which belongs to heuristic procedures, takes into account mainly the probability and various combinations of new risks options (Mayerova 2012). The procedure is carried out by the so called RISKMAN, a software support. This is an IT solution that may be used for processing information and creating database about the existing risks, which demonstrated already in the past, as well as for brand new risks (Urban, Urban a Urbánek 2012). This tool allows the actual risk assessment. Thy systematic approach provides a wide flexibility of the impacts prediction of a whole range of possible risks.

Figure 1: „RISKMAN“ (screenshot of entering scenario and word database)



Z/V	ID slova	Hodnotiteľ	Slovo	Rating	Druh	Dátum zmien
	1	5	Accident	43	NOM	13-APR-13
	2	5	Activity	6	NOM	13-APR-13
	3	5	Area	8	NOM	13-APR-13
	4	5	Attack	60	NOM	13-APR-13
	5	5	Calculation	42	NOM	13-APR-13
	6	5	Catastrophe	95	NOM	13-APR-13
	7	5	Collegue	20	NOM	13-APR-13
	8	5	Department	50	NOM	13-APR-13
	9	5	Error	64	NOM	13-APR-13
	10	5	Establishment	50	NOM	13-APR-13
	11	5	Hacker	80	NOM	13-APR-13
	12	5	Initiator	35	NOM	13-APR-13
	13	5	Manager	38	NOM	13-APR-13
	14	5	Material	24	NOM	13-APR-13
	15	5	Organisation	88	NOM	13-APR-13
	16	5	Person	18	NOM	13-APR-13
	17	5	Process	90	NOM	13-APR-13
	18	5	Salesman	28	NOM	13-APR-13

Source: „RISKMAN“ (Jonaštík and Urban 2013)

The set of ranked assessed risks, which is shown as actual scenarios in the application, is stored in the programme database. Each scenario has own semiotics and semantics structure and logic and is decomposed or composed under the methodology based on individual words according to the functional matrix of the discussed methodology below.

The key step of the new approach is the creation of functional transformation matrix of human thoughts into individual “expressions – words” that specify the severance and the progress of the scenario. The combination of various words creates an unlimited amount of exactly and fully defined scenarios with various impact severities. The table below shows the basic structure of semantical matrix.

Figure 2: Functional matrix of the method based on semiotics and semantics

	Semantics					
	Syntax				Morphology	
Name:	Generator	Operation	Impact	Spread	Attribute	(Re)action
Used as:	Subject	Use case	Matter	Mediator	Function	Predicate
Represented by:	Author, basis, factor, event., head, causer, source, origin, parentage, option, scenery, former, root, leader, etc.	Scene, phenomenon, instance, incident, episode, story, occurrence, case, account, description, option, entity, etc.	Object, element, task, management, ownership, ability, background, piece, thing, article, product, matter, theme, goal, topic, item, type, property, output, etc.	Environment, agent, means, device, fixer, objective, circumstance, instrument, form, moderator, contact, negotiator, etc.	Specification, definition, merit, size, sales, character, determination, diagnosis, dimension, facility, feature, nature, ability, quality, symptom, significance, etc.	Report, reaction, feedback, fact, blazon, relation, annexation, reality, declear, relationship, thesis, claim, elaboration, behavior, argument, function, etc.
Grammar	Nominative	Gerund	Object	Substantive	Adjective	Verb

Source: „C A S T L" (Urban, Urban a Urbánek 2012)

This matrix indicates the logical structuring of a scenario, i.e., scenario words, based on semiotics and semantics. The fundamental basis of words is structured into six columns, according to syntactical and morphological category: generator (G); operation (O); impact (I); spread (S); attribute (A); (re)action (R). The row marked "Used as" represents the variability of descriptors within a possible scenario.

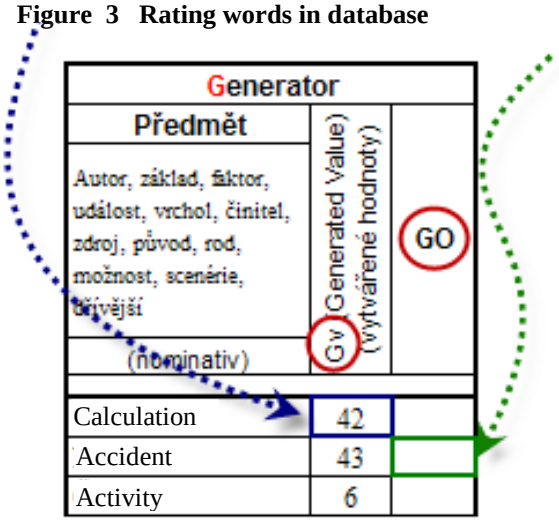
Words from already existing scenario can be entered retrospectively in the same methodological way via functional matrix.

The key of the new mental approach to risk assessment (risk scenarios) integrated into RISKMAN software tool for creating final scenario ranking is the portfolio of rated assessed words, which create the database for modelling. Individual words in the database may be prepared in advance or may be added retroactively as already described above

Important step is the creation source words database, where the words are rated by an expert /risk manager in order to stimulate new threats = creating ranking.

The figure 3 below shows the process of database creations.

Figure 3 Rating words in database



Each word is assigned a GV (generated value) representing the relevant rating index (blue arrow in Fig. 3), which is defined by the expert group/risk manager in line with the methodology.

The auxiliary column marked as „GO" (green arrow in the figure), is shown here in order to display the programme procedure (path).

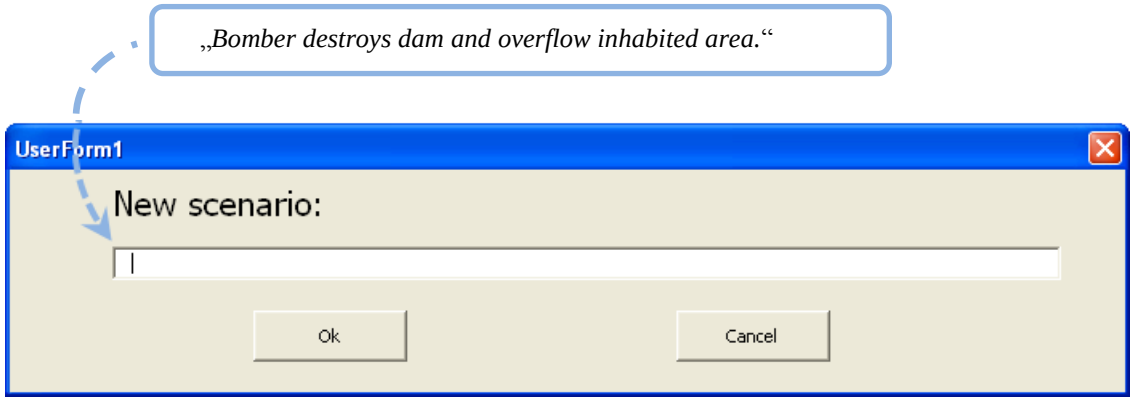
RISKMAN programme enables the user to create a scenario. Furthermore, it verifies whether all scenario words are in the database (if not, it asks the authorized persons to add and to rate such words) and it calculates the rating value of RA. For the applied ranking formula (R. Urban, Optimalizace alokace zdrojů pro podporu ochrany obyvatelstva 2012) see below.
RATING (RA) is done based on this mathematical formula:

$$RA = \sum_{i=1}^{n} \sum_{j=1}^{c} \frac{y_{ij}}{\max j - \min j}$$

where i = 1, 2, …, **n** is the number of rated columns, i = 1, 2, …., n; n ϵ N;
j = 1, 2, …, **c** is the number of rated words in a column, j = 1, 2, …., c; c ϵ N;
y … is the actual rated word used in a scenario.

End user may define via RISKMAN programme thousands of scenarios (risks), archive them and use them within the risk management process, i.e. compare them, assess their size, create statistics and filters, define necessary measures, assign material, financial, professional and information sources, check them, i.e. make well-informed economic decisions (Hofman, Hošková 2014). Individual risk management phases are maintained in modules in the programme and interlinked in order to create, process and archive information as compact tool for risk manager's needs in any organisation.

The graphics depicts the calculation of RA value incl. process path in an actual scenario of terrorist attack in order to demonstrate the usability of the expected process.

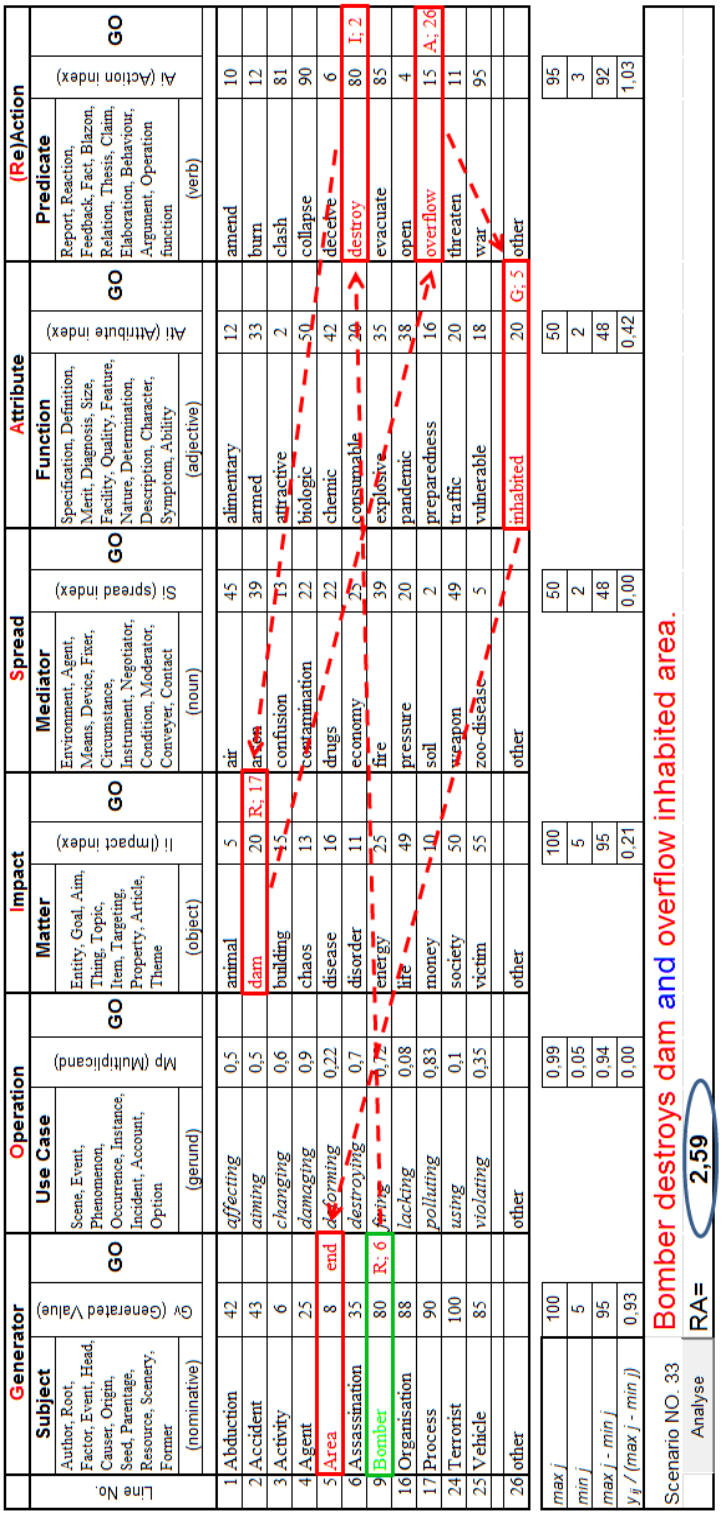


When processing example, the words of a scenario with the following word rating indices.

Figure 4 Words of the used scenario, their indices and RA value calculation.

Bomber: Gv = 80	Overflow: Ai = 15
Destroy: Ai = 80	Inhabited: Ati = 20
Dam: Ii = 20	Area: Gv = 8

RA = 88/95 + 0/0 + 20/95 + 0/0 + 20/48 + 95/92 = **2.59**
The process of RA value calculation is shown in the following Figure 5 Rating Computation.



The final ranking score of the selected scenario amounts to 2,59 (RA = 2,59). This, along with other scenarios and their RA values, provides the option to assess the significance of the scenario and, in parallel, to make a final comparison with other risks/scenarios; this allows the formulation of judgments about priorities, measures and needed resources.

Such risk assessments using virtual scenarios present a dynamic method, which is an important part of the planning phase in the risk management process. It is a practical and user-friendly approach with the potential to acquire information about risks and about the need for mitigating and dealing with them. The method is particularly suitable for cases where the acquisition of historical data for modelling and the actual calculation in order to define the distribution function are difficult due to the given risk group. Generally, this method can be used in all cases where the exact and quantitative expression of the potential loss of existing or future threats is extremely difficult.

III. CONCLUSION

Aiming at a 'more integrated view of risk' (Turner & Pidgeon, 1997) the purpose of this article is to show that even in organizational contexts in which risk management is not explicit and risk is not addressed in a formal manner, the management of risk can nevertheless be systematic and possibly effective. There are many standards or methodologies which look too cumbersome for crisis situations, asymmetrical threats to be adopted by organizations and risk managers too. Our method shoves that ability to imagine possible outcomes and maintain a safety imagination. Scenarios can also embed in work practices to support decision-making process. We would like to appeal to organizations or experts to support story-scenarios based learning and decision making with as much vigour as formal systems for crisis managers development.

IV. REFERENCES

1. Beck, U. (nedatováno). Towards a New Modernity. *Risk Society.* London, UK: Sage.
2. Boholm, A. (nedatováno). The cultural nature of risk: Can there be an anthropology of uncertainty? . *Ethnos 68, Pg. 159-178.* 2003.
3. Cleary, S., & Malleret, T. (nedatováno). Global Risk - Businesses in Turbulent Times. *2008.* Basingstoke, UK: Palgrave Macmillan
4. Corvellec, H. (2009). The practice of risk management: Silence is not absence. . (stránky 285 - 304). Gothenburg: Gothenburg Research Institute.
5. Crouhy, M., Galai, D., & Mark, R. (2006). The Essentials of Risk Management. New York, USA: McGraw Hills.
6. Douglas, M. (1992). Risk and Blame: Essays in Cultural Theory. London, UK: Routledge.
7. Hood, C., Rothstein, H., & Baldwin, R. (2001). The Government of Risk: Understanding Risk Regulation Regimes. Oxford, UK: Oxford University Press.
8. Jonaštík, P., & Urban, R. (2013). Softwareová podpora hodnotení operačních rizik - Riskman. Žilina, Slovakia.
9. Löfstedt, R. (2005). Risk Management in Post-trust Societies. Houndmills, UK: Basingstoke: Palgrave Macmillan.
10. Mayerová, Š. (2012) Probability and Statistics, Brno , ISBN 978-80-7232-854-4, p. 135, University of Defence, Czech Republic
11. Hofmann, A., Hošková-Mayerová, Š. Talhofer, V., Kovařík, L.,(2014) HYPERLINK "http://redir.netcentrum.cz/?noaudit&url=http%3A%2F%2Flink%2Espringer%2Ecom%2Farticle%2F10%2E1007%2Fs11135%2D014%2D0072%2D1" \t "_blank" Creation of models for calculation of coefficients of terrain passability , Quality and Quantity, ISSN: 0033-5177 (Print) 1573-7845 (Online).
12. OECD (Organisation for Economic Co-operation and D. (nedatováno). Emerging Risk in the 21st Century. Paris, France: OECD.
13. Palenchar, M., & Heath, R. (2007). Strategic risk communication: Adding value to society. *Public realation Review.*
14. Perrow, C. (1984). Normal Accidents – Living with High-risk Technologies. New York, USA: Basic books.
15. Reason, J. (nedatováno). Managing the Risk of Organizational Accidents. Aldershot, UK: Ashgate.
16. Reith, G. (2004). Uncertain times – The notion of 'risk' and the development of modernity. *Time and Society 13 (2/3)*, (stránky 383-402).
17. Renn, O. (2006). White Paper on Risk Governance - Toward and Integrative Approach. CHatelaine (CH), France: The International Risk Governance Council.
18. Roberts, K. (1990). Managing high reliability organizations. *California Management Review 32 (4)*, (stránky 101-114). USA.
19. Sauer, B. (2002). The Rhetoric of Risk: Technical Documentation in Hazardous Environments. Mawah, NJ: Lawrence Eribaum Associates.
20. Smith, D. (2009). Making accidents happen in the imagination - Simulation, fitness landscapes and the management of crisis. *Simulation and Gaming.* in press.
21. Smith, D., & Fischacher, M. (2009). The changing nature of risk and risk management: The challenge of borders, uncertainty and resilience. *Risk management*, (stránky 26-34).
22. Štěpánek, L. (2011). Insurance in stage of structural changes requiring new internal organization of insurance companies (management and new forms of steering) - in Czech. Prague, Czech Republic: University of Economics in Prague.
23. Turner, B., & Pidgeon, N. (1997). Man Made Disasters. *2nd edn.* Oxford, UK: Butterworth-Heinemann.
24. Urban, R. (2012). Optimize the allocation of resources to support the protection of the population. V *Disertation.* Brno, Czech Republic: University of Defence.
25. Urban, R., Urbánek, J., & Urban, R. (2010). EU FP 7 Grant Agreement No. 218070. Project Comparative Assessment of Security-Centered
26. Urban, R., Urbánek, J., and Roman, U. (2012). CASTL. Czech Republic – Ministry of Defence, Defence Univeristy, Trade Mark 323369 (February 22).