Establishing a conceptually founded maturity development model for Enterprise Risk Management System in Austrian non-financial Enterprises

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Affidavit

I, Davide Raffaele, hereby declare

1. That I am the sole author of the present Master Thesis and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and

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Abstract

Enterprise risk management (ERM) has recently emerged as a new paradigm to support organizations in facing risk in an integrated, enterprise-wide manner, and policy makers continue to focus on mechanisms to improve corporate governance and risk management (e.g. COSO). Despite these developments, many companies still struggle with ERM development, as there is a lack of good information on the management of ERM, on how to bring all the risk silos together. In order to cover this gap, and support entities in overcoming the ERM development challenge, this research proposes a maturity development model for Enterprise Risk Management System. In developing this maturity development model, a structured framework is followed where an agreed upon conceptual model is before developed and subsequently operationalized (via a questionnaire). Once the maturity development model is in place, results are gathered in a sample of Austrian non-financial enterprises and statistically insights into their maturity levels and their determinants are provided.

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1. Introduction

In recent years, the enterprise risk management (ERM) is rising up the agenda of companies as important topic of discussion. It emerged as a powerful technique to drive managers evaluating and managing risk in an integrated, enterprise-wide way. COSO claims that ERM helps to identify the sources of risks and to address them by improving strategic and operational decision-making (Monda & Giorgino 2013). As a result, firm performance should increase, volatility decrease and cost of capital should be reduced, positively influencing firm value (Beasley et al. 2008).

No sector and no country is exempt of risks, and neglecting them is the only sure way to disaster (Oesterreichische Nationalbank 2006). For these reasons, in order to make firms embracing (enterprise) risk management, Austria has a few legal requirements in place (i.e. §267 Abs. 1 Unternehmensgesetzbuch (UGB), § 243 UGB and unternehmensrechts-Änderungsgesetz 2008). However, as evidenced by surveys and research, many companies still struggle with ERM development (Fraser & Simkins 2016) as there is a lack of good information on the management of ERM (Bromiley et al. 2015). Fraser et al. (2010, p. 400) found that *many of the articles describe what the process* [of ERM] *should look like and how it should function, but there are few that provide details of how to get to that step*. *Many of the articles use great overarching statements that seem very much like motherhood statements*. *There is a distinct lack of information on how to bring all the silos together—other than to say that a common reporting system and language are important*.

In order to cover this gap, and support entities in overcoming the ERM development challenge, the Institute of Management Science of the Vienna Technical University, sponsored by the Funk foundation, made a research project[1] (which is at the basis of this thesis) to establish a maturity development model for Enterprise Risk Management System in Austrian non-financial Enterprises. This research aims to provide a conceptually founded framework that triggers ERM-system development through assessing the as-is situation, benchmarking it across the Austrian industrial sector and presenting a development roadmap for improvement.

Although there is no accepted methodology for impartially measuring management practices across different industries (Ibbs & Kwak 2000), we considered that maturity models could contribute to the discussion on how to measure and gain control of enterprise risk management practices, because they initially judge the sophistication of a specific process of an organization to then identify the key practices that are required to increase the maturity of those processes (Cienfuegos 2013).

To develop the enterprise risk management maturity development model presented in this study, an advancement of the predictive validity framework (PVF) of Bisbe et al. (2007) and Libby et al. (2002) from theory-based empirical research was followed. Primary, a classification schema for the conceptual modeling of the maturity model (the *Enterprise Risk Management Maturity Assessment* [ERMMA] *classification schema*) was established. Accordingly, a three-dimensional/five stages maturity model

[1] The research project team was led by Univ. Prof. Mag.rer.soc.oec. Dr.rer.soc.oec. Walter S.A. Schwaiger and formed by Michael Brandstätter, Theresa Fröschl, Maximilian Irro, and Davide Raffaele

was deductively derived, namely operationalized by specifying a set of progressive observable indicators for each dimension of the model (i.e. *the ERMMA model*). The indicators are binary and, in the last step of the PVF, they are translated in valid and reliable questions (*ERMMA questionnaire*). Eventually, the questionnaire was also implemented in an intelligent web application (named *ERMMA online).*

Following this approach, the questionnaire developed in this research differs consistently from traditional surveys. First of all, the questions asked in the ERMMA questionnaire are not formulated ad hoc but rather are deductively deduced using a refined version of the Predictive Validity Framework (Bisbe et al. (2007) and Libby et al. (2002)); from the ERM system theoretical construct, questions are explicitly modeled via observable indicators. Second, different levels of ERM implementation are not addressed by generic questions and then measured using a Likert-scale but rather each question measures the presence or absence of indicators assigned to the five maturity levels of ERM system via dichotomous (yes / no) answer options. These indicators (multiple for each of the five ERM maturity levels) represent, by their consecutive arrangement, the progressively increasing maturity levels of a development model. Thanks to this arrangement, not all companies are asked the same questions but rather they are asked only questions as long as they have the attributes required for the consecutive maturity levels. Finally, the participating companies do not have to wait until the study is evaluated to get results. After completion of the survey, the maturity level achieved and the related indicators as well as the development roadmap for the next maturity level are directly provided to the participants. As the ERMMA questionnaire is designed not to be a one-time endeavor but a recurrent monitoring tool to control the ERM system development of enterprises, companies can also follow the evolution of their maturity levels over time.

The ERMMA maturity development model will include COSO, as the most well known framework, but also ISO 31000 (and other frameworks as well) for additional perspective and guidance on implementation considerations, as The Institute of Internal Auditors suggests. An effective enterprise risk management cannot be based on just one framework, but needs to go further and include more perspectives, because those are just different aspects of Enterprise Risk Management. COSO, ISO 31000, Three Lines of Defence and the over 80 risk management frameworks reported worldwide do not match entirely, but there is a lot of overlap (Olson, 2008).

The methodology used for this thesis will clearly start from a literature review, where the existing (enterprise) risk maturity models found in the literature will be discussed. Then, following a refined version of the predictive validity framework (PVF) of Bisbe et al. (2007) and Libby et al. (2002), we will first build an agreed upon conceptual model that will be subsequently operationalized (via a questionnaire). Eventually, the results gathered through the operationalized questionnaire in a sample of Austrian non-financial enterprises will be analyzed and presented.

This research will provide a twofold contribution. On the scientific level, a novel development model for maturity measurement will be provided; and on the empirical level, statistically insights into the present Austrian non-financial enterprises´ risk maturity levels and their causes will be shown.

The thesis will proceed as follow. First, a literature review about enterprise risk management maturity models will be presented. It establishes the foundation from which to develop, providing a common language and highlighting the benefits and limitations of the current works. Then, the focus will move towards the literature of theory-based empirical research to investigate how to correctly address the definition of a construct. Then, the measurement instrument for the operationalization of a construct will be discussed. The following section will examine the (cumulative) stage model theory, which gives theoretical base to maturity models supporting the principles behind this method. The following chapter will then present the theoretical construction and the operationalization of the construct of the proposed ERMMA enterprise risk maturity development model. The results gathered in a sample of Austrian non-financial enterprises will be then analyzed and presented. Finally, a last section closes the paper, where conclusions are drawn and future research possibilities are highlighted.

2. Background and conceptual frameworks

In this section, the previous literature in the empirical (E)RM maturity assessment research will be elaborated and presented. Next to that, additional conceptual frameworks which are relevant for the development of the ERMMA study will be presented as well.

In addition, it was noticed an inconsistent use of terminology within the research area. A lack of a common language presents a number of issues for research. From a literature perspective, inconsistent use of terminology makes comparing and contrasting extant literature more complex as the exact meaning of a term, as used within an article, may be open to interpretation (de Bruin 2009). Consequently, in order to pursue clarity, the terminology of Bisbe et al. (2007) will be followed and the diverse terms used by different authors will be reported to this common terminology. In particular, we use *the term <u>construct</u> to refer to a theoretical creation that can be defined in conceptual terms but cannot be observed and therefore is anchored to observable reality by means of indicators ... We use <u>indicator</u> (observables) to refer to an observable variable that represents an observable manifestation or an observable facet of a construct ... <u>Operationalization</u> is the process of developing operational definitions of indicators. <u>Operational definitions</u> are empirical referents that specify the exact operations to be carried out in measuring such indicators ... <u>Operational variables</u> (attributes, items) are the variables that result from such operational definitions ... Finally, we use the term <u>measure</u> to refer to an observed score of an operational variable* ... Bisbe et al. (2007, p.790).

2.1 Overview of Maturity Models and Literature review of (E)RM Maturity Models

Maturity methodology has found increasing acceptance and interest by practitioners and scholars (MacGillivray 2006b); and this is confirmed by the steadily rise of maturity-related topics publications over the last decade (Wendler 2012). Its success is driven by the fact that maturity models offer organizations a simple but effective method to measure the quality of their processes (Wendler 2012). They capture the "current" and "desired" state of implementation of a specific discipline (Maier et al. 2006), and define an evolutionary plateau to cover these two states (SEI 2009). The way to maturity is usually break down into specific levels, where each level consists of related practices for a predefined set of process areas (SEI 2009). An enterprise reaches a new maturity level when a set of practices has been established to provide results that the firm did not have at earlier levels. The way of transformation is different at each level but always requires capabilities established at previous levels. Consequently, each maturity level provides a foundation of practices on which procedures at subsequent maturity levels can be built (MacGillivray et al. 2007).

In the following section, a number of maturity models in the (enterprise) risk management domain, which are considered relevant for this article, will be elaborated and presented.

2.1.1 (E)RM Maturity Models

A few proposals of (Enterprise) Risk Maturity Models are provided in the literature as well as in the applicative studies of consultants. All available models follow a *general idea of construction with a gradual description of risk management advancements towards full maturity. These models differ, however, with the number of* (maturity) *levels evaluated and the* dimensions (called *attributes* in the original publication) *examined* (Wieczorek-Kosmala 2014, p. 141). Accordingly, maturity models are classifiable via its one (1-dim.) or more (n-dim.) dimensional construct and its two or more (n-stage) maturity levels.

Hillson's proposal, published in 1997, should be considered as the pioneering model in risk management (Wieczorek-Kosmala 2014). Hillson adapts the Capability Maturity Model[2] to the context of risk, implementing a 4-dimensional/4-stage "risk (management)" maturity development model. The suggested maturity levels (naïve, novice, normalized and neutral) hing on the idea that *the approach of organization towards the management of risk can be categorized into groups which range from those who have no formal process through to organizations where risk management is fully integrated into the business* (Hillson 1997, p.36). The 4 construct's dimensions (culture, process, experience and application; called "attributes headings" is his pubblication) intend to provide more details to the model, and indeed its content is specified via detailed indicators (called "attributes" in his pubblication) representing the observable

[2] The Capability Maturity Model (CMM) is a maturity model in the field of software development. In the CMM model, five consecutive (cumulative) maturity levels are defined: 1) Initial (where processes are only sporadic or not defined at all), 2) Repeatable (where processes are subject to simple monitoring), 3) Defined (where processes are defined company-wide), 4) Managed (where processes are controlled by quantitative measures) and 5) Optimizing (where processes undergo a continuous improvement process). The content of the five levels of maturity is covered by indicators, which are essentially based on dichotomous variables (i.e. yes / no to answer questions) (SEI 2009).

manifestation of the dimensions. However, Hillson remains at the conceptual level, as he does not assign any operational variable to the indicators of the 16 dimensions. The aim of the author is to provide a development model to organizations so as to *assess their current level of maturity, identify realistic target for improvement, and produce action plans for developing or enahncing their risk capability* (Hillson 1997, p.35).

Beasley et al. (2005) define an n-dimensional/5-stage “ERM” implementation maturity model, where the implementation maturity stages are defined in an ordinal increasing scale. In contrast to Hillson, Beasely et al. studied ERM at a high level of aggregation, as they do not clearly define dimensions nor indicators of the ERM construct and, instead, base their scale on broad statements regarding ERM implementation, derived by the COSO ERM framework (2004). This because the authors investigate the entity´s stage of ERM maturity merely as a mean to explore organizational factors associated with it. The firm´s ERM maturity is aimed to be an ordinal dependent variable that reflects a value ranging from 1 to 5 and thus, a high-level description of the as-is situation is sufficient.

As Beasely et al. (2005), Monda & Giorgino (2013) focused on the specific field of Enterprise Risk Maturity, improving its implementation measurement quality by specifying a 3-dimensional/continuous-stage “ERM” implementation maturity model. In their research, the authors run an e-mail Delphi procedure (involving a panel of experts on ERM) to select and prioritize best practices of enterprise risk management found in the literature (in the area of organization, risk culture and process), which are then used to develop a structured questionnaire. Each participating firm answers the 22 closed-end questions and receives eventually a final score: the ERM index (the higher the value, the higher the maturity of the company). For aggregating the question responses to the ERM index, weightings for the answer options, calibrated through the Delphi procedure, are used. The aim of the authors is to *propose a robust and rigorous model to evaluate the quality, or maturity, of ERM programs implemented by firms* (Monda & Giorgino 2013, p. 1).

Cienfuegos (2013) establishes a 5-dimensional/5-stage “risk (management process)” maturity model for municipalities, focused on the Nederland; and although the author named it as “risk management maturity model”, it is built on organization-wide risk management processes. The author strongly relies on the literature of organizational change and organizational learning for the theoretical reasoning that guides him towards the construction of his risk maturity development model. However, confusing is that he uses the stage modeling for defining the five “stages” in the risk management process (i.e. context and objectives, identification, analysis and measurement, decision or control as well as implementation, review and feedback) which are then use as dimensions of the maturity model. Cienfuegos (2013, p.9) eventually aims *to diagnose accurately the present state of risk management processes in Dutch municipalities, guiding them as well on the implementation of the best practices of risk management… by focusing on a limited set of activities and working aggressively to achieve them*.

Lundqvist (2015) develops a 2-dimensional/4-stage “ERM” implementation maturity model by assuming that two latent dimensions (called components in the original publication) determine the ERM: traditional risk management and risk governance. The four stages are generally defined on a range from zero to three, while the dimensions are more in details specified by 59 sub-dimensions. These stages and dimensions are then operationalized in a survey methodology *used to get inside firms risk management implementation and gain information about the implementation of a variety of dimensions of ERM* (Lundqvist 2015, p.8). The author uses the results of the survey for analyzing the drivers of the implementation maturity through an explanatory factor analysis. The resultant factor loadings are analyzed with respect to the additionally measured “environmental/contingent” variables (e.g. size of the firm) in order to determine the drivers of the implementation maturities. As for Beasely et al. (2005), the aim of Lundqvist (2015) in developing a maturity model is to collect information regarding the current as-is state of an organization in regards of enterprise risk management, to then further analyze this information; thus, making the maturity model purely descriptive.

Finally, Oliva (2016) develops a 4-dimensions/5-stages “ERM” maturity assessment model focused on supply chain. In his research, differently from the previous scholars, the author identifies stages and dimensions in retrospect, based on extensive open-question-interviews to expert in the field and a survey proposed to a sample of large Brazilian companies, whose responses are then clustered into dimensions and stages that constitute the maturity model. As the author explicitly states, his research *aims to analyze the enterprise risk management in the supply chain of Brazilian companies...* [proposing] *a maturity level assessment model with respect to enterprise risk management* (Oliva 2016, p. 66-67); making the maturity model purely descriptive.

In Table 1 the (enterprise) risk maturity models considered relevant for this article are summarized with respect to their levels, dimensions and model aim. For this latter, ● is indicative of a primary focus and ◗ denotes what the researcher sees as a secondary focus of the model.

Model	**Stages**	**Construct Dimensions**	**Model Aim**	
			Descriptive Model	Development Model
Hillson (1997)	4 Stages ○ Naive ○ Novice ○ Normalized ○ Neutral	4 Dimensions ○ Culture ○ Process ○ Experience ○ Application	●	●
Beasely et al. (2005)	5 Stages ○ No Plans to implement ERM ○ Investigating ERM; No decision yet ○ Planning to implement ERM ○ Partial ERM in place ○ Complete ERM is in place	n-Dimensions	●	

Monda & Giorgino (2013)	Continuous Stages	3 Dimensions ○ Risk culture ○ Organization ○ Process	●	
Cienfuegos (2013)	5 Stages ○ Initial ○ Repeatable ○ Defined ○ Manage ○ Optimized	5 Dimensions ○ Risk Identification ○ Decision or control ○ Implementation and reviewing ○ Risk analysis and methods ○ Context and objectives	●	◗
Lundqvist (2015)	4 Stages ○ Level 0 (*Non-existent*) ○ Level 1 ○ Level 2 ○ Level 3 (*Robustly implemented*)	2 Dimensions ○ Traditional risk management ○ Risk governance	●	
Oliva (2016)	5 Stages ○ Insufficient ○ Contingent ○ Structured ○ Participative ○ Systemic	4 Dimensions ○ Organization ○ Technicality ○ Transparency ○ Involvement	●	

Table 1 - Comparison of stages, construct dimensions and aim of relevant (enterprise) risk management maturity models found in the literature

Descriptive and development model can be seen as distinct model types, though they actually represent evolutionary phases of a model: before being a supportive tools to assess the as-is situation of an entity, to then derive and prioritize improvement measures and subsequently control the progress of their implementation (Becker et al. 2009). A maturity development model serves first as scale for the appraisal of the position on the evolution path; a snap-shot of the organization regarding the given criteria is made (i.e. description of as-is situation). Once maturity is assessed, the development model provides guidelines for planning and orchestrating the evolutionary journey so that steps can be taken towards higher maturity (Hillson 1997; Solli-Sæther & Gottschalk 2010).

All (enterprise) risk maturity models presented in this chapter, assume that firms at first stage essentially do not manage risk, or if they do, they are chaotic, ad-hoc and are unaware of the need for (enterprise) risk management and of its benefits (Cienfuegos 2013; Hillson 1997; Wieczorek-Kosmala 2014). The subsequent levels of (enterprise) risk management *reflect the maturity advancements an organization may undertake in developing and improving the implementation of a strategic* (enterprise) *risk management framework* (Wieczorek-Kosmala 2014, p.142). From the second to the second-to-last level of maturity, a firm first understands that it has risks that require formal management and thus experiments application of (E)RM, and then built management of risk into routine processes throughout the whole organizational hierarchy and across all functional boundaries. Finally, at the higest level of maturity, the firm has developed a risk-aware culture with a proactive approach in all aspect of the business, it is an adaptive entity, learning continually and improving its (enteprise) risk management processes (Cienfuegos 2013; Hillson 1997).

Existing literature provided us with insights into how different criteria are applied when measuring the progression of (enterprise) risk management within organizations. The different models showed a wide range of possible approaches and procedures. For the purposes of ERM system design, Hillson's 4-dimensional / 4-level Risk Maturity Model is the most insightful. The 4 dimensions and 4 maturity levels of the model indicate a construct consisting of 16 dimensions. Through the progressive specification of maturity indicators, the risk maturity model is a development model that provides normative clues for improving maturity levels.

2.2 Theory-based Empirical Research: The Predictive Validity Framework

The previous section presented a number of risk maturity models which are, except of Hillson (1997), freely operationalized in questionnaires without previously undertaking a clear conceptualization of the (enterprise) risk management construct. A lack of attention concerning conceptual specification can lead to considerable ambiguity regarding the specific meaning of the constructs under consideration, which, in turn, threaten the subsequent operationalization of the construct by hindering its validity (Bisbe et al. 2007). Enterprise risk management is not a directly observable construct, and in this section we discuss an advancement of the predictive validity framework of Bisbe et al. 2007 and Libby et al. 2002: a theory-based empirical research methodology through which unobservable (i.e. latent) constructs are conceptualized and then modeled on the basis of dimensions and indicators before being operationalized into an operational measurement models. Following this framework, the latent constructs becomes measurable, before through a conceptual measurement model and then through an operational measurement model.

The predictive validity framework elaboration presented in Figure 1 derived from Bisbe et al. (2007) and Libby et al. (2002) is a framework that, as said, provides a description of the process by which an operational measurement model can be derived by a latent construct. Within the PVF, two levels are distinguished: the conceptual level and the operational level. At the conceptual level (top part of Figure 1), theory identifies the construct of interest and specifies its meaning. Theory subsequently develops a model that represents the expected relationships between construct, dimension(s) and indicator(s). Research moves from the conceptual to the operational level (bottom part of Figure 1) by engaging in an operationalization process by which constructs are translated into operational variables that measure the variability associated with constructs.

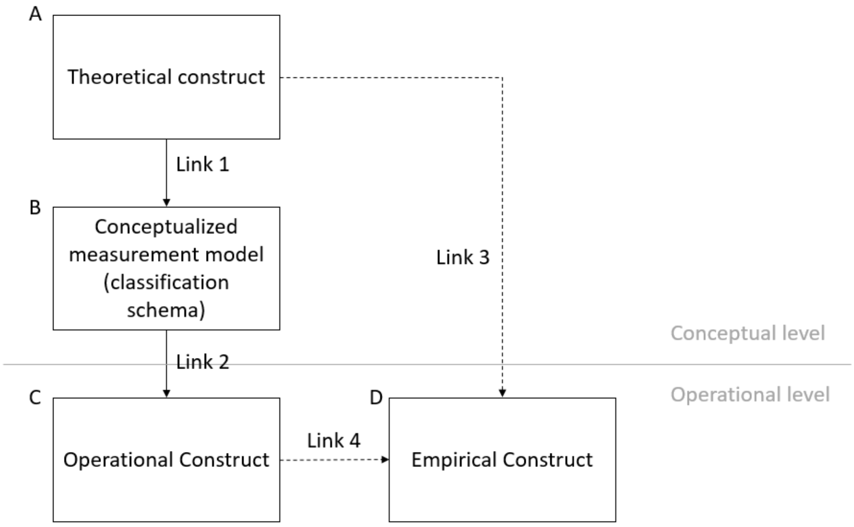

Figure 1 - Elaboration of the Predictive Validity Framework of Bisbe et al. (2007) and Libby et al. (2002)

As suggested by Mackenzie et al. (2011), a structured framework in developing measurement instruments is required (1) to avoid the risk of failing to adequately define a construct domain, and (2) to avoid the risk of improper specifying the measurement model that relates the latent variable representing a construct to its measures. Failing to adequately define the conceptual domain of a construct causes confusion about what the construct does and does not refer to and fuel the risk that indicators may be deficient as the definition of the construct is not properly deepened. Misspecifying the measurement models (i.e. not correctly distinguishing between formative and reflective measurement models) can cause structural parameter estimates to be biased, when indicators that should be modeled as having formative relationships with a construct are modeled as having reflective relationship, and can undermine construct validity, if a scale development procedures recommended for latent constructs with reflective indicators is applied to latent constructs with formative indicators. To prevent these issues, the proposed framework should be followed.

The first step of the PVF displayed in Figure 1 is to identify the construct of interest, specifiy its meaning and its conceptual domain. *A construct is a conceptual term used to describe a phenomenon of theoretical interest* (Bisbe et al. 2007, p.791). Although constructs are literally constructed terms put together by the researchers, constructs refer to phenomena that are real and exist separately from the interpretation of the researcher and the persons under study (Edwards & Bagozzi 2000). Referring to a real phenomena does not make themselves real in an objective sense, instead constructs are elements of scientific discourse that serve as verbal surrogates for phenomena of interest. These phenomena can be either observable or unobservable but in any case, the construct itself remains an abstract term that describes the phenomenon (Edwards & Bagozzi 2000).

The researcher should specify the construct in clear, unambiguous terms, preventing it to be subject to multiple interpretations, overly technical (i.e. using terms with narrow meanings) or be affected by circular or tautological definition. Additionally, a discussion of how the construct differs from other related constructs should be undertaken (Mackenzie eat al., 2011). Each of these elements is essential. It is important for researchers to be as clear and concise in their definition as possible at this stage of the construct development (Churchill 1979). *The failure to adequately specify the conceptual meaning of a study's focal constructs…triggers a sequence of events that undermines construct validity (primarily due to measure deficiency), statistical conclusion validity (due to the biasing effects of measurement model misspecification), and ultimately internal validity (due to a combination of factors)* MacKenzie (2003, p. 323).

Once the construct has been carefully defined, it is important to step back and, in the second step of the PVF (box B displayed in Figure 1), explitely specfiy the signs of the presence or absence of the construct under study. *These signs of presence or absence of the construct of interest are captured by observable variables referred to as indicators. Indicators identify the signs of the presence of a construct by referring to its observable manifestations (i.e., indicators as reflections of an underlying construct) or to its observable constitutive facets (i.e., indicators as the diverse aspects that combine to form a construct)* (Bisbe et al. 2007, p.791). For example, Rai et al. (2006) identified a set of indicators that collectively form the construct of operational excellence. These indicators include product delivery cycle time, timeliness of after-sales service, and productivity improvements in terms of assets, operating costs, and labor costs. A second example can be found in Onsi (1977), who identified three observable indicators for the construct "presence of budgetary slack": easiness of budget attainability, setting of different budget levels across the hierarchy, and enabling of non-officially approved actions.

In some cases, it is not possible to directly observe the manifestation or constitute facets of a construct, as they are in turn manifested through, or constituted by, indicators. We refer at these cases as *multidimensional constructs*, and at the non-observable manifestation or constitutive facets as *dimensions*, which are in turn sub-constructs of a higher-order construct (Edwards 2001; Bisbe et al. 2007). For example, Rai et al. (2006) defined firm performance as a multidimensional construct, with customer relationships, revenue growth and operational excellence as dimensions (this latter, was already exemplary specified through indicators in the previous paragraph). Once the researcher has delineated, through reviewing relevant literature, along with case study and formal interview, what is included and what is not included in the constructs (i.e. its dimensions and indicators), its domain is explicitly established (Segars 1997).

Having defined the three entities construct, dimensions and indicators, a researcher needs to subsequently determine, at the conceptual level of PVF, the nature and direction of the relationships among them (i.e. between a construct and its indicators, or between a construct, its dimensions and its indicators in case of multidimensioality) (Bisbe et al. 2007). We refer at this conceptually-defined relationship between a construct, (its dimensions) and its indicators as *epistemic relationsip* (Hulland 1999). There exist two alternative types of models to raprestent different natures and directions of epistemic relationship between construct and indicators: reflective models and formative models (Bollen & Lennox 1991). *Under a reflective model an underlying construct is reflected or manifested by a series of indicators. The direction of causality implied by the conceptual specification is from the construct to the indicators. Because indicators are conceptualized as reflections or manifestations of an underlying construct, changes in the construct are expected to cause changes in the indicator…. Alternatively, if a construct is formed or induced by indicators that describe its inherent constitutive facets, a formative model applies. The direction of causality flows from the indicators to the construct, and the indicators as a group jointly determine the conceptual meaning of the construct. The indicators are not driven by an underlying construct, ... and indicators are not necessarily interchangeable (*Bisbe et al. 2007, p. 800).

In Figure 2, the two types of models can be seen. Note that the direction of the arrows from the X´s to the ξ and η is the mark of wheter the contruct is thought to be, and thus modeled, as formative or reflective. As suggested by Petter et al. (2007), a way of reading this directionality is to think of the ξ as "causing the indicators" in case of reflective construct and to think of the η as "being caused by the indicators" in the case of formative construct.

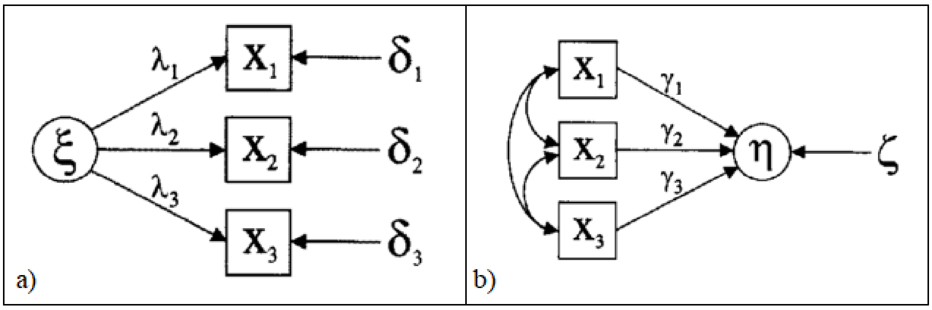

Figure 2 - Diagram of reflective (figure a on the left) and formative measurement (figure b on the right) models (from Edwards and Bagozzi 2000).

Edwards and Bagozzi (2000) illustrate the relationship between reflective indicators and the construct mathematically as

$$x_i = \lambda_i \xi + \delta_i \quad (1)$$

Each indicator of a reflective construct is thus rapresented by its own equation, in which each of the x_i measures is influenced by the construct ξ, the random measurement error δ_i and the λ_i are factor lodings depicting the magnitude of the effect of ξ on the x_i.

In a similar manner, also the formative concept is presented by Edwards and Bagozzi (2000) through the equation:

$$\eta = \sum_i \gamma_i x_i + \zeta \qquad (2)$$

Where γ_i deptict the magnitudes of the effects of the indicators x_i on the construct η, and $\sum_i$ rapresent the summation of the $\gamma_i x_i$ products (with i ranging from 1 to 3 in the model in Figure 2). For this latter, MacKenzie et al. (2011) proposes an alternative to the solely summation view. The authors claim that for some constructs is legit to combine indicators in a compensatory fashion to induce the meaning of the construct in such a way that the effect of each indicator on the construct is independent of the effects of the other indicators; in this structure, a change in one indicator is sufficient (but not necessary) to produce a change in the meaning of the construct. However, this summation approach is not appropriate for all constructs. For some constructs the indicators *are necessary and jointly sufficient for the meaning of the construct* (MacKenzie et al. 2011, p.302), thus suggesting that the construct represents the intersection of, for example in Figure 3, indicator x_1 and indicator x_2 and indicator x_3. Accordingly, a structure of this kind can be practically rapresented through a multiplicative interaction among the indicators; formally representable as:

$$\eta = \prod_i \gamma_i x_i + \zeta \qquad (3)$$

In equation 3 and 4 a disturbance term rapresented by ζ is observable. In a relationship between construct and dimensions seens as casual, ζ rapresent that part of the construct η not explained by the x_i indicators, and thus may be interpreted as measurement error. While in contrast, the x_i are considered as error-free causes of η (MacCallum & Browne 1993). However, the relationship between a construct and a measure is not necessarily causal[3] and a formative construct can be viewed as having a definitional rather than a causal relationship. In a definitional case, no measurement errror ζ would raise as no part of the construct would remain unexplained (Edwards and Bagozzi, 2000).

Either causal or definitional, a major difference between formative and reflective models is the extent to which a measure is required in order to completely represent the construct (Petter et al. 2007). *Dropping a measure from a formative-indicator model may omit a unique part of the conceptual domain and change the meaning of the variable, because the construct is a composite of all the indicators*

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3 According to Edwards and Bagozzi (2000, p.157), four conditions need to be satisfied for establishing causality. *First, causality requires that the cause and the effect are distinct entities. When two variables are not distinct, their relationship is tautological and therefore should not be viewed as causal. Second, causality requires association, meaning that the cause and the effect covary. Association is usually viewed as probabilistic rather than definitional, meaning the cause increases the likelihood of the effect but does not guarantee that the effect will occur. Third, causality requires temporal precedence, such that the cause occurs before the effect. Although causality may be nearly instantaneous at the micromedial level, the cause must precede the effect by some minimal time interval. Finally, causality requires the elimination of rival explanations for the presumed relationship between the cause and the effect.*

(Mackenzie et al. 2005, p. 712). Instead, *under a reflective model, indicators are essentially interchangeable and removing specific reflective indicators does not alter the conceptual domain of the construct and does not cause direct consequences in terms of conceptual misspecification* (Bisbe et al. 2007, p. 800).

Related to the concept of formative and reflective constructs is that of multidimensional constructs. These latter are constructs with more than one dimension, where each dimension can be measured using either reflective or formative indicators (Petter et al., 2007). These multiple dimensions *are grouped under the same multidimensional construct because each dimension represents some portion of the overall latent construct* (Law & Wong 1999, p.144). Mirroring the differences between reflective and formative models, two basic types of epistemic relationship between a multidimensional construct and its lower-order dimensions may be proposed: latent models (also named "reflective second-order models") and emergent models (aslo named "formative second-order models"). *A latent model assumes there is a multidimensional construct that exists at a deeper and more embedded level of abstraction than its dimensions ... a change in the higher-order latent construct is expected to result in changes in all dimensions. …Under a latent model, dimensions are essentially interchangeable and removing specific dimensions does not need to cause direct consequences in terms of specification problems, since dropping a dimension should not necessarily alter the conceptual domain of the construct…Unlike latent multidimensional constructs, emergent multidimensional constructs exist at the same level of abstraction as their dimensions and are defined as combinations of their dimensions. ... Dimensions are not interchangeable and leaving out constitutive dimensions of the higher-order construct may provoke severe specification problems. Omitting a dimension that represents a facet has serious repercussions because it means omitting a part of the multidimensional construct itself…* (Bisbe et al. 2007, p. 804).

In Figure 3, the two types of models, as illustrated by Edwards and Bagozzi (2000), can be seen. The model on the left shows that the effects of the construct ξ on its y_i indicatros are mediated by multiple dimensions, η_j^*. In the model on the right, the x_i indicators induce one or more dimensions η_j^*, which in turn induce the construct of interest, η.

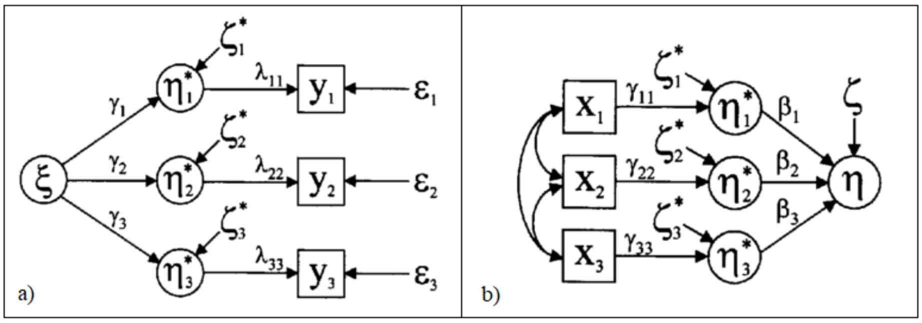

Figure 3 - Diagram of latent (figure a on the left) and emergent model (figure b on the right) (from Edwards and Bagozzi 2000).

As reflective models, latent models can also be illustrated mathematically through a set of equations. One rapresenting the epistemic relationship between dimensions and construct :

$$\eta_j^* = \gamma_j \xi + \zeta_j^* \quad (4)$$

and a second equation rapresenting the relationship between indicators and dimensions, which are in turn sub-constructs (thus, equation 5 is conceptually identical to equation 1):

$$y_i = \lambda_{ij} \eta_j^* + \varepsilon_i \quad (5)$$

In Equation 4, γ_j indicates the effect of the construtct ξ on the dimensions η_j^*, and in Equation 5, λ_{ij} captures the effects of the dimensions η_j^* on the indicators y_i (with i and j ranging from 1 to 3 in Figure 3). Combining Equation 4 and Equation 5, the following can be obtained:

$$y_i = \lambda_{ij} \gamma_j \xi + \lambda_{ij} + \varepsilon_i \quad (6)$$

An important remarks can be gained by observing Equation 6. The relationship between the indicators y_i and the construct ξ are rapresented by the product $\lambda_{ij}\gamma_j$. Therefore, any estimate of the relationships between the construct (ξ) and the indicators (y_i) necessarily confounds the relationships between the construct (ξ) and the dimensions (η_j^*) with the relationships between the dimensions (η_j^*) and the indicators (y_i) (Edwards and Bagozzi 2000).

In a similar manner, also emergent models are presented mathematically by Edwards and Bagozzi (2000) through the set of equations:

$$\eta_j^* = \sum_i \gamma_{ji} x_i + \zeta_j^* \quad (7)$$

and

$$\eta = \sum_j \beta_j \eta_j^* + \zeta \quad (8)$$

Where equation 7 illustrates the relationship between indicators and dimensions (which are sub-constructs and thus equation 7 is conceptualy identical to equation 2), and equation 8 illustrates the relationship between dimensions and construct.

In Equation 7, the γ_{ji} represent the magnitudes of the effects of the indicators x_i on the dimensions η_j^*, and $\sum$ is the summation of the $\gamma_{ji} x_i$ products over i (with i ranging from 1 to 3 in Figure 4). In Equation 8, the β_j indicate the magnitudes of the effects of the dimensions η_j^* on the construct η, and $\sum$ is the summation of the $\beta_j \eta_j^*$ products over j (with j ranging from 1 to 3 in Figure 4). The relationship between the construct (η) and the indicators (x_i) can be further clarified substituting equation 6 into equation 7, obtaining:

$$\eta = \Sigma_j \Sigma_i \beta_j \gamma_{ji} x_i + \Sigma_j \beta_j \zeta_j^* + \zeta \quad (9)$$

Equation 9 shows that the relationship between the indicators (x_i) and the construct (η), is represented by the summation of the $\beta_j \gamma_{ji}$ across all the dimensions (η_j^*). Thus, an estimate of the effect of the indicators (x_i) on the construct (η) confounds the effects of the indicators (x_i) on the dimensions (η_j^*) with the effects of the dimensions (η_j^*) on the construct (η). In addition, variance in the construct is attributable not only to its indicators (x_i) but, when the construct is not seen as definitional (i.e. error-free), also to the distubrances ζ and ζ_j^* .

Since emergent model are a formative second-order models, the multiplicative interaction proposed by MacKenzie et al. (2011) in opposition to the summation approach proposed in equation 7, 8 and 9 is still valid. In multidimensionsal constructs, a summation view on the dimensions suggest that a change in one dimension is sufficient (but not necessary) to produce a change in the meaning of the construct; while a multiplicative view on the dimensions suggests that dimensions are necessary and jointly sufficient for the meaning of the construct.

Having clearly specified the differences between reflective and formative models (as well as between latent and emergent models), should help a researcher to achieve completeness at the conceptual level of PVF through determining the nature and direction of the relationships between a construct and its indicators, or between a construct, its dimensions and its indicators in case of multidimensionality. This task is undertaken at conceptual level, as specifying what is the nature and direction of epistemic relationship should not be based on post hoc empirical evidences (Bisbe et al., 2007). The justification of defininig indicators (and also dimensions in case of multidimensonal constructs) as manifestation or constittue facets of a construct must be conceptually justified (Jarvis et al. 2003); it should be regared as a crucial step, grounded on the conceptual underpinnings of indicators, dimensions and constructs (Edwards and Bagozzi, 2000). The identification of dimensions and indicators as well as the consequent establishment of the domain of the construct, is of a conceptual nature and consequently corresponds to the conceptual level of PVF (i.e. box B in Figure 1) (Bisbe et al., 2007).

Once the conceptual level of the PVF is specified, the research moves from the conceptual to the operational level, where operational definitions (i.e. the specification of the exact operations to be carried out in measuring indicators) are specified and measured (bottom part of Fig. 1) (Bisbe et al. 2007). Operational definition are of salient concern in the PVF as *measured variables often provide the keys to understanding underlying processes that produce the effects of interest* (Libby et al., p 800).

Researchers may opt for three approaches to operationalize constructs into empirical constructs. In case of latent models (i.e. a second-order reflective models), *since* [these] *are realized through their dimenions, ... operationalize is to represent the multidimensional constructs as the common factor underlying the dimensions* (Law et al. 1998, p.750). In case of an emergent model, the researcher can either *define the multi-dimensional construct as an algebric function of its dimensions* (i.e. aggregate approach) *... or ... use different combinations of the dimensions to form various profiles of the multidimensionsal construct* (i.e. profile approach) (law et. al 1998, p. 750).

In the aggregate approach, the overall multidimensional construct is formed as an aggregate (i.e. an algebraic function (Jarvis et al., 2003)) of its dimensions and thus, the dimensions are components of the overall multidimensional construct (Wong et al. 2008). For example, Locke (1969) clearly defined overall job satisfaction as the sum of factors such as satisfaction with pay, promotion, coworkers, the supervisor, and the work itself. Important is, that before a research estimates the operationalization of an emergent construct under an aggregate approach, all its parameters are identified because enough information needs to be available for the estimation of every parameter in the model (Bisbe et al. 2007). Under the profile approach instead, constructs are specified as discrete combinations of various levels of their dimensions because *the dimensions of these multidimensional constructs cannot be combined algebraically* (Law et al., 1998, p. 746). In other words, the nature of a profile multidimensional construct precludes the overall construct from being defined as an algebraic function of its dimensions (Wong et al. 2008) and consequently, the researcher should artificially partition each dimension into discrete levels and state the overall construct as a combination profile of the levels of its dimensions. For example, Jung (1971) proposed a model to define the personality of individuals using four personality dimensions (extraversion–introversion, intuitive–sensing, thinking–feeling, judgmental–perceptual). He then used all possible combinations of the four personality dimensions to form 16 different personality profiles. According to Jung, individuals in each personality profile have totally different orientations and behavioural tendencies in their daily lives.

In this chapter, a framework that provides a description of the process by which an operational measurement model can be derived by a latent constructs was explained. Following the PVF of Figure 1, a questionnaire (the operational measurement instrument of interest in this research) can be developed on a sound theoretical foundation. The questions asked in the questionnaire are not formulated ad hoc. Rather, the questions are deductively derived from explicitly modelled constructs via observable indicators. A researcher is guided from the conceptualization of the construct of interest, through the conceptualized measurement model (i.e. a classification schema that conceptually provides a categorisation for an entity under evaluation) towards the operationalized measurement model (i.e. the definition and measurement of operational variables and the subsequent empirical construct). For this last step of the PVF however, further insights on the development of the operational definitions (i.e. questions) are required in order to drive the researcher towards an optimal choice. The following chapter will address this issue.

2.3 Operationalization of a construct: the measurement instrument

The construction of the measuring devices is perhaps the most important segment of any [empirical] *study. Many well-conceived research studies have never seen the light of day because of flawed measures* (Schoenfeldt 1984, p. 78). Additionally, at the same time, the greatest difficulty in conducting research in organizations is assuring the accuracy of measurement of the constructs under examination (Hinkin 1998).

The main measurement instrument in the social sciences is a questionnaire (Dolnicar & Grün 2007), thus putting deep enough thought into formulating its questions and choosing their correct answer format is needed, or answers to carelessly formulated questions are useless, meaningless and potentially misleading junk (Dolnicar 2013).

A survey question consists of two parts: the query and the return. The query can be a statement or a question. … The return is what respondents return in response to the query. The return can be open, requiring respondents to use their own words when responding. Alternatively, the return can consist of a check, or tick, to one or more response options, or answer options listed in the questionnaire. … Response options can be anticipated, meaning that they contain the kind of answer the survey designer anticipates. The number of anticipated answer options provided to respondents can range from one only to many (Dolnicar 2013, p. 552). Bad choices with respect to these elements can significantly reduce the quality of survey measures which, in turn, will decrease the validity of knowledge developed from a survey study (Dolnicar 2013).

The query may or may not require input from persons other than the researcher. The more the construct under study is perceptual, the more likely is the scholar to seek for support (e.g. interviews or focus groups) in order to size every important aspect that needs to be captured in the query (Dolnicar, 2013). In any case, the key challenge in formulating survey questions is to ensure that respondents interpret them the same way, because as Payne (1980) reports in his experiments[4], minimal wording differences can lead to a consistent variability of interpretation.

Concerning the return, open questions play an important role in survey research because respondents are not influenced. The main advantage of closed questions instead, is that they are more specific because all participants see the same responses (Dolnicar, 2013). Presently, the most popular answer format for maturity models is a five-point Likert scale (De bruin et al. 2005); however, popularity is not a measure of quality, and indeed Rossiter (2011, p. 79) notices that *all the findings in the social sciences based on Likert items … are suspect—and this means the majority of findings!* As for Maturity Model literature, ordinal answer format dominates empirical research in general, however this preeminence is surprising given the methodological problems associated with it. The first problem *concerns the question about "who is making the*

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[4] Payne (1980) reports, for example, that using the word *should* versus the word *might* in the following question: "Do you think anything should/might be done to make it easier for people to pay doctor or hospital bills?" leads to a 19% difference in agreement: 82% say it "should," but only 63% say it "might."

measurements". Measurement presupposes an objective standard…The usual case, however, is that respondents individually answer questions about, for example, the degree to which they agree with one or another statement – and it is hardly tenable that these respondents can be viewed as identically calibrated instruments. In practice, uncalibrated measurement will lead to ambiguous results, and to the impossibility of comparing respondents (Kampen & Swyngedouw 2000, p90). The second problem is the lack of equidistance, that makes it difficult to justify the use of analytic techniques developed for metric data, thus limiting the available methods to those specifically designed for ordinal data. Finally, the last issue is the distributional assumptions typically made for parametric tests, which cannot be tested, as even the existence of an underlying metric variable cannot be proven (Dolnicar & Grün, 2007). Although these several issues with ordinal answer formats identified in the literature, a possible reason for the popularity is its user-friendliness. Preston & Colman (2000) investigated this matter and found that individuals can better express their feelings when a number of categories are offered (e.g. Likert-scale). This is to the disadvantage of perceived speed, which is instead associated with lower numbers of answer categories (e.g. dichotomous).

Measures matter in developing a questionnaire. Even more since saturation of people with survey puts pressure on questionnaire development; the shorter and simpler the questionnaire, the higher the probability that potential respondents will agree to participate, thus potentially reducing response bias and possibly fatigue effects (Dolnicar & Grün, 2007). One way of achieving this is to replace traditionally used ordinal multi-category answer formats (such as Likert scales) with binary scales. This proposition is only attractive if it indeed shortens the survey time while not compromising the quality of managerial insights from the data. A few studies were made in this matter and the results are in favour of the suggestion. Grassi et al. (2007) compared a binary and a Likert-scale version of a standardised health survey, concluding that *despite the loss of information due to the reduction of response's possibility, our results indicate that … the binary recoding ensure the [original] underlying structure … is not jeopardized. In addition, it meets at least the same required standards, giving the possibility to propose a new version of smarter and easier methodology of administration, compilation, score calculation, and data processing* (Grassi et al. 2007, p.487). Or similarly, Dolnicar et al. (2011) investigate the two answer formats (i.e. binary and Likert-scale) concluding that *(1) the binary format led to equally reliable results; (2) managerial interpretations based on typical managerial analyses would not differ; (3) the binary format saved respondent time; and (4) the binary format was perceived as simpler* (Dolnicar et al. 2011, p.247) and that *binary format outperforms ordinal multi-category formats with respect to survey efficiency, without generating different results from a typical positioning analysis point of view* (Dolnicar et al. 2011, p.247). Or finally, Komorita and Graham (1965, p. 989) after the comparison of reliability and validity measures conclude that *the major implication is that, because of simplicity and convenience in administration and scoring, all inventories and scales ought to use a dichotomous … scoring scheme.*

In this chapter, the formulation of survey questions, and specifically the choice of a correct answer format, was discussed. Despite the popularity of five-point Likert scale answer format, the methodological problems associated with it were addressed. Additionally, it was noticed the nowadays saturation of people with surveys and the consequent pressure that a researcher has to develop short and simple questionnaires to obtain a high response rate and potentially reduce response bias and possibly fatigue effects. One way to avoid these two issues, was found in replacing traditionally used ordinal multi-category answer formats (such as Likert scales) with binary scales. Several studies were reported as having found at least the same required standards when using binary scales instead of Likert scales, and thus this configuration is suggested and will be use in the operational measurement instrument developed in this study.

2.4 The (cumulative) stage model theory, a ground for maturity development models

As stated in the introduction, this research aims to establish a maturity development model for Enterprise Risk Management System in Austrian non-financial Enterprise in order to support entities in overcoming the ERM development challenge. In chapters 2.2 and 2.3, before a framework to solve the methodology gap for measurement model development was presented. Then, a further discussion on the development of the operational definitions was reported. These two are needed to correctly develop the measurement instrument to assess the as-is situation of entities under examination. In this chapter, we will engage in the discussion on how to gain control of enterprise risk management practices (i.e. the development issue of considered entities).

2.3.1 Stage model theory

As presented during the literature review, (enterprise) *risk maturity models suggest that organizations could progress in the implementation of risk management practices through stages sequentially followed. This assumes a process of development, wherein the entity experiences a transformation from an immature application of a discipline to an optimal application in the organization* (Cienfuegos, p. 85). These principles can be traced back to the theories on stage models.

Stage models are one specific class of development model… [They] *describe and explain change. They trace the condition or activities trough trasformations across time period…. and always describe discontinuos processes. In a stage model, change is characterized as a fixed sequence of static and deterministic stages, separated by predictable, programmed … trasformations* (Stubbart & Smalley 1999, p.274). These models support the evolution of an entity as they emphasize the direction of change through which perfection can be increased over time, ultimately reaching an end state (Damsgaard and Scheepers, 2000). To support this developent, or growth, Solli-Sæther & Gottschalk (2010) suggest that the stages in this type of models should be *(1) sequential in nature, (2) occur as a hierarchical progression that is not easily reversed, and (3) involve a broad range of organizational activities and structures* (Solli-Sæther & Gottschalk, 2010 p. 3).

2.3.2 Maturity (development) model

Based on these assumptions of predictable patterns and stage models, maturity models developed, representing how organizational capabilities evolve in a stage-by-stage manner along an anticipated, desired, or logical maturation path (Pöppelbuß & Röglinger 2011). Although some authors argue that multiple paths through the stages might exist, contrary to linear progress through stages, Kazanjian (1988) applied dominant problems to maturity models. Dominant problems imply that there is a pattern of primary concerns that firms face for each theorized stage. Either implicitly or explicitly, stages of growth models share a common underlying logic: o*rganizations undergo transformations in their design characteristics which enable them to face new tasks or problems that growth elicits. The problems, tasks or environments may differ from model to model, but almost all suggest that stages emerge in a well defined sequence such that the solution of one set of problems or tasks leads to a new set of problems or emerging tasks which the organization must address* (Kazanjian & Drazin 1989, p.1489).

With maturity models representing theories of evolution in a stage-by-stage manner, their basic scope consists of describing stages and maturation paths (Pöppelbuß & Röglinger, 2011). Accordingly, characteristics for each stage and the logical relationship between consecutive stages need to be explicated (Kuznets 1965). For their practical application, maturity models are expected to acknowledge current and desirable maturity state and to include respective improvement measures. The intent is to diagnose and eliminate deficient capabilities (Pöppelbuß & Röglinger, 2011). Rummler and Brache (1990) indeed metaphorically refer to such tools as *roadmaps* for guiding organizations. Formally, De Bruin et al. (2005, p.2) distinguished the application-specific purposes of maturity model use in *descriptive, prescriptive or comparative in nature. If a model is purely descriptive, the application of the model would be seen as single point encounters with no provision for improving maturity or providing relationships to performance. This type of model is good for assessing the here-and-now i.e. the as-is situation…. A prescriptive model provides emphasis on the domain relationships to business performance and indicates how to approach maturity improvement in order to positively affect business value i.e. enables the development of a roadmap for improvement…. A comparative model enables benchmarking across industries or regions. A model of this nature would be able to compare similar practices across organizations in order to benchmark maturity within disparate industries. …*

Determine the purposes of the desired model (i.e. descriptive, comparative od development) is the first of six phases in developing a maturity model, identified by De Bruin et al. (2005) in their generic (standard) model development framework for MM. This proposed framework intend to guide the design of a descriptive maturity model and its advancement for prescriptive and comparative purposes.The phases of the De Bruin et al. (2005) framework are: scope, design, populate, test, deploy and maintain. The first phase is to determine the scope of the desired model, deciding the focus of the model. Focus refers to which domain the maturity model would be targeted and applied. With the initial focus of the model identified, stakeholders from academia, industry, non-profits and government can be identified to assist in the development of the model. The second phase of the proposed framework is to determine a design or architecture for the model; this is of particular importance as in this phase the needs of the intended audience are defined and how these needs will be met. Once the scope and design of the model are agreed, the content of the model must be decided. In this phase it is identified *what* needs to be measured in the maturity assessment and *how* this can be measured. Once a model is populated, it must be tested for relevance and rigor. Following population and testing, the model must be made available for use and to verify the extent of the model's generalisability. Finally, evolution of the model will occur as the domain knowledge and model understanding broadens and deepens and thus, it needs to be maintained.

In connection with the theory-based empirical research, the scope and design phases are of special importance. The latter, identifies the principles of form and function that maturity models should meet (Pöppelbuß & Röglinger). T*he model design … needs to strike an appropriate balance between an often complex reality and model simplicity. A model that is oversimplified may not adequately reflect the complexities of the domain and may not provide sufficient meaningful information for the audience. Whilst a model that appears too complicated may limit interest or create confusion. In addition, a model that is too complicated raises the potential for incorrect application resulting in misleading outcomes* (de Bruin et al. 2005, p.12). In order to avoid these issues, design principles for the development of maturity models should be followed. Pöppelbuß & Röglinger (2011), De Bruin et al. (2005) and Johansson et al. (2008) suggest four main principles to follow: (1) to represent maturity as a number of cumulative stages, (2) to hierarchically structure MM into multiple layers referring to different levels of granularity of maturation, (3) to operationalize maturity in a multi-dimensional manner and (4) to ensure that maturity levels architecture follow the stage-gate approach:

(1) *A common design principle is to represent maturity as a number of cumulative stages where higher stages build on the requirements of lower stages with 5 representing high maturity and 1 low. This practice was made popular by the CMM and appears to have wide practical acceptance. … Stages should also be named with short labels that give a clear indication of the intent of the stage. (de Bruin et al. 2005, p.4).*

(2) *Maturity models can be structured hierarchically into multiple layers referring to different levels of granularity of maturation. A high level of abstraction provides a simple means for comparing and documenting maturity levels (e.g. on corporate level) … A lower level of abstraction, in contrast, enables to cope with maturity within complex domains and provides better help with choosing among improvement measures. … Maturity models following a descriptive purpose of use need to propose assessment criteria for each available level of granularity… Maturity models following a prescriptive purpose of use need to include improvement measures for each available level of granularity* (Pöppelbuß & Röglinger 2011, p. 8). This approach[5] removes the potential for losing

[5] This approach is named "stage-gate" by de Bruin et al. (2005). However, in this research it was preferred to report the definition of Pöppelbuß & Röglinger (2011) to

insight and context from only viewing a single rolled-up figure (de Bruin et al. 2005).

(3) With maturation as primary subject matter, maturity models are required to define constructs associated to maturity and maturation (Becker et al. 2010). It has to be defined what maturity means in relation to the application domain under investigation. *Such an explication may be one-dimensional. Many maturity models, however, operationalize maturity in a multi-dimensional manner…. A multi- dimensional approach facilitates the definition of assessment criteria for a descriptive purpose of use and the classification of improvement measures for a prescriptive purpose of use* (Pöppelbuß & Röglinger 2011, p.7).

(4) The idea of the gated maturity assessment is to support the assessment and evaluation of the level of maturity through a stage-gate process (Johansson et al. 2008). The stage-gate concept was originated by Cooper (1990) in the field of innovation management. He defined the stage-gate system as a process *subdivided into a number of stages.... Between each stage, there is a quality control checkpoint or gate. A set of deliverables is specified for each gate, as is a set of criteria* [that must be passed]… *before moving to the next work station. The stages are where the work is done; the gates ensure that the quality is sufficient* (Cooper 1990, p.46). Similarly, Johansson et al. (2008) suggest that in a maturity assessment, an entity should remain at a defined level until all the attributes defined at that level (i.e. the "sufficient quality" as defined by Cooper (1990)) are achieved. Assessing maturity using a gated assessment technique is *essentially about comparing the 'as-is' level with a predefined 'pass profile' (i.e. 'to-be') on the components that are being assessed* (Johansson et al. 2008, p. 5). The pass profile is a combination of the necessary conditions required for an entity to develop on the maturity scale. Once all the necessary conditions are reached, the sufficient condition to pass the gate is achieved. In Figure 4 an overview of a stage-gate system of Cooper (1990) adapted to the maturity model concept is visible.

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not confuse the reader with the design principle (4), which is instead named "stage-gate".

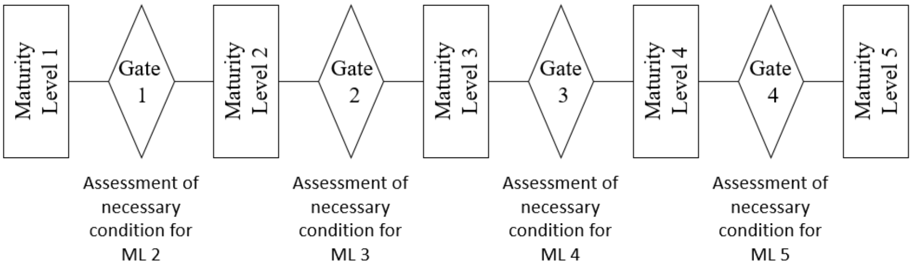

Figure 4 - Overview of the stage-gate system of Cooper (1990) adapted to the maturity model concept

In this chapter, guidance to correctly address a stage model were collected and presented as it is important to avoid the problems often found in stage model applications: *many of the published stage models were presented without defining their stages, without showing evidence of transformations, without explaining the use of stages, and apparently without understanding fully the pitfalls of stage models* (Stubbart & Smalley 1999, p.284). From stage models, the concept of maturational process was broadened, including the research on maturity models. Adding the notion of descriptive, comparative and prescriptive models, as well as the design principles for the development of maturity models, a researcher has a sound theoretical basis to establish a development model.

Having examined the predictive validity framework as well as the maturity model theory, the following chapter will discuss their application into the enterprise risk management context.

3. ERMMA ERM-System maturity development model

Following the predictive validity framework, the first task in building a survey is not to start with the specification of questions. Instead, the conceptual model underlying the construct to be measured has to be specified first. In order to be able to specify a conceptual model the requirements of the model have to be determined. This occurs in the scope and design phases of the maturity model development framework from De Bruin et al. (2005). Once these stages have been performed, it has been clarified that the ERM system maturity model to be specified should:

- be based upon a comprehensive (i.e. multi-perspective) view upon the ERM system that has as primary audience the top management (including the top supervisory entity) of all firms in the non-financial industry;.
- represent maturity as a number of cumulative stages;
- be hierarchically structured into multiple layers, so that more granular maturity assessments can be derived for other audiences as well;
- include descriptive, comparative and prescriptive model characteristics, so that it can be used by the firm to diagnostically assess its current as-is

maturity level, to get a roadmap for improvement to the to-be level and to allow a comparative benchmarking with other firms;

- ensure that the maturity levels architecture follows the stage-gate approach;
- avoid the circular reasoning pitfall[6], so that it can be used for causal investigations in explorative statistical analyses to find drivers of the maturity levels;
- define cumulative attributes within each stage, so that the meaning of the progressions in the maturity levels are determined by design and not interpreted by the respondents of the survey;
- define binary attributes for better understanding and increased answering stability.

A maturity model with all these characteristics, would be an advancement of a prescriptive model, and thus named *development model*.

In order to define the ERM system conceptual measurement model, Enterprise Risk Management standards, as well as academic articles and reports written by researchers, practitioners and consultancy firms in the area of risk management were reviewed. Ultimately suggesting the ERM system construct to be defined upon three dimensions (i.e. ERM-Governance, ERM system and Risk-based planning and control system), each of them formed by three sub-dimensions (Figure 5). Clearly, the relationship between dimensions and construct (as well as sub-dimensions and dimensions and later indicators and sub-dimensions) is not seen as causal but rather definitional. Thus, no measurement error is assumed to raise, as no part of the construct remains unexplained

The first dimension is ERM-Governance: the direction and control of Enterprise risk management. *Risk Governance sets the organization's tone, reinforcing the importance of, and establishing oversight responsibilities for, enterprise risk management* (COSO 2017). It provides the structure of the risk management system and specifies responsibilities, authority, and accountability in the risk management system as well as the rules and procedures for making decisions in risk management (Lundqvist 2015). Enterprise risk governance is intended in this study as the combination of risk strategy, risk understanding and risk organization and it is a central identifying component of an enterprise risk management. Enterprise risk governance is about encouraging a culture of risk-awareness throughout the firm, having an organizational structure to support the risk management system, and having in place governance mechanisms to oversee the system in a formal manner (Lundqvist 2015).

The second dimension is the RM system: the risk management system (itself), supported by adequate skills and a suitable risk information system. The enterprise risk management system is an iterative and structured process that includes two parts: the sequence of logical steps often referred to as the *risk management process* (i.e.

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[6] As explained by Stubbart & Smalley (1999, pp.278–279), *a tautology occurs when stages are used to "explain" observations which are actually features of the stages themselves. For example, you can't explain your son's "defiance of authority" by the fact that he is a teenager, if defiance of authority is one of the characteristics that defines "teenager".*

determining the objectives of risk management, identifying the risks, evaluating the risks, considering alternatives and selecting the risk treatment devices and implementing and reviewing the risk management program) (Cienfuegos 2013) as well as coordination efforts to include the whole enterprise. However, this cannot be achieved without the support of adequate skills, because education of managers is, in reality, a key enabler for the implementation of advanced RM systems. As Colquitt et al. (1999) reports in fact, there are statistically significant differences between companies using and non-using advanced risk management tools based on management qualification, and they emphasize how *the already important role of risk management in organizations will become even more critical as the movement toward an enterprise view of risk management continues* (Colquitt et al. 1999, p. 55). Lastly, Babaliyev (2012) notices how the management of risk data and information is key to the success of any risk management effort regardless of an organization's size or industry sector. Agreeing on this matter, risk management information system makes the last sub-dimension of ERM system. These systems support expert advice and cost-effective information management solutions around the RM system.

Finally, the third area is the Risk-based planning and control system: the capability of the firm to plan and control its risk at strategic, business performance and process level. At the lowest level, the operational processes are planned and controlled, focusing on what Kaplan & Mikes (2014) define as preventable risks. At business performance level, the management has to understand the characteristics of the strategy execution risks (Kaplan & Mikes 2014), those risks, which are now connected also with chances, that have to be taken into account in order to generate superior returns for the enterprise. Finally, at the strategic level, the risk has to be considered within a long-term perspective, focusing on the external risks (Kaplan & Mikes 2014), which are here connected with chances as at business performance level, but cannot be influenced by the firm.

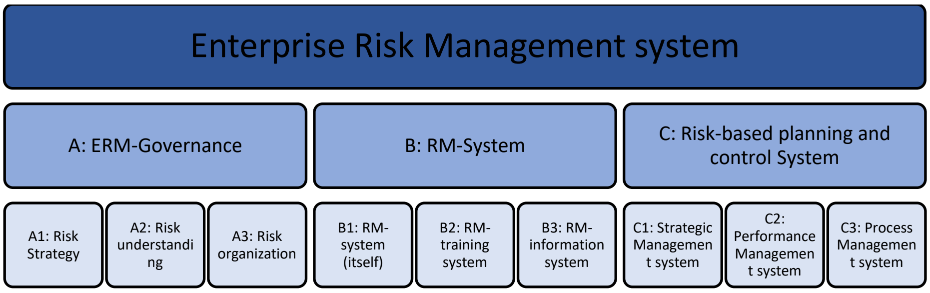

Figure 5 - Dimensions and sub-dimensions of the Enterprise Risk Management system (i.e. the ERMMA model)

In attempting to describe the dimensions and sub-dimensions that represents a construct, it is important to pay attention to *the degree to which* [those] *items … reflect the content universe to which the instrument will be generalized* (Straub & David 2004, p.424), i.e. the content validity issue. Bisbe et al. (2007, p.812), define content validity as the *degree to which a measure covers the relevant domain of a construct or its range* *of meanings.* It is a definitional issue and concern the matter of capturing the extent to which an operationalization captures the relevant domain of a construct. The previous attempt of describing the ERM system construct as a combination of ERM-Governance, Risk Management system and Risk-based planning and control system, needs to be justified as representing all facets of the construct. In this matter, the COSO (2017) framework provides the theoretical foundation for the selection of these dimensions. The Commission of Sponsoring Organization of Tread way (COSO) was formed as a joint effort of five international private sector organizations[7]. COSO ERM is one of the most widely cited frameworks among the academic researchers (Boatright, 2011; Cienfuegos, 2013; Manab et al., 2012; Monda & Giorgino, 2013; O'Donnell, 2005). According to COSO (2017), governance is the first pillar of foundation for ERM, it is defined as *the organization's tone, reinforcing the importance of, and establishing oversight responsibilities for, enterprise risk management* (COSO 2017, p. 6). Secondly, identifying and managing risk entity-wide (i.e. RM system dimension) is a clear purpose of COSO (2017)[8]: *Every entity faces myriad risks that can affect many parts of the organization. Sometimes a risk can originate in one part of the entity but impact a different part. Consequently, management identifies and manages these entity-wide risks to sustain and improve performance* (COSO 2017, p. 3). Finally, COSO (2017) suggest to integrate ERM into the existing systems (i.e. Risk-based planning and control System dimension); risk shall be *evaluated primarily in relation to its potential effect on an already-determined strategy. In other words, the discussions focus on risks to the existing strategy: We have a strategy in place, what could affect the relevance and viability of our strategy?* (COSO 2017, p. 4).

The approach of organizations towards the management of enterprise risk as previously defined, can be categorized into groups that range from those who have no formal process, to organizations where enterprise risk management is fully integrated into the business (Hillson 1997). In order to reflect this concept with clarity, the ERM classification scheme here proposed, includes five levels of risk maturity (Figure 6).

At the bottom, we find the 'silo-centric' management systems (ISO 31000:2011) where the different departments and functions are seen as closed doors, managing risk in an atomistic way. In this perspective, the responsibility of handling a specific risk is assigned to the units "threatened" by the risk (Cienfuegos 2013). Companies classified as having this approach would be sharing little of information and even less sharing techniques and methodologies with other functions and departments of the firm (Drennan and McConnell, 2007). Moving further in the maturity levels, the silo perspective is replaced by a more holistic approach to risk management that

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[7] The five private sector organisations are the American Accounting Association (AAA), the American Institute of Certified Public Accountant (AICPA), Financial Executives International (FEI), the Institute of Internal Auditors (IIA) and the Institute of Management Accountants (IMA).

[8] COSO (2017) provides a strong reference in regards of RM system concerning the management of risk in an entity-wide manner. However, this advanced approach of risk management is in the ERMMA maturity model addressed from the 3rd level of maturity. Thus, for the lower maturity levels that refer to the risk management process (including silo-oriented risk management), a strong contribution of the ISO standard (ISO-RM 2011) is included.

proactively increases the organizational performance, as suggested by the COSO framework (2017). At this level of maturity, risk management becomes a wider Enterprise risk management, which aligns strategy, processes, technology, people and knowledge with the objective of assessing and managing threats and opportunities that firms face in creating value (Cienfuegos 2013). Under this perspective, there is a more centralized risk management function that directs the management of the risk management policy of the entity. This integrated perspective of risk management assumes that whether at the planning stage, during the development of a new project or as a part of day to day operational management, risk needs to be managed in an integrated way, encompassing potential threats in each level of the organization (Drennan and McConnell, 2007). Finally, the highest maturity for an organization is reached when single- and double-loop learning (Simons 1990) capabilities are developed. Single and double loop learning is related to the execution of the strategy according to plan. In the single loop learning managers receives and incorporate feedbacks regarding their planned risk strategy and if it's executed according to plan; these feedbacks are used to make corrective actions and adjust the execution process. Double loop learning is a further development of a single loop. Next to the corrective control inputs, managers question their underlying assumption and reflect upon the theory under which they are operating remains consistent with current evidences, observations and experience. Managers need information to question whether the fundamental assumptions made when they launched the strategy are valid (Kaplan & Norton 1996).

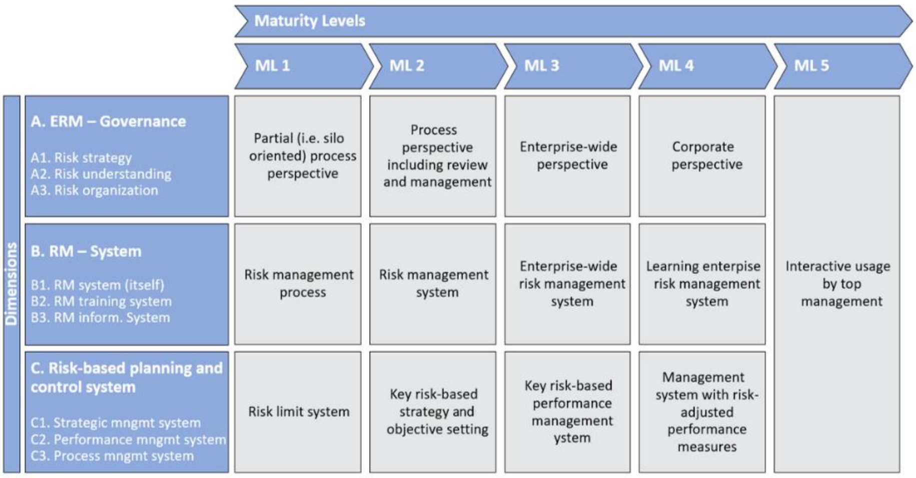


Figure 6 - ERMMA classification schema (i.e. a 5-stage maturity model)

The next step in the predictive validity framework is the translation of the ERMMA classification schema, which explicitly specifies the observable and named indicators, into operational variables (i.e. attributes). The result of this transformation step is the corresponding ERMMA attribute schema. This schema contains the binary, cumulative attributes for all nine sub-dimensions of the ERMMA classification schema.

Exemplarily, the transformation from the risk management process (ML1) in the RM-System (B1) to the risk management systems (ML2) is taken for illustration purposes. This transformation is defined according to the distinction between the risk management process and the risk management framework in the ISO 31000 Risk Management standard (2009), where the framework governs the risk management process by monitoring and adjusting it over time to ensure its effectiveness (Figure 7).

In order to assure independency from specific industry requirements, only functional (e.g. management function) and conceptual (e.g. risk aggregation) attributes and no institutional (e.g. manager) and technical (e.g. Monte Carlo simulation) attributes are used.

Note that the inclusion of binary attributes constitutes an important deviation from the traditional maturity assessment approach. In fact, all the maturity models mentioned during the literature review, with Hillson (1997) as only exception, are *latent model types*, as defined in the predictive validity framework. That means that the (E)RM constructs defined there are seen as underlying constructs that appear in form of the correspondingly defined indicators. With the attribute-based approach taken in this survey study instead, the ERM system construct gets explicitly defined via the indicators specified in its dimensions. As such the ERM system construct is not a latent, but an explicitly defined construct and correspondingly of an *emergent model type*.

ML 1	ML 2	ML 3	ML 4	ML 5
B.1 Risk management (RM-Process)	**B.1 Risk management (RM-System)**	**B.1 Risk management (E-wide RM System)**	**B.1 Risk management (Learning RM System)**	**B.1 Risk management (Debated RM System)**
1. RM Process is partially documented +1a. Risk identification +1b. Risk assessment +1c. Risk mitigation	1. docum. RM System exist because of docum. RM Process with Monitoring (+1a, +1b, +1c) +1d. Implementation of Monitoring	1. E-wide coordinated RM System is documented (+1a', +1b',+1c',1d') +1e. ERMgr coordinates the RM System	1. documented ERM system exists by incorporation of enterprise-wide risk aggregation (+1a', +1b',+1c',1d',+1e) +1f. ERMgr coordinates the Risk aggregation	1. Audited ERM-System is debated and discussed (according to culture and impact) (+1a',+1b',+1c',1d',+1e,+1f) +1g. Top Management debates and discusses the ERM
2. RM Process is not reviewed	2. RM System is reviewed (regarding its appropriateness) +2a. IA (or other instances) performs the review	2. Reviewed E-wide RM System +2a´. IA review	2. Reviewed ERM System +2a´´. IA review +2b. IA includes realized risks in the review +2c. Internal audit includes unrealized opportunities in the review	2. (+2a´´, 2b, 2c)

Figure 7 - ERMMA attribute schema. Example of the B1 sub-dimension: Risk Management System. Note that the apostrophes identify those attributes that are a development of previous one in the conception of the new maturity level (e.g. 2a, 2a' and 2a'')

The attribute in the the ERMMA attribute schema are seen as binary, as each item can either be or not-be in place in the entity under assessment. The binary measurement of dichotomous indicator variables allows a precise measurement with respect to the intended indicators as it restricts the answer choice to the respondent and gives a lower base level instability (Dolnicar & Grün 2007) in compare to polytomously defined variable (e.g. traditional Likert-scales). Additionally, this binary structure ensures the maturity assessment to follow the stage-gate approach. To move throughout the maturity levels, all the attributes (i.e. the necessary conditions) needs to be in place for each level. This would ensure the sufficient condition to pass the gate to be reached. All attributes of each maturity level are necessary and jointly sufficient conditions for the development through the maturity model.

Finally, the cumulative binary attribute arrangement allows the precise setting of attribute sets for delineating the five maturity stages and thus establishing a layered maturity model that *enables the provision of more differentiated maturity assessments within complex domains…by providing additional layers of detail that enable separate maturity assessments for a number of discrete areas, in addition to an overall assessment for the entity. These layers can be represented by the domain, domain components* (dimensions) *and sub-components* (sub-dimensions) (de Bruin et al. 2005, p.4).

3.1 Survey Methodology: translating binary attributes into an intelligent questionnaire

After having explicitly defined the binary ERMMA attribute schema, it can be translated into questions[9] to build the questionnaire for the ERMMA survey. An entity, answering all the proposed questions undertake the assessment of the 'as-is' situation, ultimately summarized by a maturity score. Following de Bruin (2009), in calculating the maturity score a bottom-up approach was used, calculating scores at lowest level and then rolling these up to provide scores at higher level. This means that the scores for each sub-dimension are combined to give a score for each dimension, and that the scores for the three dimensions are combine to provide an overall score assessment (as seen in Figure 8). This additional granularity removes the potential for losing insights and context from only viewing a single rolled-up figure. Equal weighting was applied to each sub-dimension as well as to all dimensions as there was no clear reason that any one was more or less significant than the other.

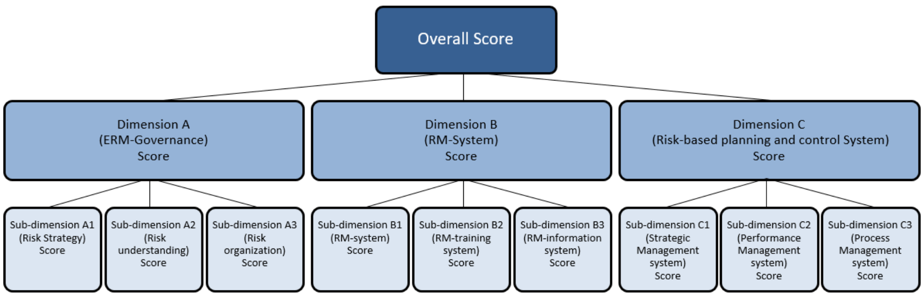


Figure 8 - Calculation of layered Maturity Score

[9] Questions in the ERMMA questionnaires are statements to be answered with a Boolean logic

Table 2 shows a sample of subsequent questions for the sub-dimension B1 Risk Management System.

#	Questions and multiple answers	Maturity Level	Indicator
1	The identification of risks is documented for		
	○ Selected areas of the company (e.g. production, logistics, finance, ...)	1	B1.1a
	○ All important areas with different methods (e.g. top-down and bottom-up)	3	B1.1a

Table 2 - Extract of ERMMA questionnaire, questions regarding sub-dimension Risk Management System.

The ERMMA questionnaire was available on-line on the ERMMA online application, developed upon a modern web-based 3-tier information technology. Differently from a traditional questionnaire design, where all respondents get the same questions in the same order, the ERMMA questionnaire is an "intelligent questionnaire" as the questions proposed to the participant depend on the previous answers given. Such intelligence is enabled by the multi-dimensional layered structure of the ERMMA attributes, which permit a flexible navigation through the ERMMA questionnaire. From an IT perspective, the intelligence of the questionnaire is implemented by a branch-and-cut mechanism that is used for the hierarchical single label classification that guides the application intelligently through the questions by taking into account the answers given.

In Figure 9 a sample of screen shots from the ERMMA online are presented. The panel on the left shows the homepage of the ERMMA online application. With the left-sided button the registration can be started. After registration, the survey can be started by pressing the right-side button. The panel on the right shows an introductory question to the ERMMA questionnaire.

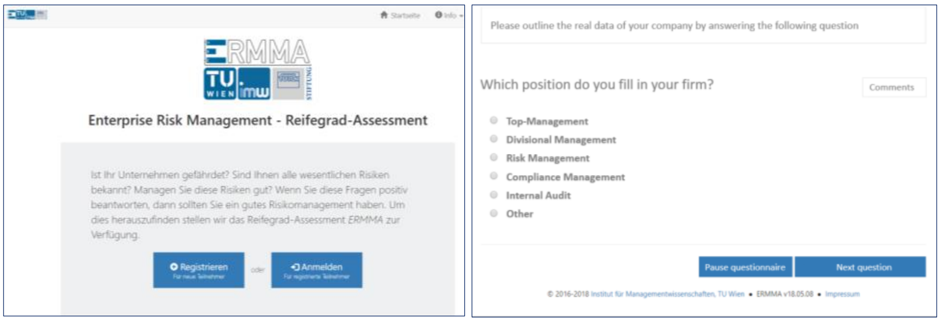


Figure 9 - ERMMA online - sample of screen shots

The maturity score previously described is also provided to each participating firm in form of feedback format after submitting the ERMMA questionnaire.

Exemplarily, in Figure 10 a firm with a quite good overall ERMMA maturity score of 2.44 (blue box) is taken for illustration.

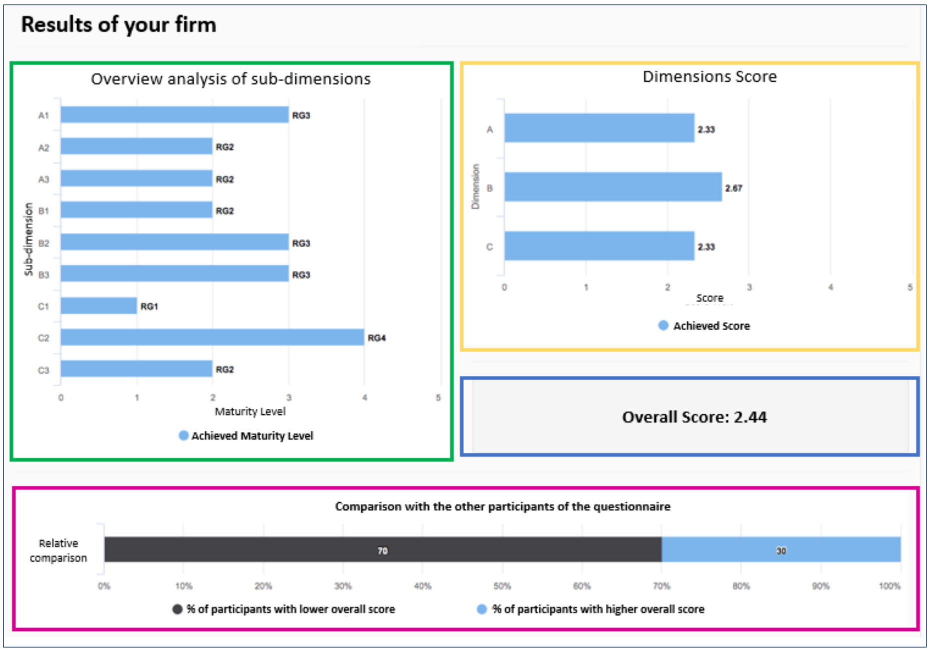


Figure 10 - Feedback format for participants of ERMMA questionnaire. In green is highlighted the ERMMA profile, in yellow the aggregated scores and in violet the comparison with other participants

The overall score is the most aggregated feedback information the participants get. The three bars in the yellow box are the scores that the firm reached in the three dimensions. Compared to the overall score they deliver additional information by showing the ERMMA scoring results in less condensed form. The finest granularity of score information is given in the nine bars in the green box. They are called "ERMMA profile" and they give the most complete picture of the as-is maturity stages.

In addition, the feedback format provides information regarding the comparative benchmarking with other firms (i.e. the comparative purpose of the maturity model). This is visible in the violet box of Figure 10. From this, it can be seen that 70% of the survey participants have a lower score that this exemplary firm.

As firms differ among each other, they might have different to-be plans for the specific shape of the ERMMA profile, i.e. ERMMA profile target. So when monitored the profile over time, the focus might lie on the development of only specific and not all sub-dimensions. The roadmap information for improvements in all nine sub-dimensions is given to the participants as well (i.e. the prescriptive purpose of the ERMMA model). This information specifies all reached attributes as well as the attributes to be achieved in order to progress to the next maturity stage. An example is provided in Figure 11.

Analysis for Dimension B: ERM - System			Score : 2.67
Sub-Dimension	**Achieved ML**	**Achieved Content**	**To-be achieved Content for higher ML**
B1 : Risk management	**ML 3**	✓ A risk management system is integrated in all key business units	✗ The learning (e.g. Review) ERM system aggregates risks across the enterprise
B2 : RM Training system	**ML 1**	✓ The required competences of the responsible person for the risk management process are ensured by training courses	✗ The required competences of the responsible person for the risk management system are ensured by training courses
B2 : RM Information system	**ML 4**	✓ The risk management software aggregates risks throughout the entire group	✗ The Top-Management regularly questions the appropriateness of the risk management software with the supervisory board

Figure 11 – Exemplary roadmap information for improvement

4. Survey Results: a sample of Austrian non-financial enterprises

The ERMMA survey closed at the end of September 2017. In the ERMMA questionnaire also exploratory questions with respect to exploratory variables (e.g. size of the firm) were included next to the attribute questions used to measure the ERM system maturity levels. In this chapter, an overview of the results in a sample of Austrian enterprises will be presented, obtaining information concerning the implementation of enterprise risk management best practices in these entities. Next to descriptive results, also explanatory statistical analyses aiming to investigate the drivers of ERM system development will be shown.

4.1 Reach

The questionnaire was first promoted through the main project sponsor, the *Funk Foundation*, a German Foundation (operating also in Austria) that promotes primarily scientific and practice-oriented projects in the field of risk management. Then the questionnaire went on to be distributed through *Creditreform*, a firm that provides an international expert network for credit reporting and debt collection services, and finally the Vienna university of technology (TU Wien) own network was used to reach out further participants. This distribution method is reflected in the constituency reached, in that there is, for example, a limited response rate from Vienna-far regions (Figure 12), where the influence of the sponsors and the reputation of TU Wien is weaker. The lack of responses from Burgenland is maybe due to a number of factors: the distribution networks not reaching this region, the actual lower number of firms in this area, or a general lack of awareness of risk management in the region. Still, it was found that with the numbers of returns, we received a meaningful number of people interested in the domain. The survey questionnaire was available, with a few interruptions, for 11 months: from November 2016 until September 2017. After removal of incomplete responses (30% of the total), we analyzed answers from 61 participants.

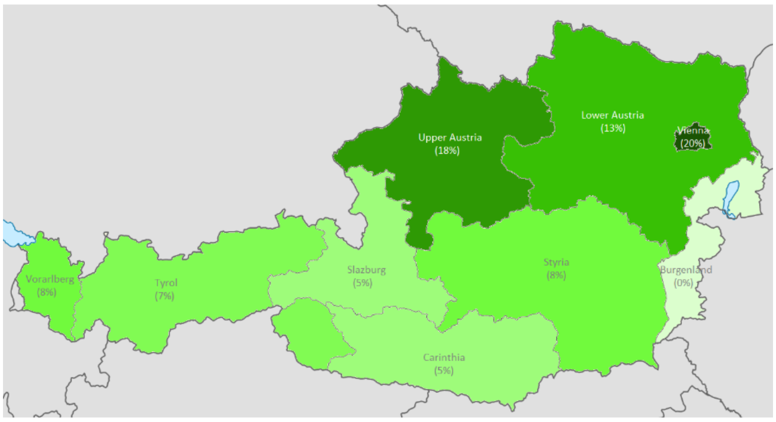


Figure 12 - Geographic distribution of responses (the darker the colour, the higher the number of respondents)

4.2 Participants

Although an equal promotion of the questionnaire to all the sectors was sought, a significantly higher response from the manufacturing sector was received (22 respondents and 36% of the total), followed by service providers (16%), construction companies (11%), logistic (10%), utility and wholesale (8%), retail (5%) and others (5%). Small companies were founded more interest in the research than big ones, with 26% of the participating firms having less than 49 employees, 21% with 49 to 499 employees, 16% with 500 to 999 employees, 18% with 1000 to 4999 employees and 18% with more than 5000 employees.

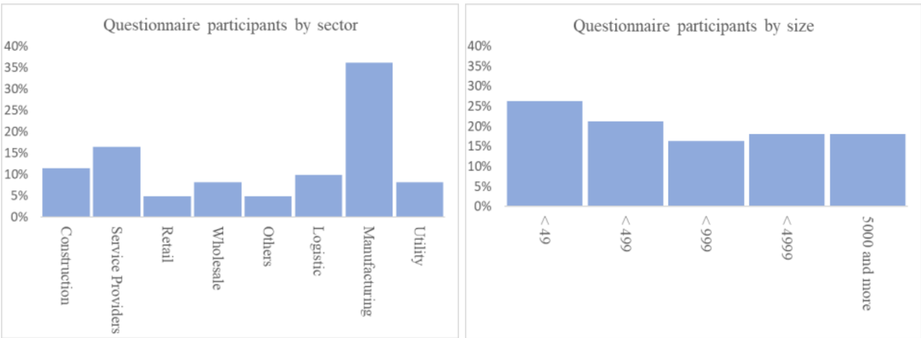


Figure 13 - Questionnaire participants a) by sector b) by size

Conforming to Figure 13b (i.e. most respondents are small firms), the largest groups of our sample were firms with a turnover lower than 50 million euros (43%), and 36% those with more than 250 million of turnover (as 36% are the participating firms with more than 1000 employees). The most common legal form in the sample is the limited liability company (69%), which is in contrast with the data from the WKO that named in 2018 *individual companies* as the most common legal form among Austrian firms (WKO 2018) (this latter account for just 3% of our sample), but makes sense because individual companies are such small businesses that are not interested in enterprise risk management, rather limited liability companies and public limited companies (this latter account for 25% of our sample) are more complex and require more attention on enterprise risk management.

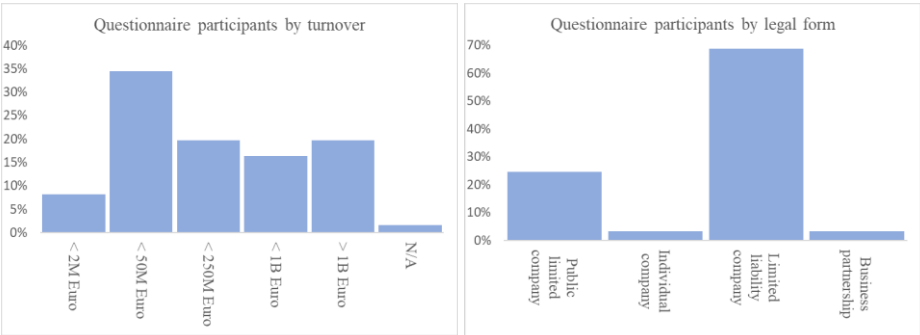


Figure 14 - Questionnaire participants a) by turnover b) by legal form

A further demographic characteristic collected, regards the years since Compliance Management (CM), Internal control system (ICS), Internal Audit (IA) and Risk Management (RM) are established. Interestingly, ICS is commonly implemented since long time (57% of the participating firms established it more than 5 years ago). Also risk management and internal audit are implement from almost half of the firms since more than 5 years (precisely 49% of the participating firms in both risk management and internal audit), even though the latter is still not implemented from 33% of the firms. CM instead, is not implemented from 30% of the participating firms, is implemented since just 1 year from 8% of the firms, since 3 years by 21% of the firms, since 5 years by 13% of the firms and about one-third (28%) of the participating firms implemented CM more than 5 years ago.

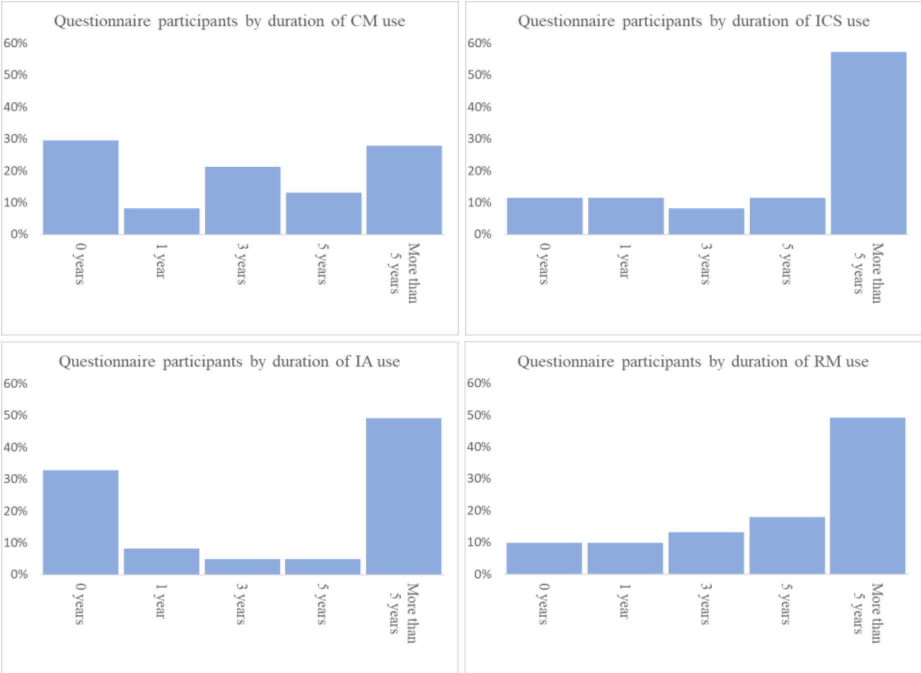


Figure 15 - Questionnaire participants a) by Compliance Management (CM) b) by Internal control system (ICS) c) by Internal Audit (IA) d) by Risk Management (RM).

4.3 Descriptive statistics

The ERMMA questionnaire resulted in the calculation of quantifiable maturity scores for each responding firm. Figure 16 shows the distribution of ERMMA maturity score achieved by all responding firms that completed the questionnaire. As indicated earlier, the overall score has been calculated by averaging responses from the three dimensions/nine sub-dimensions: 0 reflects low maturity and 5 high maturity. The line in the middle of the box indicates the median (second quartile) amounting to 1.33. The 1st quartile is 0.73 and the 4th quartile is 1.95. The minimum and maximum scores reached are 0.11 and 4.67. The "x" in right side of the box indicated the average value, amounting at 1.57. From the plot, it can be seen that the distribution is skewed to the right, as the dispersion from the median is larger on the right hand side than on the left. The small circles in the plot indicate the outliers[10]. They come from the large firms that have substantially higher overall ERMMA maturity scores.

[10] Outliers are here defined as those values lying 1.5 times below or above your inner quartile range.

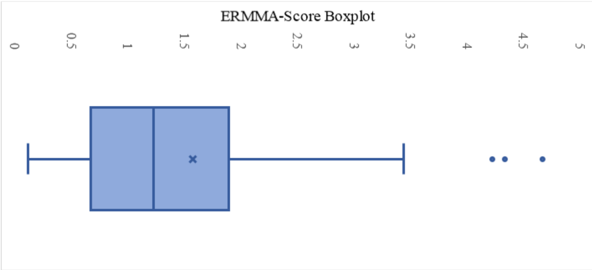


Figure 16 - Distribution of ERMMA maturity score for all responding firms

Figure 17 shows the additional layers, or granularity, of the maturity assessment. The diagram on the left shows the distribution of ERMMA maturity score achieved by all responding firms for each dimension. The diagram on the right shows the distribution of ERMMA maturity score achieved by all responding firms for each sub-dimension.

In Figure 17a it is visible a more right-skewed distribution for the dimension "ERM-governance" (dim A) and "RM-system" (dim B) in compare with the "Risk-based planning and control system" (dim C). Thanks to the higher granularity displayed in Figure 17b, it is evident that this skewness derives from the more dispersed values of the sub dimensions A1-B3. The C dimensions (as well as the C1-C3 sub-dimensions) is more uniformly distributed as it is of interest for both small and large firms. However, Figure 17b shows that Austrian firms have directed more attention towards the sub-dimensions B1 (risk management system), as it displays the highest median and average. This should be caused by the fact that most survey respondents undergo public audits where normally a strong focus is given upon the risk management system. The worst sub-dimensions are reached in the risk organization (A3) and the risk management training system (B2), where the 1st quartiles are zero and the average is the lowest. This indicates deficiencies in the organizational implementation of the risk governance and weaknesses in the risk communication within the firms.

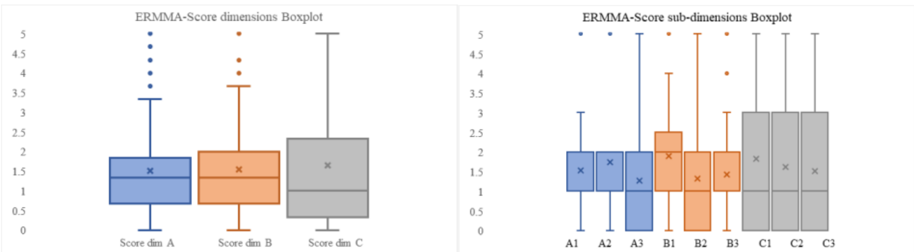


Figure 17- a) (on the left) the distribution of ERMMA maturity score achieved by all responding firms for each dimension; b) (on the right) the distribution of ERMMA maturity score achieved by all responding firms for each sub-dimension

4.4 Explanatory analysis

The descriptive analysis has so far shown the distribution of maturity levels measured by the ERMMA measurement model. However, given the importance of ERM it is paramount to understand the determinants of it. Which conditions favor ERM development and which hamper it? Are there underlying factors that need to be in existence so that ERM can develop? In this chapter, the ERMMA measurement results are examined with regards to their dependence on exogenous variables (i.e. its determinants).

In the ERMMA questionnaire, as introduced in chapter 4.2, several data regarding exogenous variables were collected: yearly turnover, number of employees, existence of a risk management function and its organization, (non) externally audited, sector of activity, legal form of the enterprise, region of domicile, owner managed/non owner managed, years of activity, existence of a compliance management function and its organization and existence of an internal audit function …

Two academic studies mentioned in the literature review (chapter 2) addressed a similar investigation of ERM adoption determinants. Beasley et al. (2005) examined characteristics of 123 US and international organizations finding *the stage of ERM implementation to be positively related to the presence of a chief risk officer, board independence, CEO and CFO apparent support for ERM, the presence of a Big Four auditor, entity size, and entities in the banking, education, and insurance industries* (Beasley et al. 2005, p. 521). Lundqvist (2015) used leverage, size, market-to-book, managerial ownership, managerial option compensation, diversification, dividend, board independence, CEO on board, publically rated debt, big 4 auditor and industry sector to examine the determinants of ERM adoption. The author found that size, board independence, publically rated debt and being in the financial industry have positive influence in the adoption of ERM.

To further examine this area, while taking into consideration the previous results, four further hypothesis of determinants are explored (i.e. having a well-established internal audit function, having a well-established risk management function, having a well-established compliance management function, and being (non-)owner managed).

Figure 18 shows the mean values (and its standard error) of the overall ERMMA score for the first group of determinant investigated: employees number (above 1000 or below 1000), turnover (above 250M or below 250M), firms legal entity (limited liability or public joint-stock company), externally audited. Table 3 shows the analytic results of the determinants analysis. Employees number and turnover are both an approximation of the size variable also investigated by Beasley et al. (2005) and Lundqvist (2015). As for these two authors, the level of maturity of ERM is found to be positively related to the size of the entity. Similarly, when the firm is externally audited, the ERM maturity level is found to be consistently higher. Finally, being a public joint-stock company or limited liability company is found to have no influence in the adoption of ERM; as displayed in Table 3 in fact, the two groups are not different on a statistically significant level.

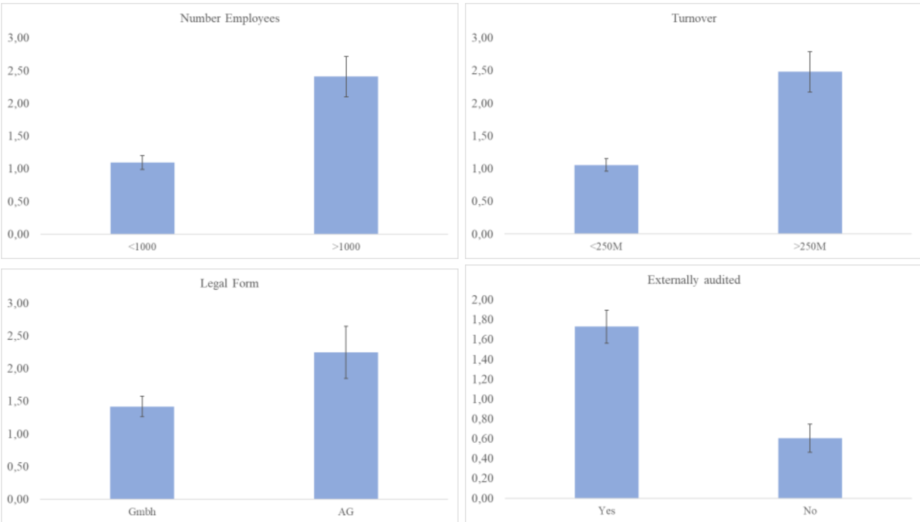


Figure 18 - Explanatory Analysis for a) Number of Employees b) Turnover c) Legal Form d) Owner Managed/Non Owner managed.

	Mean	SD	H-statistic	Significance
Number Employees				
<1000	1,09	0,68	14,2118	0,00016***
>1000	2,41	1,46		
Turnover				
<250Mln	1,05	0,59	16,5058	0,00005***
>250Mn	2,48	1,45		
Legal form				
Gmbh (limited liability)	1,42	0,99	2,2897	0,13023
AG (public joint-stock)	2,24	1,55		
Externally Audited				
Ja	1,74	1,21	12,0931	0,00051***
Nein	0,61	0,42		

* significant at p< 0.1; **significant at p< 0.05; *** significant at p< 0.01

Table 3 - Explanatory Analysis for Number of Employees, Turnover, Legal Form, Owner Managed/Non Owner managed. Kruskal-Wallis Test.

Following the hypothesis of Beasley et al. (2005) and Lundqvist (2015), variables for region of domicile and sector of activity were also collected and investigated as determinants for ERM adoption. However, as evident in Figure 19, Figure 20 and Table 4, these variables are not significant, not positively nor negatively influencing ERM adoption.

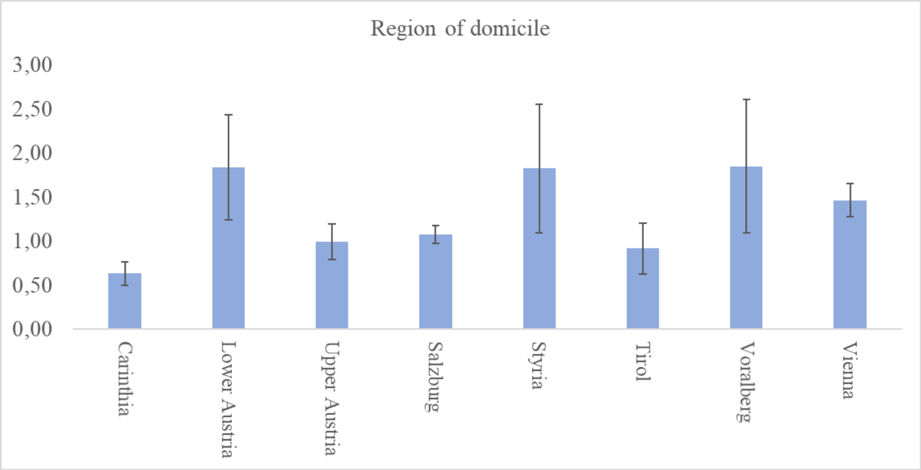


Figure 19 - Explanatory Analysis for region of domicile

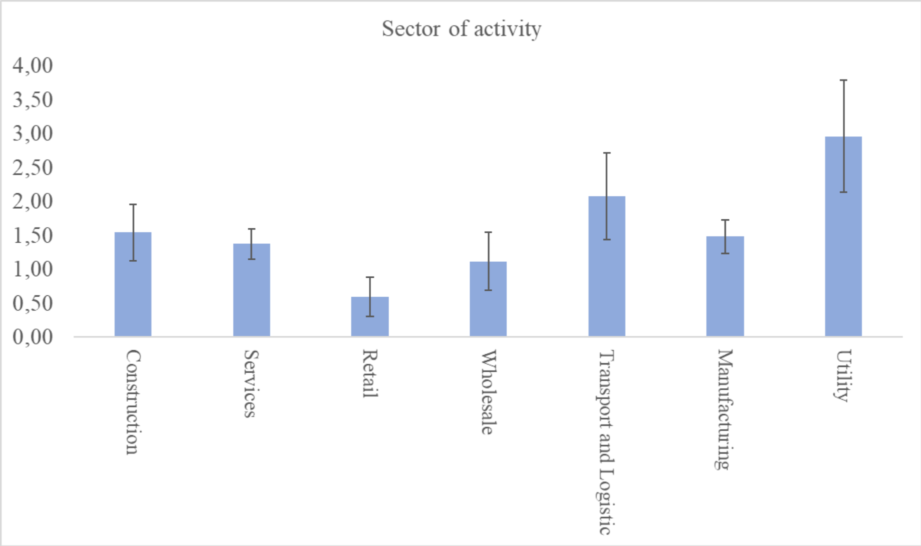


Figure 20 - Explanatory Analysis for sector of activity

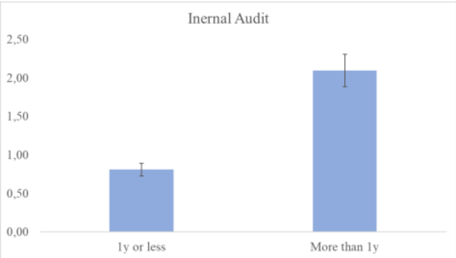
	Mean	SD	H-statistic	Significance
Region of domicile				
Carinthia	0,63	0,23	3,769	0,43817
Lower Austria	1,84	1,68		
Upper Austria	0,99	0,67		
Salzburg	1,07	0,17		
Styria	1,82	1,63		
Tirol	0,92	0,58		
Vorarlberg	1,85	1,69		

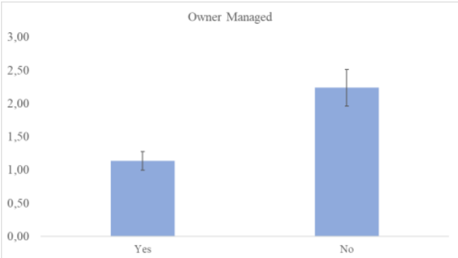
Vienna	1,46	0,66		
Sector of activity				
Construction	1,54	1,10	1,9291	0,7488
Services	1,37	0,72		
Retail	0,59	0,50		
Wholesale	1,11	0,96		
Transport and Logistic	2,08	1,57		
Manufacturing	1,48	1,16		
Utility	2,95	1,84		

* significant at p< 0.1; **significant at p< 0.05; *** significant at p< 0.01

Table 4 - Explanatory Analysis for region of domicile and sector of activity. Kruskal-Wallis Test.

In the last group of determinants investigated, four further hypothesis are considered: having a well-established (i.e. more than 1 year) internal audit function, having a well-established (i.e. more than 1 year) risk management function, having a well-established (i.e. more than 1 year) compliance management function, and being (non-)owner managed. Note that the three institutional aspect investigated in this group (i.e. internal audit, risk management and compliance management) were collected by the specified exploratory survey variables. As these variables were not used in the attribute variables, with which the ERM systems maturity levels are measured, the circular reasoning pitfall has been avoided. In Figure 21 and Table 5, is evident how well-established internal audit, risk management and compliance management functions is found to have positive influence in the adoption and development of ERM. In contrast, when the owner directly manages the firm, the ERM maturity level is found to be consistently lower.





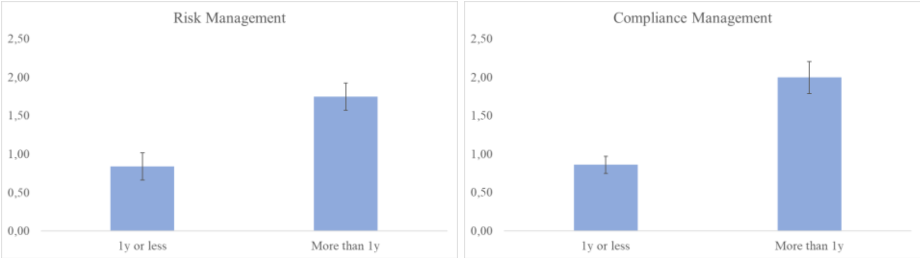


Figure 21 - Explanatory Analysis for a) well-established internal audit function b) well-established risk management function c) well-established compliance management function d) (non-)owner managed.

	Mean	SD	H-statistic	Significance
Internal Audit				
1 year or less	0,81	0,42	22,8551	0,00001***
More than 1 year	2,10	1,28		
Risk Management				
1y or less	0,84	0,61	8,2693	0,00403***
More than 1y	1,75	1,24		
Compliance Management				
1y or less	0,86	0,54	16,9304	0,00004***
More than 1y	2,00	1,29		
Owner Managed				
Ja	1,136	0,857	12,8174	0,00034***
Nein	2,235	1,353		

* significant at p< 0.1; **significant at p< 0.05; *** significant at p< 0.01

Table 5 - Explanatory Analysis for, well-established internal audit function, well-established risk management function, well-established compliance management function, (non-)owner managed. Kruskal-Wallis Test.

5. Conclusion

The main objective of this work was to establish a maturity development model for Enterprise Risk Management System in Austrian non-financial Enterprises. By reviewing current (enterprise) risk maturity models found in the literature, it was noticed a limited attention in addressing the issue of development of an entity and rather previous literature focused on the evaluation of the as-is state of ERM programs implemented by organizations or on the analysis of the factors that influence ERM adoption.

To reach the goal of this thesis, the standardized research process prescribed in the predictive validity framework of Bisbe et al. (2007) and Libby et al. (2002) was refined and followed. First, an adequate definition of the construct ERM (system) was settled by following the emergent model type. Then, the construct was operationalized by following the profile approach. In chapter 3, specific aims for the ERMMA maturity development model were set and subsequently achieved. By using binary attributes for the specification of the different maturity levels, a layered ERM system maturity model could be established for the first time. In the ERMMA model, evidence of the transformation from one stage to another is explicitly specified by fulfilling all attributes of the preceding stage. Additionally, this attribute-fulfillment-logic provides also the clear stage-gate approach. Through the feedback format that participants obtain by taking part of ERMMA questionnaire, each entity receives an evaluation of the current as-is status as well as information regarding the comparative benchmarking with other firms. This, next to the roadmap information for improvements. Furthermore, the ERMMA model has the advantage of a more precise measurement of the maturity stages compared to polynomial (Likert) scales due to limiting the decision discretion of the respondents to yes/no decisions (survey answers). As the specification of this model happened at the conceptual level and by following the revised predictive validity framework, the advantage of the model directly carries over to quality of the operational model as well as to the quality of the questionnaire and to the thereof measured results.

When applying the ERMMA maturity development model to a sample of Austrian non-financial enterprises, interesting results were found. For example, that Austrian firms have directed more attention towards the sub-dimensions "risk management system" (as it scored the highest), while neglecting "risk organization" and "risk management training" (as they scored the lowest). Additionally, the ERMMA questionnaire provides statistical evidences that the overall ERMMA maturity score is driven by the size of the firms, the owner-management, the well establishment of an internal audit/risk management/compliance management function and the audit of external auditors.

Lastly, by implementing the ERMMA questionnaire in the intelligent ERMMA online application, the ERMMA study is not a one-time event. Instead, the application allows the study to be run several times. Each time, additional information will be collected in order to determine the development of the overall ERMMA score distribution over time. This information is not only interesting for academic purposes, but also for the participating firms as they can monitor their individual development over time and comparatively benchmark this with the other participants. Accordingly, the ERMMA online application can be used by firms as a tool for diagnostic control and improvement by monitoring the maturity performance of its ERM system over time.

In summary, this research provided a twofold contribution. On the empirical level, statistically insights into the present Austrian non-financial enterprises maturity levels and their determinants were shown. The ERMMA project also achieved a scientific contribution through the development of an innovative development model for the self-assessment of ERM system maturity. The research objective in this context was to close the gap found in the literature with regard to a methodologically sound conceptualization and operationalization of maturity models for ERM system design. To close the gap, the methodology of the Predictive Validity Framework was used. The resulting ERMMA measurement model has, on the one hand, its (ERM) foundation on the best practice model in the form of the COSO / ISO standards, and on the other hand, the indicators and dichotomous operational variables provide an objective, reliable and valid measuring methodology. Then, making the ERMMA online application available as an ERMMA monitoring tool provides the opportunity for the companies participating in the study to initially determine their maturity level and then monitor it over time. Thus, the monitoring tool provides an important support for the maturity controlling, with which initially the weak points in the ERM system can be identified and on the basis of the given feedback information concrete improvements can be worked on. Over time, the monitoring tool then measures the development of maturity, and if there are any discrepancies between the targeted and actual score values, then corrective or adaptive measures to eliminate them can be taken.

5.1 Future research

The elements of future research could be derived from the limitations of this research. On the empirical level, enlarging the catchment area (e.g. including Germany in the study), would help in receiving a higher number of respondents, providing a better basis for statistical analysis. On the scientific level, this research followed a framework where an agreed upon conceptual model was before developed and subsequently operationalized (via a questionnaire). Possibly, this methodology can be further refined.

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7. Appendix

7.1 ERMMA attribute schema

In the following three tables, the attributes for the five levels of maturity are displayed for each of the three dimensions/nine sub-dimensions. The attributes are distinguished between *original attributes*, which are collected directly from questions, and *derivative attributes*, which are indirectly derived from original attributes.

Original attributes can be newly introduced (red colour), extended from a lower maturity level (green colour) or unchanged compared to a lower maturity level (black colour). The Scope of original attributes is limited to the respective sub-dimension. *Derivative Attribute* are derived from original attributes and are displayed with blue colour. The scope of derivative attributes is unlimited. As they can be used flexibly in all (sub-) dimensions.

Dimension A: ERM governance model	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4	Maturity Level 5
	A.1 Risk strategy (partial R-strategy) 1. Risk mitigation consisting of risk appetite (Limit) and policy (IDW PS 981) is partially documented	A.1 Risk strategy (partially audited R-strategy) 1. documented Risk strategy including monitoring was audited + 1a. Inclusion of monitoring	A.1 Risk strategy (Company-wide goal-oriented R-strategy) 1. documented Risk strategy is differentiated company-wide (+1a) +1b. There are multiple risk strategies for different management areas + 1c. Risk strategies are goal oriented e.g. COSOII goals	A.1 risk strategy (integrated learning R-strategy) 1 doc. Risk strategies are integrated and learned through (+1a, +1b, +1c, +1d) +1d. Risk strategy is consistent with corporate goals (IDW EPS 981) +1e. Inclusion of realized risks +1f. Inclusion of unrealized opportunities	A.1 Risk strategy (discussed R-strategy) 1. doc. Risk strategy is debated and discussed (+1a, +1b, +1c, +1d, +1e, +1f, +1l) +1g. Top management discusses and debates the risk strategy
	2. Risk strategy is not audited	2. Adequacy of the risk strategy is examined	2 Adequacy of the risk strategy is examined (including the scope of the audit)	2. Adequacy of the risk strategy is examined (comprehensive audit scope)	2.
	A.2 Risk Understanding (partially available) 1. Understanding of risk is partially documented	A.2 Risk Understanding (partially available and goal-oriented) 1. Understanding of risk includes clear goal aligned with risk strategy +1b. COSOII target categories (risk of target deviation)	A.2 Risk Understanding (differentiated according to opportunities and risks) 1. Understanding of risk is differentiated with regard to opportunity / risk +1 c. Risk types [Kaplan & Mikes (2014)] opportunity / risk +1a. +1b.	A.2 Risk Understanding (differentiated according to influence) 1. Understanding of risk (differentiated according to influence) +1d. Risk Types [Kaplan & Mikes (2014)] influenceable/ uninfluenceable +1a. + 1b. +1c.	A.2 Risk Understanding (discussed) 1 Understanding of risk is debated and discussed. +1e Top management discusses debates the understanding of risk +1a. +1b. +1c. +1d.
	A.3 Risk organization (Basis of legal requirements) 1. RM functions are partially set up according to legal minimum requirements (2nd column in 3 Lines of Defence)	A.3 Risk organization (Basis of audit) 1. RM functions are partially set up with monitoring +1a. Basis of Monitoring	A.3 Risk organization (Basis of Company-wide risk management) 1. RM functions are differentiated and are supported by the Top Mgt (+1a') +1b. Differentiation according to management levels +1c. RM coordination via B1.RG3.1e +1d. Top MGT support for RM functions	A.3 risk organization (Basis of risk aggregation) 1 RM functions inc. coordination and aggregation are set up (+1a, +1b, +1c, +1d) +1e. Company-wide risk aggregation via B1.RG4.1f	A.3 Risk organization (Basis for discussion) 1. Established RM functions are discussed (+1a, +1b, +1c, +1d, +1e) +1f. Top Management discusses and debates the RM functions
	2. RM functions are not Audited	2. Basis of the adequacy of the RM system by Internal audit (or other entities) (3rd column in 3 Lines of Defence) via B1.RG2.2	2. Basis of the adequacy of the company-wide RM system by Internal audit (or other entities) via B1.RG3.2	2. Basis of the adequacy testing of the learning ERM system by Internal audit (or other entities) via B1.RG4.2	2. Basis of assessing the adequacy of the ERM system discussed by Internal audit (or other entities) via B1.RG5.2

Figure 22 - Attributes Dimension A

Dimension B: RM-System

Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4	Maturity Level 5
B.1 Risk Management (RM Process) 1. RM process is partially documented + 1a. Risk identification + 1b. Risk measurement + 1c. Risk management	B.1 Risk management (RM-System) 1. documented RM system exists for RM process with monitoring (+1a, +1b, +1c) +1d. Carrying out risk monitoring	B.1 Risk management (Company-wide RM system) 1. Company-wide coordinated RM system is documented (+1a, +1b, +1c, +1d) +1e. ERMgr leads coordination	B.1 Risk Management (Learning ERM System) 1. Documented ERM system exists by including Company-wide risk aggregation (+1a', +1b'. +1c',+1d, +1e) +1f. ERMgr carries out risk aggregation by	B.1 Risk Management (Discussed ERM system) 1. The assessed ERM system is debated and discussed. (e.g. Culture, influence) (+1a', +1b', +1c, +1d, +1e, +1f) +1g. Top management discusses and debates the ERMS
2 RM process is not audited	2. assessing the RM system (regarding appropriateness and effectiveness) +2. Internal Audit (or other entities) performs audit	2. audited Company-wide RM system + 2a'. Internal Audit (or other entities) performs audit	2. assessing ERM-System +2a'.Internal Audit (or other entities) performs audit +2b. IA et al. includes realized risks during verification + 2c. IA et al. Does not include realized opportunities on review	2. (+2a",2b,2c)
B.2 RM training system (partial RM process training) 1. Instruction of Risk Management Officers regarding the organizational design of RM processes	B.2 RM training system (RM system training) 1. Instruction of risk management officers regarding the design of RM systems +1a. Instruction regarding RM Framework	B.2 RM Training System (Company-wide RM system training) 1. Instruction of the risk manager regarding the design of the Company-wide RM system (+1a) +1b. COSOII- target categories (Risk as target deviation) + 1c1. Risk Types [Kaplan & Mikes (2014)] Chance / Risk + 1c2. Risk Types [Kaplan & Mikes (2014)] Influenceable / uninfluenceable	B.2 RM Training System (ERM System Training) 1. Instruction of the Risk Management Officer regarding. (+1a, +1b, +1c1, +1c2) +1d. Risk aggregation +1e ERM-System Review	B.2 RM Training System (ERMS Discussion Training) 1. Training of the Top MGT with regard to. (+1a, +1b, +1c1, 1c2, +1d, +1e) +1f ERMS discussion
2. Training the Risk Owners on how to control their respective risks	1. Further education of the IR regarding +2a. Assessing the adequacy of RM system	2. Further education of IA et al. regarding. +2a'. of the adequacy of the enterprise RMS	2. Further education of IA et al. regarding + 2a". examining the appropriateness of the ERMS	2. (+2a")
B.3 RM information system (RM process -IS) 1 Information system about RM processes is partially set up	B.3 RM Information System (RM-System-IS) 1. Information systems about RM System is set up +1a. Implementation of monitoring	B.3 RM Information System (Company-wide RMS-IS) 1. Information system via Company-wide RM system is set up as a GRC application (+1a) +1b. Involvement of all areas of the company	B.3 RM-Information system (ERMS-IS) 1. Information system about ERP system is set up (+1a, +1b) +1c. Inclusion of company-wide aggregated risks + 1d. Inclusion of risks regarding suppliers, customers and competitors	B.3 RM-Information system (discuss ERMS-IS) 1. ERMS-IS will be debated and discussed (+1a, +1b, +1c, +1d) +1e. Top management discusses and debates the ERMS-IS
2. RMS-IS is not audited	2. IR (or other entity) examines appropriateness of RMS-IS	2. IA et al. audit Company-wide RMS-IS +2a. Assess all RMS IS areas	2 IA et al. assess ERMS-IS +2a'. Audit all ERMS IS areas	2.

Figure 23 - Attributes Dimension B

Dimension C: risk (based) planning and control systems	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4	Maturity Level 5
	C.1 Strategic management system (risk limit system with monitoring) 1. Isolated risk limit system for selected strategic risks	C.1 Strategic Management System (Key risk-based Strategy Assessment) 1. Key Risk-based strategic planning system + 1a. Inclusion of opportunities in strategic planning + 1b. Basing of KR in strategic planning	C.1 Strategic Management System (KR-based strategy definition with monitoring) 1. Key Risk-based strategic MGT system + 1c. Inclusion of key risk in strategic controlling	C.1 Strategic Management System (Risk-adjusted key performance indicators) 1. Integrated risk-adjusted stakeholder value management system +1d. Inclusion of sustainable risk considerations in strategic controlling	C.1 Strategic Management System (Discuss risk-adjusted key performance indicators) 1 Debate and Discuss Stakeholder Value MGT Systems + 1e Top Management debates and discusses stakeholder value MGT system
	C.2 Performance management system (risk limit system with monitoring) 1. Isolated risk limit system for selected business performance risks	C.2 Performance Management System (KRI-based targeting and) 1. Key Risk Indicator (KRI) - based financial planning system + 1a Include opportunities in financial planning +1b Anchoring KRI in financial planning	C.2 Performance Management System (KRI-based target setting with monitoring) 1. Key Risk Indicator (KRI) - based performance MGT system + 1c, inclusion of KRI in financial controlling	C.2 Performance Management System (risk-adjusted key performance indicators) 1. Integrated risk-adjusted performance MGT system +1d. Inclusion of risk-adjusted performance indicators (e.g. RAPM) in financial controlling	C2 Performance Management System (Discussed risk-adjusted key figures) 1. Debate and discuss performance MGT system + 1e. Top Management debates and discusses risk-adjusted Performance MGT
	C.3 Process Management System (Risk Limit System with Monitoring) 1. Isolated risk limit system for selected process risks	C.3 Process Management System (KRI based target setting) 1. Key Risk Indicator (KRI) -based process planning system + 1a. Inclusion of opportunities in process planning + 1b. Anchoring KRI in the process planning	C.3 Process Management System (KRI-based targeting with monitoring) 1. Key Risk Indicator (KRI) -based process MGT system +1c Inclusion of KRI in process controlling	C.3 Process management system (risk-adjusted success metrics) 1Integrated risk-adjusted process performance MGT system (e.g. expected costs) + 1d. Integration of risk-adjusted performance indicators into process controlling	C.3 Process Management System (Discussed risk-adjusted key performance indicators) 1. Debate and discuss process performance MGT system + 1e. Top Management debates and discusses risk-adjusted process performance MGT

Figure 24 - Attributes Dimension C

7.2 ERMMA questionnaire

Based on the attribute schema, each question of the ERMMA questionnaire directly addresses one of the attributes. Other comparable studies (e.g. Cienfuegos 2013), defined multiple questions per each indicator as a way to improve the validity of the questionnaires. However, due to the large amount of developed indicators, following this same approach would cause a cumbersome questionnaire, thus a single-question approach is kept and validity is assured in different manners, including, but not limited to[11], adding clarifying examples per each question (an example is visible in Table 6).

Table 6 - Extract of ERMMA questionnaire, questions regarding sub-dimension "Risk Management System". It is here visible the use of examples to clarify the questions to the respondents

#	Questions and multiple answers	Maturity Level	Indicator
1	The identification of risks is documented for		
	○ Selected areas of the company (e.g. production, logistics, finance, ...)	1	B1.1a
	○ All important areas with different methods (e.g. top-down and bottom-up)	3	B1.1a

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Additionally, to diminish the length of the questionnaire, and since the choice of dichotomous and multichotomous question type allows it, one single question can address:

a) one attribute per multiple levels of maturity
b) similar attributes per multiple sub-dimensions but same maturity level

In these cases, the question text sets the context and the multiple answers address the multiple levels/subdimensions. To understand better this concept, an extract of one questions of type a) and one question of type b) is depicted in Table 7.

[11] a pilot study as well as one-to-one survey sessions with representative from engaged Austrian enterprises were undertaken to directly test the understanding of the participants

Table 7 - Extract of ERMMA questionnaire showing the possible combinations of one indicator per multiple levels of maturity (question #1) or similar indicators per multiple subdimensions but same maturity level (question #2)

#	Questions and multiple answers	Maturity Level	Indicator	Sub dimension
1	The identification of risks is documented for			
	○ Selected areas of the company (e.g. production, logistics, finance, ...)	1	B1.1a	B1
	○ All important areas with different methods (e.g. top-down and bottom-up)	3	B1.1a	B1
2	At which management level are key risks or key risk indicators (KRIs) monitored and controlled?			
	○ Strategic level	3	C1.1c	C1
	○ Business performance level	3	C2.1c	C2
	○ Process level	3	C3.1c	C3

In the above table, we can see how in question #1 the same attribute B1.1a (i.e. documentation for risk identification) is addressed for two subsequent maturity levels. This is possible thanks to the progression logic included in the indicators, which requires the same concept (in this case risk identification) to exist in each level of maturity but to be more advanced for higher maturity levels. Question #2 instead, presents the b) possibility (i.e. similar indicators per multiple subdimensions but same maturity level). In this case, the three sub-dimensions of *risk-based planning and control system* are included in one question, because, although with different scopes, in each management domain (operational, financial and strategic) the same overall requirements need to be fulfilled.

As evident from the extracts of the ERMMA questionnaire showed in this annex, each question directly addresses specific attributes. To clearly display this direct connection between question and respective attribute, the questions derived for the subdimension “Risk Management training system” are shown in Table 8.

Table 8 - Extract of ERMMA questionnaire. The questions refer to the Risk Management training system sub-dimension.

#	Questions and multiple answers	Indicator	ML
1	Those responsible for risk management are instructed on the proper functioning of the risk management process		
	○ Yes, applies	B2.1	1
2	Those responsible for risk management are instructed on the proper functioning of the risk management System		
	○ Yes, applies	B2. 1	2
3	Those responsible for risk management are instructed on the proper functioning of the company-wide risk management system		
	○ Yes, applies	B2.1	3
4	Those responsible for risk management are instructed on the proper functioning of the Enterprise risk management system		
	○ Yes, applies	B2.1	4
5	The Top management is instructed to engage in interactive discussions regarding the effectiveness of the ERM system		
	A. Yes, applies	B2.1f	5
6	When instructing the person responsible for the risk management is taken into account inter alia		
	B. The design, implementation, monitoring and improvement of the risk management process	B2.1a	2
	C. The consideration of opportunities and risks with regard to set goals	B2.1b	3
	D. The distinction between preventable risks, strategy execution risks and external risks	B2.1c	3
	E. The company-wide aggregation of risks	B2.1d	4
	F. The review of the ERM system in terms of its appropriateness	B2.1e	4
7	Risk owners are trained to manage their respective risks		
	G. Yes, applies	B2.2	1
8	Internal Audit (or other entity) continues to be trained to assess the appropriateness of the risk management system		
	H. Yes, applies	B2.2a	2
9	The Internal Audit (or other entity) continues to be trained to assess the appropriateness of the company-wide risk management system		
	I. Yes, applies	B2.2a’	3
10	The internal audit (or other entity) continues to be trained to examine the appropriateness of the ERM system		

J.	Yes, applies	B2.2a’’	4

In Table 8 is evident how, per each question, is made explicitly clear (during the construction phase) the addressed indicators in the second column. The indicators are different per each subdimension, as reflected from the coding method of the attributes: *subdimension.#* (e.g. attribute number B2.1 means B2 dimension, which is RM-training system, #number 1).