MULTI-OBJECTIVE RANKING OF RISK ASSESSMENT TECHNIQUES: EVIDENCE FROM POLISH SMEs

The Society for Risk Analysis – European Conference 2021, June 14-16 in Espoo, Finland
The Discipline(s) of Risk Science

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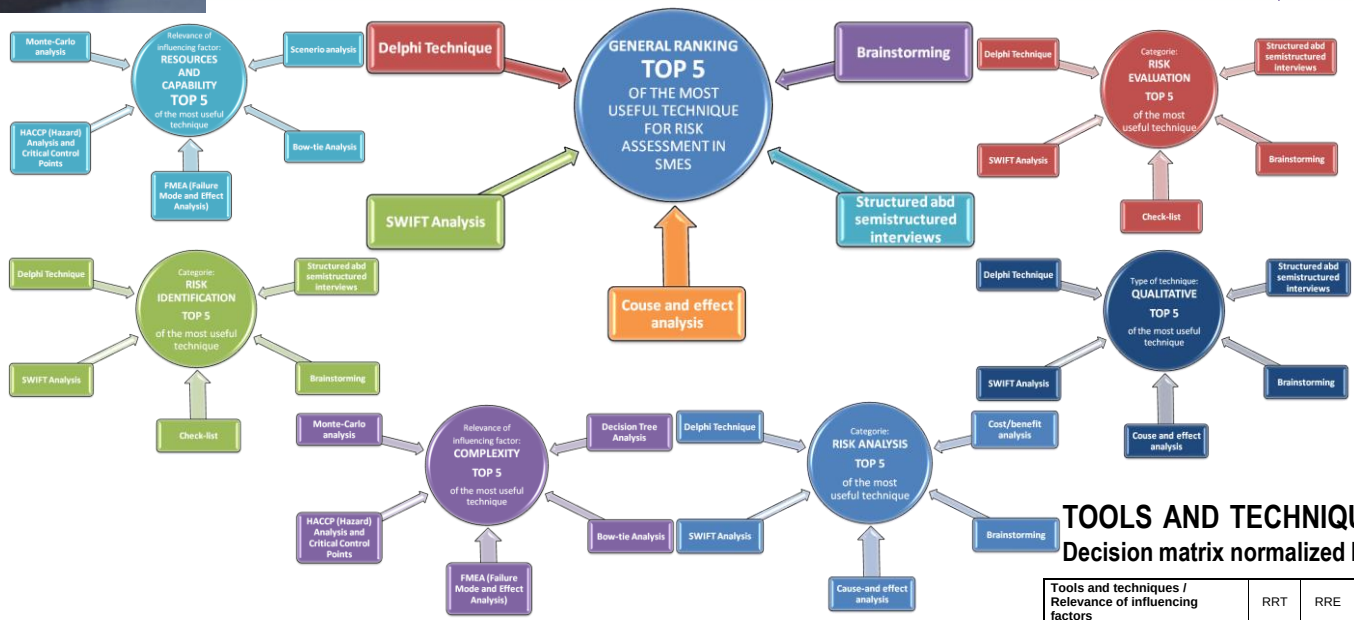
PROBLEM FORMULATION AND METHOD

Risk management is a process that is a complex challenge, especially for SME enterprises. Effective risk management requires, among other things, the selection and application of appropriate risk assessment methods and techniques. The difficulty in matching appropriate risk assessment tools and techniques is one of the key barriers to the practice of risk management in SMEs.

This study examines what risk assessment techniques are preferred by Polish SMEs. We build 7 rankings - one general ranking and 6 specific rankings based on 6 characteristics based on ISO 31010: 2019. The assessment of preferences was made by creating original rankings constructed on the MULTIMOORA multi-criteria decision-making tool. The MULTIMOORA (The Multi-Objective Optimization by Ratio Analysis with the Full Multiplicative Form of Multiple Objectives)method was used as suitable for the analysis of problems in which there are several alternatives (in our case 31 different techniques) and several objectives (in our case 6 factors that describe the preferences in the choice of technique).

Research has shown that Polish SMEs manage risk at a very basic level and prefer simple, especially qualitative, risk assessment techniques.



PROBLEM SOLUTION

The survey was conducted from October – December 2019 on a sample of 294 SMEs. A diagnostic survey method based on the CAWI (Computer Assisted Web Interviews) technique was used. This was the author's second study investigating the issue of preferences for the choice of risk assessment techniques in SMEs (the first study was conducted in 2017 on a group of 353 companies).

The MULTIMOORA PROCEDURE

Calculation steps	Methods	Formula	Description of symbols
Step 1	Raw data matrix	----	----
Step 2	Data normalisation	$x_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}}$	x_{ij} – response of alternative j on objective i $j = 1,2,\ldots,m$ m – number of alternatives $i = 1,2,\ldots n$ n – number of objectives x_{ij}^* – normalized response of alternative j on objective i
Step 3	The Ratio System (RS)	$y_j^* = \sum_{i=1}^{i=g} x_{ij}^* - \sum_{i=g+1}^{i=n} x_{ij}^*$	y_j^* – normalized assessment of alternative j with respect to all objectives $i = 1,2,\ldots g$, as the objectives to be maximized $i = g+1, g+2,\ldots n$, as the objectives to be minimized
Step 4	The Reference Point (RP)	$\min_{(i)}\left\{\max_{(j)} \left\|r_i - x_{ij}^*\right\|\right\}$	$r_i - \max x_{ij}^*$ in maximization case
Step 5	Full Multiplicative Form (FMF)	$U_i' = \frac{A_i}{B_i}$ $A_i = \prod_{j=1}^{g} x_{ij}$ $B_i = \prod_{j=g+1}^{n} x_{ij}$	A_i – the product of the objectives of the i alternative to be maximized with g n – the number of objectives to be maximized B_i – the product of the objectives of the i alternative to be minimized with n g – the number of objectives (indicators) to be minimized

CONCLUSION

Risk identification and risk assessment are vital components of an effective RM system. Research has shown that Polish SMEs manage risk at a very basic level and prefer simple, especially qualitative, risk assessment techniques. Methodologically, this study extends the application of MULTIMOORA capabilities and applies them to evaluate risk management tools and techniques in the context of SME preferences. In the course of the research, based on ISO 31010: 2019, 31 different risk assessment techniques were evaluated in view of 7 factors that describe the preference in technique selection by SMEs.

TOOLS AND TECHNIQUES of risk assessment

Decision matrix normalized by MULTIMOORA

Tools and techniques / Relevance of influencing factors	RRT	RRE	RRD	RRC	NDU	COM	QOUT
Brainstorming	0,2665	0,2333	0,3763	0,0944	0,4489	1,0000	1,0000
Structured or semi-structured interviews	0,4173	0,1372	0,2074	0,0335	0,8211	0,2076	0,7876
Delphi	0,4724	-0,0631	0,1603	0,1810	0,3712	0,2326	0,4173
Check-lists	0,6728	0,0915	0,0309	0,1660	0,9657	0,2486	0,4661
Primary hazard analysis	0,3290	0,0330	0,2974	0,0521	0,6626	-0,0882	0,7000
Hazard and operability studies (HAZOP)	0,2371	0,1161	0,4189	0,2367	0,3149	0,0321	0,8684
Hazard Analysis and Critical Control Points (HACCP)	0,5680	0,2943	0,0919	0,0284	0,0000	0,0295	0,3677
Environmental risk assessment	0,5276	0,0590	0,1190	0,1339	0,1304	0,5855	0,1630
Structure « What if? » (SWIFT)	0,2813	0,3921	0,3562	0,1624	0,3686	0,6753	0,6870
Scenario analysis	0,2831	0,7669	0,3540	0,3640	0,6779	0,2326	0,5727
Business impact analysis	0,4283	0,1606	0,1972	0,0488	0,6033	0,4193	0,6012
Root cause analysis	0,1434	0,0571	0,5859	0,1447	0,6094	0,0000	0,3365
Failure mode effect analysis	0,6875	0,0689	0,0232	0,1370	0,5711	0,5124	0,4269
Fault tree analysis	-0,3842	-0,1787	-0,5223	0,0571	0,3124	0,2342	0,0000
Event tree analysis	0,3217	0,3728	0,3060	0,2180	1,0000	-0,0882	0,6014
Cause and consequence analysis	0,6103	0,0919	0,0655	0,2290	0,2086	0,0035	0,5317
Cause-and-effect analysis	0,6563	0,0805	0,0398	0,1872	0,0210	0,1370	0,2243
Layer protection analysis (LOPA)	0,3235	0,3273	0,3038	0,0000	0,5762	0,1347	0,6433
Decision tree	0,2096	0,0274	0,4625	0,1393	0,6692	0,4822	0,5124
Human reliability analysis	1,0000	0,3793	0,0378	0,0617	0,4663	0,3930	0,4572
Bow tie analysis	0,6599	0,2184	0,0550	0,3123	0,1825	0,7735	0,4681
Reliability centred maintenance	0,6287	0,0000	0,2074	0,0576	0,5818	0,4713	0,5317
Sneak circuit analysis	0,4173	0,1565	0,0000	0,3995	0,2321	0,3664	0,5317
Markov analysis	0,7353	0,0675	0,1215	0,1328	0,0031	0,2968	0,6679
Monte Carlo simulation	0,5239	0,1086	0,1202	0,0893	0,1984	0,2101	0,5113
Bayesian statistics and Bayes Nets	0,5257	0,1516	0,2891	0,1077	0,5348	0,7058	0,3312
FN curves	0,3364	-0,1787	-0,5223	0,1287	0,1789	0,6420	0,7210
Risk indices	0,0000	1,0000	1,0000	1,0000	0,2572	-0,0882	0,4475
Consequence/probability matrix	0,2665	0,2333	0,3763	0,0944	0,4489	1,0000	1,0000
Cost/benefit analysis	0,4173	0,1372	0,2074	0,0335	0,8211	0,2076	0,7876
Multi-criteria decision analysis (MCDA)	0,4724	-0,0631	0,1603	0,1810	0,3712	0,2326	0,4173

Legend:
RRT - Required resources – time; RRE - Required resources - level of expertise
RRD - Required resources – data; RRC - Required resources - cost
NDU - Nature and degree of uncertainty; COM – Complexity QOUT - Can provide quantitative output