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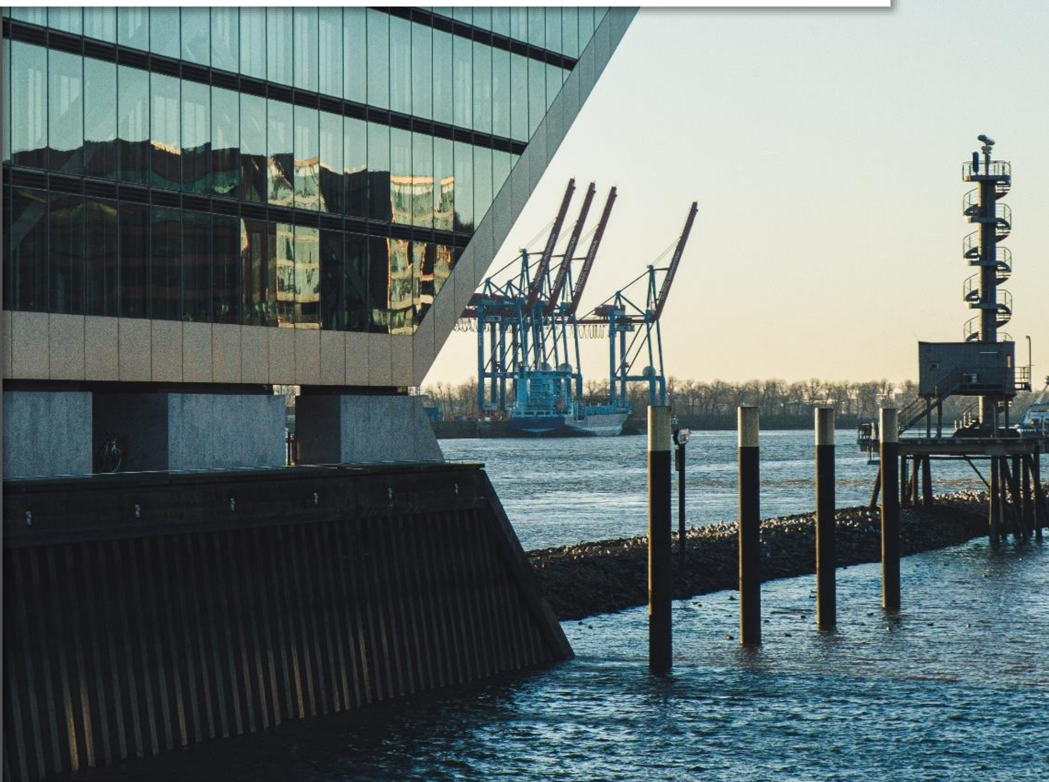

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Approach for Application-Specific Selection of Risk Assessment Methods

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Purpose: *The field of risk assessment contains many methods for evaluating risks. For companies who face the need of dealing with risks, the large number of methods might be confusing and overwhelming. This paper helps to introduce companies to the existing methods and its different requirements as well to support the application-specific selection of a risk assessment method.*

Methodology: *A systematic literature review regarding existing risk assessment methods is executed using the following identification terms: 1. "risk assessment" AND (method OR technique OR instrument OR tool OR process) AND "supply chain" 2. "risk analysis" AND (method OR technique OR instrument OR tool OR process) AND "supply chain". Used databases are EBSCOhost, Scopus, and Web of Science.*

Findings: *194 sources containing relevant content on the methods of risk assessment are identified. 138 sources are published as journal articles and 56 sources as conference contributions. The main result is a classification and an application-specific selection procedure for risk assessment methods.*

Originality: *This publication enables a comprehensive comparison and evaluation of existing risk assessment methods. It further supports the decision-making by presenting an overview and a selection procedure for choosing an application-specific method.*

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1 Motivation

During the last years, companies of all industries were exposed to supply chain risks (SCR) like price volatility, risk working capital, and inventories caused e.g. by changing demand or supply disruptions due to natural disasters, financial instability, or political interference (Galanton 2019).

Previously unknown risks arose from increasing technical progress, especially in the context of digitization, and from the complexity increase in the creation of value (Zsidisin and Henke 2019). Based on the mentioned factors and due to significant events around the world and the increased vulnerability of the supply chains (SC), supply chain risk management (SCRM) moved into the focus of many organizations (Elzarka 2013).

SCRM is already widespread in the literature. However, despite the wealth of research, several research gaps are revealed. (Bak 2018; Col-occhia and Strozzi 2012; Falkner and Hiebl 2015; Ho et al. 2015; Sodhi, Son and Tang 2012; Tran, Dubrovnik and Krummer 2018) One major gap is the lack of focus on small and medium-sized enterprises (SME).

Only with the right risk assessment SME can find the right solution to handle risks. Regarding limited time, investment capital and know how in many SME a pragmatic procedure is needed for choosing the right risk assessment method and to accompany the implementation process of SCRM by presenting an application-specific selection procedure for risk assessment methods. These needs are not addressed in literature, yet.

Since the basis of this paper is a collection of existing risk assessment methods and the categorization of them, chapter 2 presents background information regarding the literature review as a basis for a valid result. Chapter 3 deals with the identification of distinctive criteria of the identified methods. Finally, chapter 4 presents the application-specific selection procedure for risk assessment methods. Chapter 5 completes the paper with a conclusion.

2 Literature Review Regarding Risk Assessment Methods

According to Tranfield, Denyer and Smart (2003) a systematic literature review (SLR) is a fundamental scientific activity to create a transparent, systematic, and reproducible way of research (Tranfield, Denyer & Smart 2003). These characteristics of a SLR are important to generate valid input and are therefore considered for this research. The SLR includes sources available on the databases EBSCOhost, Scopus and Web of Science. The selection of databases is grounded on the extensive literature in the relevant field. The databases provide thematically appropriate, scientifically proven and peer-reviewed specialized literature. The literature is independent, i.e. there are no legal obligations or ties to specific publicists or publications. The international databases contain a large number of English literature, what reflects the globally distributed state of research. This justifies the selection of the databases. Used identification terms are:

1. "risk assessment" AND (method OR technique OR instrument OR tool OR process) AND "supply chain"
2. "risk analysis" AND (method OR technique OR instrument OR tool OR process) AND "supply chain"

3.517 publications were found which are further divided by several rejection rules. The first rejection deals with source batches of 20 publications which are in scope as long as >10% of a batch has a relevant title or keywords. In this case the first 71 batches with 1.420 sources are included for the review. Following rejections are based on detailed review of the relevance of the title, keywords, abstracts, content, and duplicate rejection. The outcome of the SLR are 194 relevant sources including nine reviews, which were published regarding risk management including risk assessment. These reviews are important for further elaboration, since there many sources are already analysed. According to the publishing years it is conspicuous that the earliest publication found in this SLR is from 2003 and till 2009 the number of publications is just on average 2,5 per year. After 2009 the interest grew significantly to an average of 17,5 publications per year till 2019. In 2016 the highest number of publications is identified with 26. Since 2003 it took ten years until the first review was published. This paper not only includes journal paper like most of the other reviews but also considers 56 conference paper as valuable input. Further the time range of reviewed papers is extended compared to the other reviews by at least 1,5 years what leads to the analysis of additional 42 sources. The reviews (Table 1) generate valuable input regarding the existing methods, their characteristics, elements and further existing criteria. This is also the required input to classify the methods, and finally create the aspired approach. Since this paper do not aim to develop new differentiation criteria, the criteria are based on these reviews.

Table 1: List of identified literature reviews regarding risk assessment methods

Review Title	Reference
Mechanisms for assessing food safety risk	Manning and Soon, 2013
A Critical Review on Supply Chain Risk – Definition Measure	Heckmann, Comes and Nickel, 2014
Quantitative models for managing supply chain risks	Fahimnia et al., 2015
Supply Chain Risk Management : A Literature Review	Ho et al., 2015
Survey of supply chains risk assessment approaches	Rangel and Leite, 2015
How Mangaers perceive and assess Supply Chain Risks? Empirical Results from a Sample of European Organizations	Gaudenzi, Confente and Manuj, 2015
Method and approach mapping for agri-food supply chain risk management. A literature review	Septiani et al., 2016
The ISO 31000 standard in supply chain risk management	Olivera et al., 2017
Supply Chain Risk Assessment: A Content Analysis-Based Literature Review	Tran, Dobrovnik and Kummer, 2018

The main part of the identified reviews not only deal with risk assessment methods but also focus e.g. on risk classification (Fahimnia et al 2015; Ho et al. 2015), general methods in SCRM (Ho et al. 2015; Septiani et al. 2016), or the implementation process for risk assessment methods from a theoretical- and practical view (Gaudenzi, Cofente & Manuj 2015; Manning & Soon 2013; Rangel & Leite 2015). In comparison to these reviews the focus in this paper as well as the focus of the review by Tran, Dobrovnik and Kummer (2018) is set on risk assessment methods for practical use (Tran, Dobrovnik and Kummer 2018). This paper presents an application-specific selection procedure for risk assessment methods, which does not exist in literature, yet. One of the biggest advantages of this paper is, that the classification criteria for further assessment are based on several individual literature reviews, combined with a huge number of additional literature.

3 Classification Criteria for Risk Assessment Methods

The outcome of the research regarding classification criteria for risk assessment methods is structured and presented in chapter 3 to define the development elements for the selection procedure. Chapter 3 presents the basic components of the approach. Essential is the clear definition of characteristics of existing risk assessment methods to provide advice for a suitable method. The different methods must be viewed from various perspectives. The structure of chapter 3 (figure 1) supports this intention.

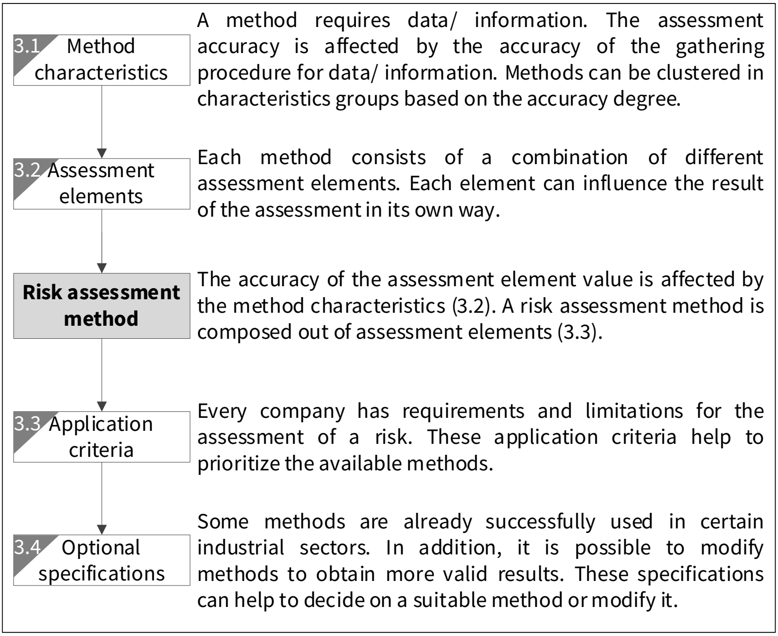

Figure 1: Structure of chapter 3

3.1 Method Characteristics

This chapter gives an insight into the characterization possibilities for the existing methods. The merge of the review characterizations is presented in the following figure.

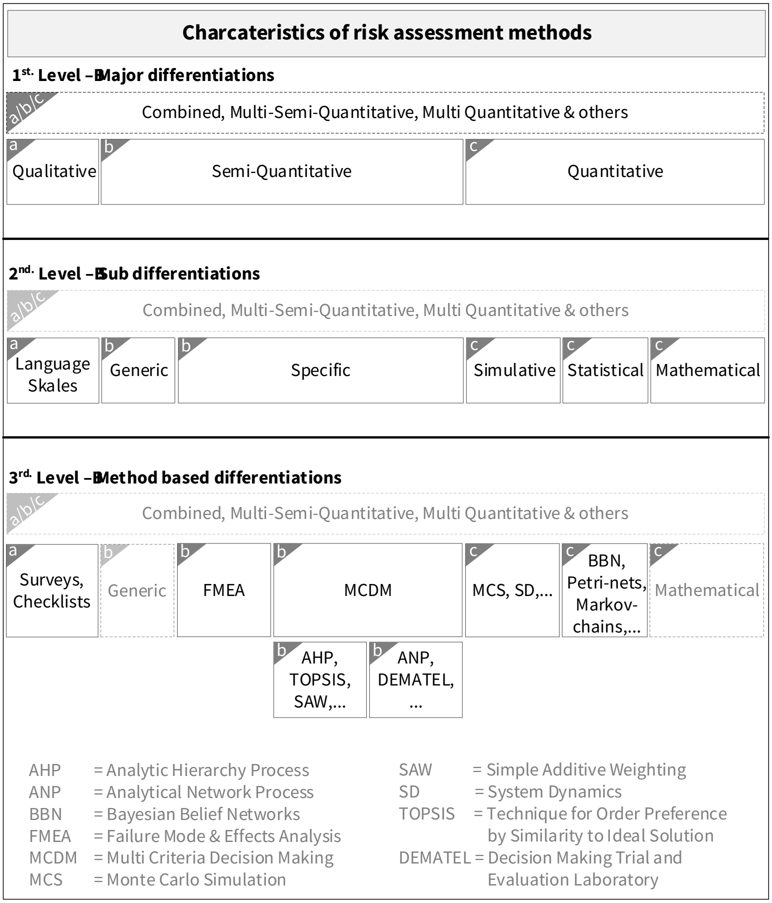

Figure 2: Overview of classified methods based on characteristics of risk assessment

In the latest review, Tran, Dobrovnik and Kummer (2018) identified general approaches to risk assessment and SCR assessment methods. According to the scientific methodology, the identified methods are classified into qualitative, semi-quantitative, quantitative, and combined methods. (Tran, Dobrovnik and Kummer 2018) This classification covers the characteristics from most of the other reviews, and therefore, it is taken as the first differentiation level. Quantitative methods are further divided into simulative, statistical, or mathematical methods, whereby semi-quantitative methods are divided into generic and specific methods. Qualitative methods are not divided but described in more detail in levels two and three. The third level gives examples of the most common methods. In this level the methods may be further divided, in case a method contains subdivisions. If no further division is made in the third level, the category might not include common methods which fit for this universal approach. In some sources, further method modifications are presented but for the general overview, the characterization in the three levels is focused because the modifications are based on the presented approaches.

In qualitative methods, the risk assessment is carried out by verbal descriptions by language scales. Thus, risk assessment elements such as the probability of occurrence are estimated based on logical conclusions by experts or involved SC companies. (Neghab et al. 2011; Tran, Dobrovnik and Kummer 2018) Typical qualitative procedures are the execution of surveys and processing of checklists (Choong, Hamid and Chew 2018; Wildgoose, Brennan and Thompson 2012). There is limited room for action to get qualitative results, therefore, the variety of methods is low.

In addition to qualitative aspects, semi-quantitative methods also consider quantitative aspects (Manning and Soon 2013; Septiani et al 2016). A distinction can be made between generic- and specific methods. Based on quantitative methods, risk assessment is carried out using relative numbers in ordinal scales. The verbal scales are expressed by numbers. In generic methods, for example, the probability of occurrence is divided into very rare = 1, rare = 2, regular = 3 and often = 4. (Tummala and Schoenherr 2011) It follows that a ranking of risks is determined (Manning and Soon 2013; Tran, Dobrovnik and Kummer 2018). Next to the generic methods, specific methods are used to assess risks. A widespread specific semi-quantitative method is FMEA, in which, in addition to risk identification, risks are evaluated by the probability of occurrence and detection, as well as the extent of damage. (Azambuja and Chen 2014; Bozdag et al. 2014; Kumar, Boice and Shepherd 2013) Normally a scale from 1 to 10 is used for the assessment (Bozdag et al. 2014). Furthermore, methods for risk prioritization like AHP, ANP, TOPSIS and other MCDM methods are used. (Cagliano et al. 2012; Ho et al. 2015; Rangel and Leite 2015)

Quantitative methods are used to evaluate risk elements systematically and analytically, for example with observations, theories and laws (Neghab et al. 2011; Tran, Dobrovnik and Kummer 2018). In contrast to qualitative methods, numerical scales form the basis and enable a more precise evaluation (Manning and Soon 2013; Tran, Dobrovnik and Kummer 2018). The extent of damage is assessed, for example, through financial losses and the probability of occurrence through data measured (Gisslen and Horndahl 2016; Landtsheer et al. 2017).

Further differentiation on quantitative risk assessment methods is possible in simulative-, statistical- and mathematical methods. Mathematical models describe formal relationships of variables, while statistical models like BBN, Petri nets, or Markov chains perform the risk assessment based on statistical distributions of the risk assessment elements. (Gisslen and Horndahl 2016; Kumar Sharma and Sharma 2015; Teerasoponpong and Sopadang 2016; Wan et al. 2013) With sufficient historical data, simulation models like MCS or SD are used to calculate the probability of occurrence and the extent of damage over time (Cagliano et al. 2012; Tuncel and Alpan 2010).

It is possible to combine methods like semi-quantitative and quantitative methods to minimize the disadvantages of individual approaches. Furthermore, the combination of semi-quantitative or quantitative methods is possible, which is called multi semi-quantitative or multi quantitative methods. (Käki, Salo and Talluri 2015; Kurniawan, Santoso and Kamal 2019; Lee, Yeung and Hong 2012; Marasova, Andrejiova and Grincova 2017; Nepal and Yadav 2015; Schaefer et al. 2019).

3.2 Assessment Elements

Chapter 3.2 deals with the focus of the different methods in terms of assessment elements which are used within the methods in order to assess a risk. The probability of occurrence, extent of damage, probability of detection, interaction between risks and the combination of risk assessment elements are taken into account, based on the most common elements used in the selected reviews (Tran, Dobrovnik and Kummer 2018; Heckmann, Comes and Nickel 2014; Rangel and Leite 2015). Figure 3 presents the chosen assessment elements and the individual allocation to the methods. The given overview can support SME in case the enterprises have already an idea about what kind of method elements and -characteristics would fit in their initial situation. A selection based on this level requires existing knowledge in risk assessment because the methods are divided based on their attributes and not on user requirements.

Method Lvl. 1	Quali-tative	Semi Quantitative			Quantitative		
Character-istics Lvl. 2	Language Skales	Generic	Specific		Simulative	Statistical	Mathematical
Risk Assess-ment Elements Lvl. 3	Survey, Checklist		FMEA	MCDM (AHP, ANP,...)	MCS, SD,..	BBN, Petri-nets,..	
Probability of occurence	X	X	X	X	X	X	X
Extent of damage	X	X	X	X	X	X	X
Probability of detection	X	X	X	X	X	X	
Interaction				X (ANP)	X	X	X
Combination (RI=1, RPN=2, Others=3)	X (1)	X (1)	X (2/3)	X (1/2/3)	X (1/2/3)	X (1/2/3)	X (1/2/3)

Figure 3: Connection between risk assessment characteristics and risk assessment elements

3.3 Application Criteria

To focus the user view within risk assessment and support the user perspective, it is important to understand what kind of criteria the user would have in mind to differentiate the existing methods and choosing the right one for the initial situation of the own SME. In this paper, these criteria are called application criteria because the focus is set on the input the company must give to get valid output.

This paper works with general application criteria, which fit most of the user requirements to simplify the procedure and to create a standard. Based on the research of the DIN ISO 31010 (2010) as an international standard as well as an empirical survey of enterprises by Ziegenbein (2007), the five application criteria usability, specific IT-necessity, information- / data origin, resource effort, and output accuracy are derived (DIN ISO 31010 2010; Ziegenbein 2007).

In the following section, these criteria are further described. Next to the definition, it is mentioned, how each of these criteria could be divided into maturity levels. The application criteria are chosen in a way, which allows SME to evaluate methods with existing knowledge and with a limited degree of complexity. Furthermore, the exact maturity level is always slightly influenced by the individual situation of the method user, which calls for a standardized allocation in the first place. These are the reasons why the different maturity levels are indicated mainly with a low, medium, or high level. Dividing the methods into two to three categories is sufficient to guide a company during the first steps of choosing an appropriate application-specific risk assessment method. A more detailed evaluation would require more background information and know how, as well as a more time-consuming evaluation what is not the purpose of the pragmatic approach.

The usability describes the level of knowledge and experience required by users for applying the risk assessment methods (DIN ISO 31010 2010; Manning and Soon 2013). The more complex a method is, the lower is the level of usability.

Qualitative methods like surveys or checklists are classified as simple methods based on the procedure by questionnaires and verbal descriptions (DIN ISO 31010 2010; Manning and Soon 2013). Generic semi-quantitative methods and FMEA are also evaluated as simple methods based on the evaluation of the risk assessment elements using verbal and associated quantitative scales (DIN ISO 31010 2010). This leads to a high usability. With MCDM methods like AHP or ANP, the valuation structure is more complex. The assessment of risks is also easy by pairwise comparisons using semi-quantitative scales, but the final prioritization of risks is done by algorithms, which require user input and advanced application knowledge. (Rangel, Oliveira and Leite 2015) This leads to a medium usability. The usability of quantitative methods is classified as low, since users need mathematical, statistical, or simulation skills to apply the methods (DIN ISO 31010 2010; Manning and Soon 2013).

Regarding the IT necessity of the methods, a distinction is made between basic programs such as MS Office and specific software. Qualitative methods, generic semi-quantitative methods, FMEA, AHP, and ANP and mathematical methods usually require standard MS Office products such as Word and Excel, whereas for methods using simulations and statistics, specific software is recommended instead.

The origin of the required information can have an influence on the decision for a risk assessment method. Some companies generate a huge amount of data in their processes, and can therefore use methods, which require a good historical- or real-time data basis. Other companies do not have this opportunity and need to use methods with low data requirements. Qualitative data are primary data from interviews and questionnaires as well as secondary data from the literature. In the case of qualitative methods, the data can be collected e.g. by interviewing external academic- or industrial experts (Markmann et al. 2013; MeiDan et al. 2011) or internal SC participants, especially managers (Tran, Dobrovnik and Kummer 2018; Venkatesh, Rathi and Patwa 2015). Semi-quantitative methods assess risks based on experts, as well as mostly incomplete historical data. E.g. with group decision making, participants give their individual opinion, which is averaged over other opinions. (Khayyam and Herrou 2017) FMEA and AHP are useful methods when no representative data are available because identifying the risks with the greatest negative impact is often sufficient. The exact monetary value is not necessarily decisive. (Dong and Cooper 2016) Therefore, for qualitative and semi-quantitative risks, no exact historical data are required for risk assessment (Berle, Norstad and Asbjørnslett 2013; Manning and Soon 2013; Ziegenbein 2007). With quantitative methods, the risk assessment is based on comprehensive data (Manning and Soon 2013; Ziegenbein 2007). This allows a precise assessment of the risks, as long as the data are correct. Access to the data is crucial, but not always possible. (Rangel and Leite 2015) Therefore, data are also obtained through simulation and statistical modelling (Berle, Norstad and Asbjørnslett 2013; Kumar Sharma and Sharma 2015). If necessary, expert estimations are also used for simulations to assume distributions, for example for the probability of occurrence (Berle, Nor-stad and Asbjørnslett 2013).

The resource effort is based on two dimensions: cost and time (DIN ISO 31010 2010). The cost and time effort for qualitative methods is low due to the conception, dissemination and result analysis of the survey compared to the other method groups. The method is quickly applied and evaluated at the discretion of the user. This is only given if questionnaires have an appropriate number of questions. Then the effort can be categorized as low. In addition, no further specialist knowledge is required during the preparation, which leads to no additional personnel costs for specialists. (DIN ISO 31010 2010; Manning and Soon 2013; Ziegenbein 2007) The resource effort for generic semi-quantitative methods can also be implemented in a time-saving and cost-effective manner by evaluating expert statements on the risks (Rangel and Leite 2015, p.6). The application of FMEA is conceptual due to the detailed decomposition of processes into failure modes and identification of control measures, therefore, time-consuming. Since the usability for the employees who work with this kind of methods is high, the need for additional expert expertise is lower. The increased time-consumption combined with the high usability and relatively low additional costs for specialized staff leads to a medium resource level (DIN ISO 31010 2010; Ghadge et al. 2017; Neghab et al. 2011). AHP is also more time-consuming due to the extended application knowledge, but the costs and personnel expenditure are relatively low as well, resulting in a medium resource effort level. With quantitative methods, the modeling of risks is associated with mathematical, statistical, and simulation knowledge, which results in increased time and personnel expenditure. Due to increased personnel effort and the necessary software, the time and costs of quantitative methods are high. (DIN ISO 31010 2010; Manning and Soon 2013; Neghab et al. 2011; Rangel and Leite 2015; Ziegenbein 2007)

Based on the data basis and the properties of the methods, the accuracy of the evaluation can be derived. Both qualitative and generic semi-quantitative methods make mainly use of the assessment of experts, taking into account little to nonconcrete data according to a less systematic procedure, therefore, provide a low output accuracy compared to quantitative risk assessment procedures. (Rangel and Leite 2015; Ziegenbein 2007) Semi-quantitative methods such as FMEA, AHP, or ANP follow a systematic and holistic approach, and the risks are compared with each other. The data are based on experts as well as partly incomplete historical data in FMEA. As a result, these methods are classified as medium. If a simulation is used as a quantitative method, a variance of scenarios can be evaluated. In addition, historical data are considered, and risks are assessed analytically. This results in a high degree of output accuracy. (Vilko and Hallikas 2012, p.592) The output accuracy of mathematical and statistical methods is also high due to the consideration of analytical principles based on historical data. (Ziegenbein 2007) Figure 4 presents the rating of the application criteria.

Method Lvl. 1	Quali-tative	Semi Quantitative			Quantitative		
Character-istics Lvl. 2	Language Skales	Generic	Specific		Simulative	Statistical	Mathematical
Appli-cation Criteria Lvl. 3	Survey, Checklist		FMEA	MCDM (AHP, ANP,...)	MCS, SD,..	BBN, Petri-nets,..	
Usability	High	High	High	Medium	Low	Low	Low
Specific IT-Necessity	No	No	No	No	Yes	Yes	No
Information-/ Data Origin	Experts	Experts	Experts / Data	Experts / Data	Experts / Data	Data	Data
Resource Effort	Low	Low	Medium	Medium	High	High	High
Output Accuracy	Low	Low	Medium	Medium	High	High	High

Figure 4: Rating of the application criteria regarding risk assessment methods

3.4 Further Optional Criteria and Modifications

Next to the described criteria in Chapter 3.1 to 3.3 there exist sub criteria. These criteria can support the decision making for a risk assessment method after using the main criteria or support the output quality of the method itself. They are presented as optional selection criteria since it is not advisable to choose methods with these criteria in the first place. Some methods are proven in certain industries or for some specific risks. Sub criteria which can support the output quality of the methods itself are modifications in terms of numerical basis and assessment weighting.

Various articles dealing with risk assessment refer to specific industrial sectors or kinds of risks. In general, the application of the assessment methods is mostly independent of the industry sector or specific risks. However, a method already proven in the same industry or for similar risks might have a higher potential to fit for the own SME.

To use the advantages of different methods as well as to compensate for disadvantages, the presented methodological approaches can be modified (Tran et al. 2018). Using modifications, an extended number basis for semi-quantitative and quantitative methods or weighting factors for qualitative or semi-quantitative methods are used.

For the methods presented in the previous chapter 3.1, the risk assessment is performed by using natural numbers. Since the risk assessment, especially by expert assessments, has a certain subjectivity, which can cause inaccuracy, the number basis is expanded. Examples for that can be using fuzzy sets, grey sets, rough number sets, or others.

Next to the number systems also weighting factors can influence the output accuracy. The subjectivity of expert assessments in semi-quantitative methods reduces the accuracy of the assessment. By interviewing several experts and weighting the results, higher objectivity, and thus, higher output accuracy is achieved.

4 Application-Specific Selection Procedure

Chapter 4 presents risk assessment methods including a differentiation in categories. Figure 5 presents the main selection procedure. It includes five steps, to select a suitable method. In addition, optional selection steps are mentioned. These optional steps can help if the main selection procedure does not yield sufficient results.

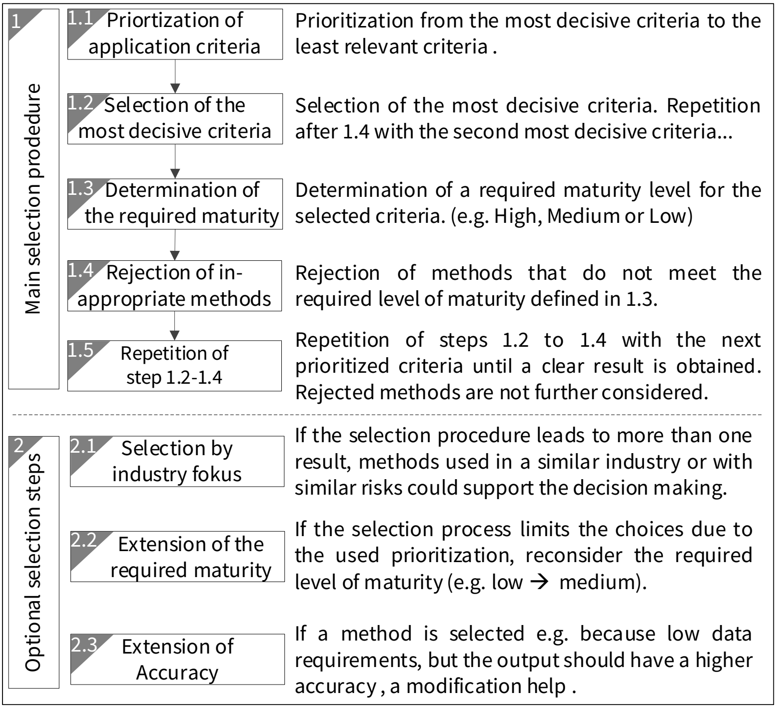

Figure 5: Selection procedure for identifying a suitable risk assessment method

To perform the selection procedure, Figure 6 gives an overview of the selection options.

1.4 Rejection of inappropriate methods

Method Characteristics / Application Criteria	Qualitative	Semi Quantitative			Quantitative		
Lvl. 1	Qualitative	Semi Quantitative			Quantitative		
Lvl. 2	Language Skales	Generic	Specific		Simulative	Statistical	Mathematical
Lvl. 3	Survey, Checklist		FMEA	MCDM (AHP, ANP,etc.)	MCS, SD,..	BBN, Petri-nets,..	
Usability	High	High	High	Medium	Low	Low	Low
Specific IT-Necessity	No	No	No	No	Yes	Yes	No
Information-/ Data Origin	Experts	Experts	Experts / Data	Experts / Data	Experts / Data	Data	Data
Resource Effort	Low	Low	Medium	Medium	High	High	High
Output Accuracy	Low	Low	Medium	Medium	High	High	High

1.1 1.2 Priorization of the application criteria & Selection of the most decisive one

1.5 Repetition (1.2-1.4)

1.3 Determination of the required maturity level

Figure 6: Visualization of the selection procedure steps

This figure helps to follow the selection procedure. In general, it is an allocation between the characteristics of the methods, including specific methods discussed in chapter 3.1 and the application criteria presented in chapter 3.3. Additionally, figure 6 highlights the main selection procedure steps 1.1 to 1.5. Since the selected application criteria will not be changed again for the further process, step five just includes the repetition of steps 1.2 to 1.4 with the following application criteria. This should help to raise knowledge regarding the common risk assessment methods by five application criteria. Furthermore, this approach supports companies in choosing the most suitable method.To avoid misunderstanding of the procedure, a short example is given: A fictive SME needs to deal with risks during the last months and decides to implement an assessment method to set a prioritization. First the management prioritizes the application criteria. Since the SME has no experts regarding simulation or statistical tools and has just access to MS Office, the company decides, that methods with requirements for specific IT-tools should be rejected. That means for the application criteria “Specific IT-Necessity” all simulative and statistical methods are rejected. In this case, the urgency for acting regarding risk reduction is high, that is why the implementation of a method should be possible within a short time frame with low or at least medium effort. Based on the “Resource Effort” these requirements lead to a rejection of mathematical methods, due to the high resource effort. From now on, all quantitative methods are rejected.

For the selection of the third application criteria, the SME chooses the “Output Accuracy”, as some of the risks can cause huge losses, and the company wants valid results. Because the methods with the high level of output accuracy are already sorted out, only low and medium ranked methods are left. The company chooses the medium level methods and rejects the low-level methods. That results in a rejection of all qualitative methods as well as generic semi-quantitative methods. For the remaining methods, the criteria information-/ data origin is on the same level. That is why this criterion is not helpful for decision making.

The last criterion is usability, and since the company has time pressure and no experts for specific methods, the company selects the methods with a high level of usability. That leads to a decision for the specific semi-quantitative method called FMEA.

The SME should now gain know-how about this method. If the output accuracy will not fit the expectations, there is the opportunity to modify the method or combine with other methods. By following this procedure companies should get an idea about categories of risk assessment methods down to specific methods which should fit for the individual needs. To reduce the risk a company selects a wrong method based on individual personal decisions regarding the prioritization of the application criteria, the procedure should be executed by a selected group of relevant employees or should be done several times by slightly changing the prioritization and comparing the outcome. In case the result is still the same, the chance that the method will fit to the companies requirements is high. In case more than one method is the outcome the company should take both methods into account for the further evaluation and make a decision after a detailed insight.

5 Conclusion

Risk management moves into the focus of many companies, e.g. due to increasing vulnerability and complexity, within the SC. The management of these risks becomes a critical capability of successful companies. Despite the wealth of research, some areas are not sufficiently revealed, yet. One research gap is the missing focus on SME and ways how these companies can identify the most suitable methods for their individual circumstances and needs regarding risk assessment.

This paper supports SME with the decision making for a suitable risk assessment method, even when the know-how regarding risk assessment in general and especially the existing methods is quite low. The developed procedure is supposed to lower the obstacles, companies encounter regarding the implementation of risk management in general.

The output enables an analysis of the methods in several ways. The aim of this analysis is to find criteria and characteristics which help to differentiate the methods for application-specific situations. Next to general characteristics like qualitative or quantitative methods, the included assessment elements like the probability of occurrence or the extent of damage are evaluated for each method or method group. Since these characteristics are still difficult for companies to relate to their individual needs, application criteria like usability level, specific IT-necessity or information- / data origin are chosen for the selection. At the end, a procedure is developed to present a way of using the application criteria to select the suitable risk assessment method.

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