RMDM – A Conceptual ICT Risk-Meta-Data-Model

Applied to COBIT for Risk as underlying Risk Model

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***Abstract*— The aim of this article is to introduce an approach that integrates the different models and methods currently applied for risk management in information and communication technologies (ICT). These different risk management approaches are usually bound to the organization where they are applied, thus staying quite specific for a given setting. Consequently, there is no possibility to compare or reuse risk management structures because they are individual solutions. In order to establish a common basis for working with different underlying risk models, a metamodeling approach from the area of Disaster Recovery is used. A first concept for a data model described in Unified Modeling Language (UML) is presented and its core components addressing the whole risk management lifecycle are described. This contribution describes a comprehensive mapping of information artefacts – in this case obtained from the COBIT for Risk framework – which are then lifted to the meta-level of the proposed ICT risk-meta-data-model in order to be able to work with them in a consolidated way. Through this mapping process, all information artefacts are extracted, consolidated and harmonized to minimize the number of relevant objects. It has turned out that both the list of consolidated objects and the derived describing attributes can in general be incorporated into the proposed ICT risk-meta-data-model (RMDM), i.e., the essential information for working with the COBIT for Risk model can be stored in the proposed ICT risk-meta-data-model. The results of the mapping show that it is worth examining a data-structure-oriented approach in order to develop both a model and a data structure for further framework-independent processing.**

Keywords-information and communication technology risk management; ICT risk-meta-data-model; COBIT for Risk; metamodeling; data model; UML.

I. INTRODUCTION

In literature and in practice, many different risk management approaches and models can be found for the area of information and communication technology (ICT) systems. Even within the field of ICT, these approaches and models are tailored quite narrowly to specific areas and are typically restricted to one single organization. Therefore, the information on risk management is usually not comparable and transferrable between different organizations. This means that the risk model, the established risk management method, the concrete process implementation, the required input data and the resulting outcome have to be adapted to the current requirements of an organization every time the risk management process is set up. This often leads to high efforts for an organization or a company because they have to initialize and re-establish the risk management frameworks and related processes each time. It is evident that these parameters result in a smaller degree of reusability of a given risk management process and less comparability of the information obtained from it.

When interpreting this problem as a pure ICT issue, an explicit ICT solution is required. This leads to the main research question of this paper, i.e., whether it is possible to develop a common risk management model, which is flexible enough to be applicable in different fields of the ICT area as well as among different organizations. To achieve that, it is crucial to define a suitable level of modeling. Therefore, the goal of the introduced approach is to design a meta-model for ICT risk management. By integrating different existing ICT risk management models, which are suitable for various fields of application into a meta-model, a generic data structure that focuses on common aspects of these models can be developed. This umbrella model simply obtains data from the underlying specialized models that have been defined by different frameworks. The approach introduced in this article postulates a superordinate meta-model for ICT risk management and represents it as a data model, expressed a UML class diagram. Considering the application of ICT risk management in practice, the state-of-the-art frameworks are well-established in the daily business of organizations. Consequently, it is not realistic to replace them by a new, universally valid model. The ICT risk-meta-data-model approach introduced here firstly establishes a common data base of risk information gathered by different risk management frameworks, secondly makes data retrieved from different sources comparable, and thirdly verifies its practical applicability by describing real-life use cases, shown as an instantiation of the ICT risk-meta-data-model.

The main goal is to specify the meta-model as a substantial data model. Using such a precise data model, the meta-model is directly applicable to real-life scenarios and enables the implementation of a dedicated ICT application or data structure. The data model is directly applicable for ICT tasks, provides a concrete ICT data structure where risk information can be stored, and is a fundamental (data) basis for ICT risk management applications.

This paper is divided into five main sections. Following this introduction, Section II discusses those processes of

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COBIT for Risk, which are relevant for risk management in detail, describes the fundamentals of the metamodeling approach, and concludes with discussing related work. In Section III, the conceptual data model RMDM, described in Unified Modeling Language (UML) is introduced. Section IV discusses the mapping of the information artefacts, input and output components of COBIT for Risk – the core of the derived risk model – and the objects of the proposed ICT risk-meta-data-model (RMDM). The objective of Section IV is to apply the postulated meta-model by modelling an instance of a concrete risk model. The concluding Section V outlines the results and proposes further research that is needed to refine the ICT risk-meta-data-model (RMDM).

II. Fundamentals

A. *COBIT for Risk*

Typically, organizations have a continuous need to manage the risks in their business environment. Such a need due to extrinsical factors is often motivated by legal requirements. Organizations have to ensure compliance with regulations, especially relating to finance and public accounting. Therefore, the responsible person implements risk management – in this case limited to the ICT area – by doing research and building upon already existing risk management structures. Special risk management frameworks that are applicable to ICT, e.g., International Organization for Standardization (ISO) 31000 [1], National Institute of Standards and Technology (NIST) Special Publication (SP) 800-30/-37/-39 [2] [3] [4], Committee of Sponsoring Organizations of the Treadway Commission (COSO) Enterprise Risk Management (ERM) [5], Management of Risk [6] or COBIT for Risk [7], have proven to be effective within one single organization. These frameworks set up a baseline in an organization when it comes to implementing risk management structures. This usually generates isolated solutions. The different risk management frameworks are characterized by relatively similar objects and terms but very different artefacts, which cannot be related, compared, or summarized. One important issue is to harmonize the semantic differences between the various risk management frameworks, and even within one single framework.

COBIT for Risk [7] is a special publication edited by Information Systems Audit and Control Association (ISACA, since 2008 the acronym itself is used as a brand name) [8] and is entirely based on Control Objectives for Information and Related Technology (COBIT, since version 5 only the acronym itself is used as a brand name) 5.0 [9], a framework for governance and management of Enterprise ICT, especially for the interaction between ICT and classic business objectives. COBIT for Risk is a comprehensive guide for risk professionals. It elaborates the driving aspects for risk management in COBIT – principles and enablers – and extends the framework with risk scenarios. Furthermore, it provides suggestions for appropriate response measures using a combination of enablers. It has – similar to ISO 31000 [1] – a two-tier approach: the risk management perspective puts the high-level principles into practice and the risk function view seeks to identify relevant COBIT processes, which support the risk management, as depicted in Figure 1. In this figure, the two core risk processes are shown in light blue, the other twelve key supporting processes are colored in dark red.

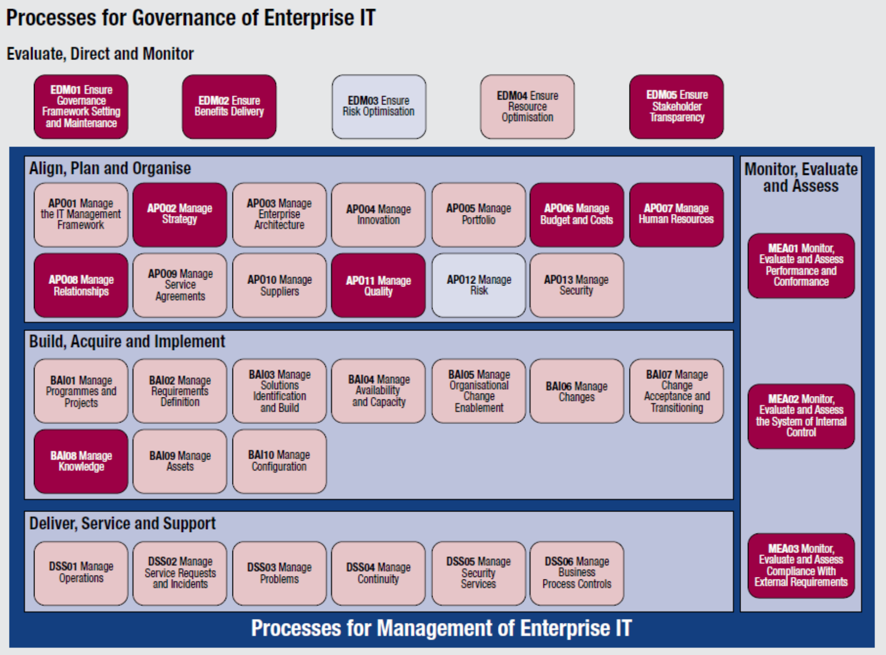

Processes for Governance of Enterprise IT
Evaluate, Direct and Monitor
EDM01 Ensure Governance Framework Setting and Maintenance
EDM02 Ensure Benefits Delivery
EDM03 Ensure Risk Optimisation
EDM04 Ensure Resource Optimisation
EDM05 Ensure Stakeholder Transparency
Align, Plan and Organise
APO01 Manage the IT Management Framework
APO02 Manage Strategy
APO03 Manage Enterprise Architecture
APO04 Manage Innovation
APO05 Manage Portfolio
APO06 Manage Budget and Costs
APO07 Manage Human Resources
APO08 Manage Relationships
APO09 Manage Service Agreements
APO10 Manage Suppliers
APO11 Manage Quality
APO12 Manage Risk
APO13 Manage Security
Monitor, Evaluate and Assess
MEA01 Monitor, Evaluate and Assess Performance and Conformance
Build, Acquire and Implement
BAI01 Manage Programmes and Projects
BAI02 Manage Requirements Definition
BAI03 Manage Solutions Identification and Build
BAI04 Manage Availability and Capacity
BAI05 Manage Organisational Change Enablement
BAI06 Manage Changes
BAI07 Manage Change Acceptance and Transitioning
MEA02 Monitor, Evaluate and Assess the System of Internal Control
BAI08 Manage Knowledge
BAI09 Manage Assets
BAI10 Manage Configuration
Deliver, Service and Support
DSS01 Manage Operations
DSS02 Manage Service Requests and Incidents
DSS03 Manage Problems
DSS04 Manage Continuity
DSS05 Manage Security Services
DSS06 Manage Business Process Controls
MEA03 Monitor, Evaluate and Assess Compliance With External Requirements
Processes for Management of Enterprise IT

Figure 1. Supporting COBIT processes for the risk function [7, p. 35]

The COBIT for Risk framework was chosen as a the first candidate for the intended mapping because of its good balance between general applicability for risk management topics and very specific statements in form of concrete control objectives for risk management. It definitely provides much more topic-oriented reference-points than standard COBIT. The framework is clearly structured and its description is not too narrative. A highly narrative framework might increase the effort for identifying class objects. In summary, all these characteristics were considered to be good prerequisites for the practical mapping work. Other frameworks, e.g., ISO 31000 [1], might be too generic in order to derive substantial class objects to a sufficient extent or, e.g., NIST [2] [3] [4], is too text-heavy for an efficient proof of concept. Consequently, all the other frameworks are rather suitable for verifying the ICT risk-meta-data-model in a more advanced state of development.

B. *Metamodeling Approach*

The semantic meaning of a risk model must be transferred to the meta-level. A formal, scientific approach to build a consistent umbrella is missing. The meta-modeling process helps to create a common basis for standardization. The instantiation procedure of the meta-model down to the distinct risk management framework provides rules for transferring data from a concrete model up to the meta-model, and is in that way working as a normalization process. The first advantage of representing the risk-meta-model as data model is the immanent design of a structured data management based on a semantic model. It must be verified whether the general concepts can be divided from content-specific aspects in such a way that the interaction between meta- and model-level still remains efficient. The data model works as a structure model and holds static information. The risk management process and corresponding workflows change this data dynamically, providing a data model for the whole risk management life cycle. However, this article focuses on the verification of the basic content and on whether the data model can process the information. In addition, the meta-model approach for standardizing risk management information can be implicitly verified by setting up the data model, at least for those risk models which have been analyzed earlier. Certainly, it is no evidence for its comprehensiveness that all existing risk models still fit in the proposed meta-model. In fact, some models might be unsuitable for mapping. However, re-performing the transformation process for a specific number of widely accepted risk frameworks ensures that the meta-model is sufficiently applicable for risk management tasks in organizations.

In the context of a metamodeling hierarchy according to Karagiannis and Kühn [10] (cf., Figure 2.), the ICT risk-meta-data-model is situated on Level 2 – Metamodel, described by the Metamodeling Language UML. The selected risk management framework, e.g., COBIT for Risk [7], corresponds to Model on Level 1. It is described by means of the published framework, here in a semi-narrative way. The underlying Original itself can in fact be referred to as Level 0, and represents the organization’s risk management structure facing a concrete risk situation. On the top of the hierarchy, the Meta^2-Model on Level 3 defines the structural elements of the general UML class diagram. The Meta^2-Modeling Language can be understood as the modeling language UML used to describe the ICT risk-meta-data-model.

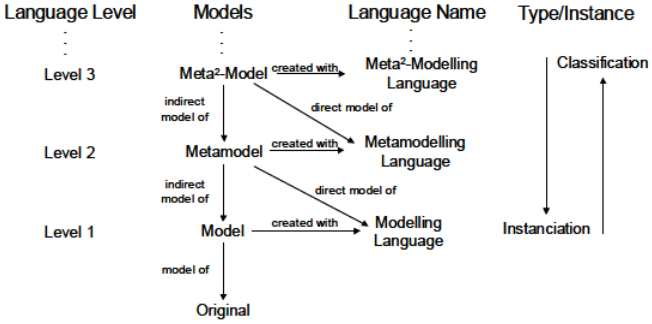


Figure 2. Metamodeling hierarchy [10]

C. *Related Work*

The approach introduced in this article is inspired by similar work in the field of disaster recovery [11] [12], which introduced a meta-model integrating data from different natural disaster scenarios. Othman and Beydoun have implemented a data model in order to store data relevant to disaster recovery and have conducted a proof of concept for two natural disaster incidents of recent history, the Christchurch earthquake and Fukushima nuclear incident [12]. In this article, their approach is shifted into the ICT risk management domain while verifying whether it is a sustainable method for risk management.

The conceptual ICT risk-meta-data-model was first introduced as a draft proposal at DACH Security 2016, Klagenfurt, Austria [13]. The present paper now provides a first comprehensive application of the mapping between the concrete risk model – here provided by COBIT for Risk – and the ICT risk-meta- data-model.

III. ICT Risk-Meta-Data-Model (RMDM)

A. *General Requirements*

One of the main objectives of the conceptual ICT risk-meta-data-model is to record key information of any underlying risk model in a way that it can be compared, consolidated, merged and subsequently analyzed from an abstract meta-perspective. This approach ensures that risk management models that have already been implemented in organizations in practice continue to be used, at least the most commonly applied frameworks. Furthermore, this abstraction step reduces the information risk managers work with to the really essential requirements needed to establish the risk management framework and to perform the risk management process. This transformation from the risk model to the more abstract and general meta-level must follow specific rules and definitely causes some information loss. To succeed it is necessary to strike a viable balance between the appropriate level of detail of the information content – by selecting only the key data, combining it semantically correct and transferring it to the meta-level – and the complexity level of the risk-meta-data-model. The authors assume that an adequate level of abstraction is reached when three to four structurally different risk models can be consistently represented as instances of the ICT risk-meta-data-model. This iterative refinement of the risk-meta-data-model through the analysis of different underlying risk models enhances its sustainability and robustness for practical application. The major advantage of formulating the ICT risk-meta-data-model as an ICT data model is that this allows organizations and companies to apply it in practice. By depicting the meta-model as unified modelling language (UML) classes diagram the modeler can immediately generate the corresponding data structure, implementing a demonstrator, which can serve as a proof of concept. Consequently, the ICT risk-meta-data-model itself constitutes an ICT application that can be applied in practice. In other words, the ICT problem to merge data from different risk models requires an ICT solution, which can immediately be applied by IT means.

The first draft of the ICT risk-meta-data-model was developed based on literature research on different risk management frameworks, which all propagate distinct risk models but use the same or similar terms. The literature research also indicated that there is a need to reflect on the exact meaning of the used terms, even if they seem to be identical. A feasible mapping of the concepts used in different risk models is a prerequisite for successfully raising the key information of the risk model up to the meta-level. This requires the definition of consistent concepts on the meta-level in order to prevent overlapping of concepts and resulting misinterpretations. However, it depends on the specific framework whether the risk model can be derived directly from the publications. ISO 31000 [1], for example, is formulated in a generic way, thus leaving room for interpretation. COBIT for Risk [7], does in contrast provide very specific control objectives for the key and supporting processes on a more detailed level. This characteristic was the main reason for selecting COBIT for Risk for the first mapping of a risk model to the ICT risk-meta-data-model. The conceptual model aims at reflecting both the fundamental framework establishment and the operative risk management process that covers the risk management lifecycle. This dual perspective is a key feature of many frameworks and easily visible in, e.g., ISO 31000 [1], NIST [2] [3] [4], or even COBIT for Risk [7]. A core aspect was to identify appropriate objects, which represent the focus points within the risk management structure. These objects are further described by dedicated attributes, which are the variables for storing the relevant risk management information. These attributes can be changed, modified, extended, and adapted by specific methods. By setting up this data structure it is possible to transfer all relevant risk management data from the origin model up to the ICT risk-meta-data-model. A very first draft of the modelling was already introduced in [13]. This article included a first draft of the ICT risk-meta-data-model and a possible approach for a proof of concept by applying COBIT for Risk as the underlying risk model. The first version of the ICT risk-meta-data-model was the result of a creative process. This process followed the life cycle of risk management: starting with the identification of risk factors, followed by the analysis of the resulting risk by linking it to the current challenges that the organization has to cope with, and finally the evaluation of the risk. Furthermore, the data-model may represent the monitoring of established treatment activities. As a consequence, the data model fulfills the essential requirements of the risk management process as suggested in [1]. The next step is to perform a precise mapping of information artefacts propagated by COBIT for Risk [7] as described in Section IV.

B. Main Components

Figure 3 shows the status quo of the advanced ICT risk-meta-data-model (RMDM) after the mapping. Classes or relationships written in italics are represented in the UML diagram. On an abstract level, all classes are derived from class *Organisation* and further divided in *Input*, *Process*, *Output* and *Actor*. The class *Actor* represents all actors and the responsibilities taken over by organizational entities, persons or roles, e.g., by the risk manager. This construction with generalization relationships both introduces an additional inherent structure of the data model and applies generalization and inheritance of attributes by superior classes in order to cope with the rising complexity. However, especially the class *Process* should also be able to summarize all important processes, policies, standards and guidelines that form the operational environment. It is not only an abstract data structure, but rather a hybrid class.

The operative part of the conceptual model and the linked classes can be divided into three virtual parts, which are not explicitly included in the UML diagram in Figure 3. In the first phase, the conceptual model shows the causal chain from the single risk factors to the identified risk, which is in fact a prerequisite for performing an operational risk management process. The causal chain starts on the left side with a pure *Hazard,* which *threatens* a particular *Vulnerability*, resulting in the associated class *Threat*. Hence, the *Threat* explicitly *affects* an *Asset* of the organization, leading to one main risk factor *Impact*, which is also designed as an associated class. The *Threat has* also some *Probability* to materialize, which is the second main risk factor. Typically, the *Risk* can be characterized by its essential components *Impact* and *Probability*, which are often shown in a risk matrix and here designed as composition of both risk factors. However, the *Risk* reflects only the identified risks and does not yet link to a detailed assessment, which the organization is required to do as a next step. The second phase of the risk management process involves the assessment of the previously identified raw risks and linking them with the given influencing factors and framework conditions. Accordingly, the class *Risk* is a composition for *AssessedRisk*. This class records all necessary evaluations of the risks.

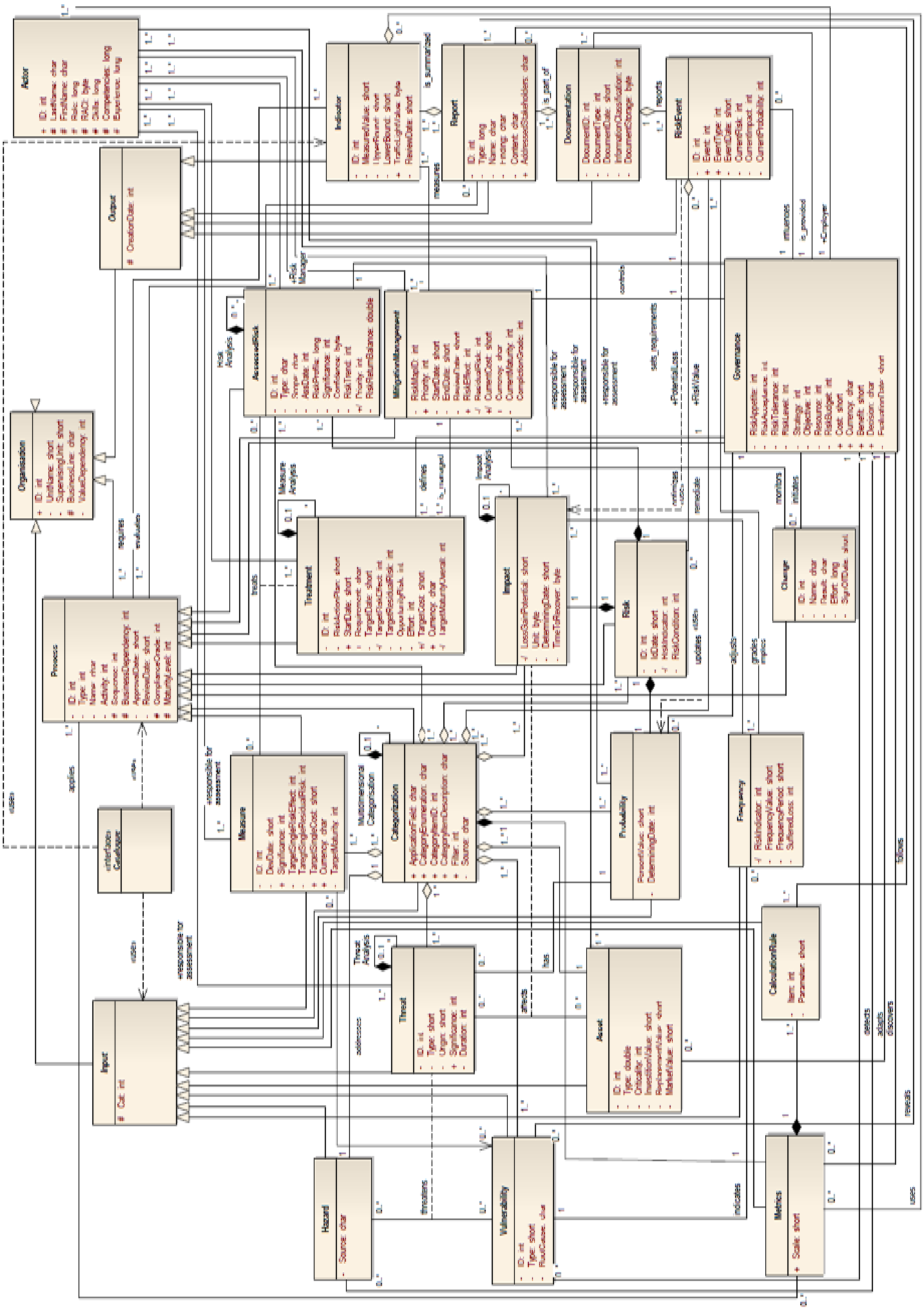


Figure 3. Conceptual ICT risk-meta-data-model (RMDM) described as UML class diagram

A *Measure* treats *AssessedRisk*, but there is no indication whether these measures are really applied in this stage. This is indicated by the associated class *Treatment*. In this way, a gradual filter starting from *Risk*, via *Measure* to *Treatment* can be applied. This filter allows focusing only on those risks, which should be actively addressed in the risk management process and further reduces the complexity of the model to the high-risk areas according to the individual risk level. Consequently, all the selected *Treatments* are managed by *Mitigation Management* during their whole lifecycle. Thus, this class represents the core structure for performing the risk management process within the defined risk management framework over time. The third part of the ICT risk-meta-data-model addresses the management's governance and its supporting elements, e.g., key output, risk events, or metrics. The class *Governance* establishes requirements for the class *MitigationManagement* and subsumes all the influencing factors to set up the appropriate risk environment. It holds management information about finance, strategy, objectives, risk appetite and tolerance etc. It is supported by ongoing *Changes*, which subsume all ancillary activities that support risk management activities, i.e., projects, changes. The class *Categorization* addresses all forms of structuring, e.g., categories, graduations, risk scales, and cluster definitions in the context of risk management efforts, and provides additional structure, while leaving enough leeway for individual metrics.

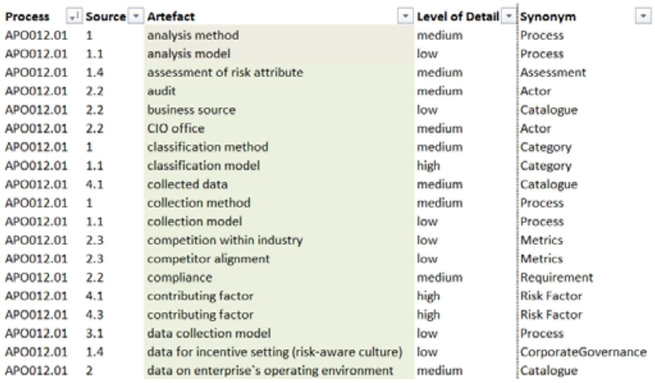
It is also possible to integrate external catalogues, frameworks, and regulations into the risk management model through the interface class *Catalogue*. *Documentation* in any form, especially *Reports* or (Key Risk) *Indicators*, has specifying classes, which are implemented as aggregations from the generic structure (*Documentation*) to more quantifiable information (*Indicator*). *Documentation* covers all documents that are relevant for governance decisions and thus creates an information repository. *Metrics* with specified *CalculationRules* stores all kinds of calculation bases, e.g., for Balanced Scorecard, Key Risk Indicators, or Process Performance. This ICT risk-meta-data-model also includes an important feedback loop. The class *RiskEvent* ensures the remediation of risk information based on new findings due to incidents based on real-life incidents. In combination with the class *Frequency*, the quantification of already suffered risk events enables the adjustment of the underlying risk factors, thus increasing the accuracy of further assessments. Intended self-referencing relationships for the classes *Categorization*, *Threat*, *Impact*, *AssessedRisk*, and *Treatment* enable further substantial analysis, e.g., multidimensional assessments of cascading effects if needed.

IV. MAPPING

A. *Method*

The critical success factor for the proper functioning of the meta-modeling idea is the coherent transformation of the information of the selected risk model up to the meta-model while at the same time sufficiently reducing the information content. This transformation is in fact a mapping of all the relevant pieces of information that is necessary for performing risk management with the selected risk model. The risk model COBIT for Risk was selected as the first proof of concept for the metamodeling approach. It provides an appropriate degree of concreteness in order to verify the draft concept that was first introduced in [13].

In a first step, both risk management core processes Evaluate, Direct and Monitor (EDM) 03 "Ensure Risk Optimisation" – the setup of the risk management environment in the organization – and Align, Plan and Organise (APO12) "Manage Risk" – the risk management process as discussed above – were analyzed. All information artefacts mentioned as input or output objects and in the description of the risk specific activities were extracted to a list. These have a different degree of concreteness, which was also assessed. This step was repeated for each of the other twelve supporting processes, which are marked in dark red in Figure 1. This finally resulted in a list of 1619 identified information artefacts, but this list included duplicates, synonyms, and different notations of the same objects, cf. Figure 4. In a second step, all these entries were consolidated in order to even out differences and reduce the amount of information artefacts for further analysis. All entries were transformed into a consolidated object, in fact performing a form of abstraction. This transformation resulted in a list of 26 objects, which corresponds to the column 'synonym' in Figure 4. The purpose of these objects was to set up a data store, leading to a UML class at the end of this process. This abstraction process was conducted as iterative working step because the consolidated object list initiated continuous improvement actions in order to get a coherent list for the subsequent steps. Once the list of consolidated objects had been verified, the consolidated object list was mapped to the classes in the UML diagram. In a third step, the class attributes were revised so that the essential data for risk management fit properly into the appropriate classes.



Process	Source	Artefact	Level of Detail	Synonym
APO012.01	1	analysis method	medium	Process
APO012.01	1.1	analysis model	low	Process
APO012.01	1.4	assessment of risk attribute	medium	Assessment
APO012.01	2.2	audit	medium	Actor
APO012.01	2.2	business source	low	Catalogue
APO012.01	2.2	CIO office	medium	Actor
APO012.01	1	classification method	medium	Category
APO012.01	1.1	classification model	high	Category
APO012.01	4.1	collected data	medium	Catalogue
APO012.01	1	collection method	medium	Process
APO012.01	1.1	collection model	low	Process
APO012.01	2.3	competition within industry	low	Metrics
APO012.01	2.3	competitor alignment	low	Metrics
APO012.01	2.2	compliance	medium	Requirement
APO012.01	4.1	contributing factor	high	Risk Factor
APO012.01	4.3	contributing factor	high	Risk Factor
APO012.01	3.1	data collection model	low	Process
APO012.01	1.4	data for incentive setting (risk-aware culture)	low	CorporateGovernance
APO012.01	2	data on enterprise`s operating environment	medium	Catalogue

Figure 4. Excerpt of the list of information artefacts [own research]

B. *Results*

The mapping process showed that it is generally possible to transform the essential risk management data from COBIT for Risk up to the meta-level. Small amendments to the draft version of the ICT risk-meta-data-model were necessary after completing the mapping process, e.g., the introduction of the new class *Changes*, which reflects all current change management activities in the considered organization. The transformation is highly dependent on how concrete the specification of the risk model and its components is. If the risk model leaves too much room for interpretation inconsistencies may appear in the instantiation of the ICT meta-data-risk-model itself. This means that activities without inputs or outputs should be scrutinized. Almost all inputs, outputs and standard COBIT 5 activities specified in the twelve risk supporting processes were unsuitable for the mapping. Thus, certain problems are expected when using ISO 31000 as base risk model because of its highly generic approach. This means that not every risk management framework may be suitable for the mapping due to the different levels of detail of the different frameworks. Furthermore, the framework must provide storage of all kind of documentation that supports the functioning of the management system. Currently, the meta-model includes the dedicated class *Documentation* for this issue. It was originally intended only for risk management documentation, but it has a broader scope, providing a repository for all documentation produced by the applied management system.

The presented work extends the proof of concept that was outlined in [13] to all affected risk management processes of the COBIT for Risk framework. Some small adjustments of the first draft of the ICT risk-meta-data-model were made, but no fundamental changes of the inherent structure of the classes or relationships were necessary. This shows that the ICT risk-meta-data-model is able to represent and store the necessary information for applying the COBIT for Risk framework in principle.

C. *Further Research*

Further research is still needed to verify the transformation process with two or three other risk management frameworks. This verification should definitely be done for ISO 31000 [1], despite the above-mentioned difficulties to be expected The suitability of ISO 31000 should be verified because of its outstanding importance as a widely accepted standard. The NIST publications [2] [3] [4] and COSO ERM in its new published version [5] also provide the more detailed content that is necessary for the mapping and are thus good candidates. If it is possible to map their information requirements in the same way as it has been done for COBIT for Risk, the ICT risk-meta-data-model can be applied at least for these four risk management frameworks, in this way providing an adequately sustainable meta-model solution. If the mapping has been applied several times and the attributes are almost stable (except for a refinement of the definite data types and the visibility properties), the methods can be refined next. The methods of a class should be able to support the complete lifecycle of the concerning attributes. The third area in which refinements are needed is the relationships. It must be verified whether a direct data exchange between the different objects is needed or transitive relationships achieve the same result. Once these three research questions have been solved, the ICT risk-meta-data-model can be implemented as a first demonstrator, thereby starting the technical verification process. Analyzing these research questions is an ongoing process in order to verify the applicability and utility of the ICT risk-meta-data-model.

The fundamental idea of aggregating risk management data that is stored in different risk models and can be effectively applied when different risk information, e.g. from different companies or organization units that still apply different risk models, need to be migrated. This might be necessary when different companies merge or Comparisons across industry sectors are needed. This means that the final evidence for the added value of the ICT risk-meta-data-model can be provided when different risk models have been analysed. The upcoming research on applying the ICT risk-meta-data-model to a second risk model will further strengthen this evidence.

V. CONCLUSION

This article shows the basic instantiation of a specific risk model – in this case the risk model of COBIT for Risk – by means of the conceptual ICT risk-meta-data-model. The objective of the research design is to introduce an ICT risk-meta-data-model for ICT, and to embed it in the context of different established risk models that are commonly applied in the ICT area. The approach of designing a consistent superstructure in form of a meta-model with no need for replacement of the already established ICT risk management models is based on the principle of an ex-post adjustment. Additionally, it provides a data-oriented and more formalized way of overcoming the current organizational and model-related restrictions. The meta-model addresses the whole risk management lifecycle as recommended in [1], from identification, analysis, evaluation to treatment. It reflects both the risk management context and the monitoring and communication requirements for the process. The three main components and the conceptual background of the involved objects are discussed. The findings can be summarized as follows:

- An instantiation of the ICT risk-meta-data-model is generally possible and is a promising possibility to overcome the current situation in ICT, where many different risk models and methods are applied.
- The critical success factor is the coherent transformation of the information of the selected risk model up to the meta-model, while at the same time sufficiently reducing the information content. All essential data of the risk model have an equivalent reference in the superstructure.
- It is crucial to repeat the mapping with other appropriate ICT risk models in order to strengthen the ICT risk-meta-data-model. Moreover, this will reconfirm the general applicability of the meta-data-model and will increase its utility due to having several different risk models mapped to a meta-level.
- The methods and relationships of the objects in the ICT risk-meta-data-model need to be refined before a practical demonstrator can be implemented that can be fed with risk management use cases.

Results show that transferring the general information artefacts specified by COBIT for Risk into the classes of the meta-model is feasible and promising. The future refinement effort will iteratively improve the ICT risk-meta-data-model in order to further develop and evaluate it and strengthen its applicability for ICT risk management.

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