Risk Management Practices in Information Security
Exploring the Status Quo in the DACH Region

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1. Introduction

Information security is concerned with the protection of information regarding confidentiality, integrity and availability. With the advent of tighter regulatory demands regarding information security (such as the EU GDPR and NIS Directive) and increasing customer demands, enterprises are forced to establish measures to ensure the information security of their valuable assets. This especially applies to enterprises working with protected Personal Identifiable Information (PII), payment data or other sensitive information. Establishing and operating an Information Security Management System (ISMS) has become the tool of choice to systematically deal with information security risks. ISMSs provide actionable sets of requirements, policies, guidelines and process definitions to aid organizations in their quest to comply with their individual information security goals. Information Security Risk Management (ISRM) is a vital part of any ISMS ensuring that information security risks are systematically identified, analyzed and treated in accordance with an organization’s risk appetite.

Over the last years the overall greater need to systematically comply with information security goals has supported the raise of a plethora of tools and methods to support all ranges of information security and information security risk management activities. For example, there has been substantial research in the state of practice of specific Information Security Management (ISM) and ISRM practices. The application of information security policies (Bulgurcu et al., 2010; Fulford and Doherty, 2003; Sommestad et al., 2014) or the automation of security controls to mitigate identified information security risks (Montesino and Fenz, 2011; Aguirre and Alonso, 2012; Tracy, 2007) as well as the support of specific risk identification techniques (Beckers, 2015; Sommestad et al., 2013; Panda, 2009) have been at the center of attention for more than a decade. Still, the general practical application and dissemination of these approaches as well as their integration in existing organizationally established ISMSs or ISRM settings, is hard to gauge (Wangen and Snækkenes, 2013). Part of this situation is due to enterprises not readily disclosing their ISRM practices especially when past missteps might have disrupted their ISM activities. Furthermore, many of the approaches proposed from academia target large-sized companies and specific information security pains they already face. Thus, they might impose higher-than-acceptable costs for other enterprises. The resulting inability of enterprises to reliably estimate the cost-benefit ratio of these highly specialized approaches might prevent them to justify their implementation, especially in light of their own pressing information security needs, their current state of practice and their budgetary boundaries. Consequently, researchers would benefit from a better understanding of the current situation regarding ISM and ISRM to better tailor their approaches to a broader audience and ensure a more general applicability of their results.

While ISM is generally considered a standardized discipline with explicit ISMS standards such as ISO 27001 (ISO, 2013) or the BSI IT Baseline Protection Methodology (BSI, 2017), the actual application within enterprises may vary greatly thanks to tolerances these standards allow. Apart from roles, workflow descriptions (which are in case of ISO 27001 rather abstract) and general requirements (which predominantly state the desired result, not the means to achieve it) there are no generally agreed upon tools or methods for
conducting specific risk management activities within ISMSs. While standards do provide best-practices it is up for organizations to choose the most fitting ones for themselves, which in turn leads to highly heterogeneous ISMSs even if they are certified by the same standard.

Research regarding the state of risk management practices applied within ISMSs is rather limited with prior publications either narrowly addressing specific aspects, focusing exclusively on the examinations of management practices, or investigating singular use cases (cf. Section 2). Wangen and Snekkenes (2013) further illustrate the overall lack of good empirical research in the area of ISMS and ISRM. Detailed studies covering ISRM practices of multiple enterprises including workflows, stakeholder collaboration and tool usage are not available. The goal of this research is therefore to evaluate the current practice and to identify potential shortcomings in ISM workflows, especially regarding the management of information security risks. The study at hand lays the foundation to address the following research objectives:

- Gain comprehensive understanding of the current state of practice of risk analysis used in Information Security Management
- Improve the current organizational information security risk analysis practices
- Identify potential means for automatization in current risk analysis approaches applicable within ISMS settings.

The scope of this exploratory investigation are enterprises that have either implemented or plan to implement an ISMS to ensure that all participants apply ISRM on a broader scale as part of enterprise-wide information security management practices. Thus, we are not interested in smaller-scale, independent, non-information-security-centric risk management activities. Our study focuses on enterprises operating in the DACH region (Germany, Austria, Switzerland) primarily due to the EU GDPR (Council of European Union, 2016b) and NIS Directive (Council of European Union, 2016a) taking effect during our investigation period. We therefore presumed an increased organizational interest in information security and privacy in that geopolitical area.

With this paper we contribute (1) the design of a detailed survey to evaluate the current state of risk management practices conducted as part of organizations ISMSs together with (2) the study results and analysis for the DACH region as well as (3) the deduction of potential points for improvement in ISRM practices. Our findings will be further used to enhance the tool-supported and continuous ISM framework ADAMANT (Brunner et al., 2019, 2018, 2017).

The remainder of this paper is structured as follows. Sections 2 and 3 describe the background and related work of our research. Section 4 presents the applied research method and the developed survey instrument. The results of our exploratory survey are presented in Section 5 before we discuss our conclusions and recommendations in Section 6. We conclude this paper with a summary and outlook on future work in Section 7.

2. Background

In this section we will present background to our study, mainly ISMS and ISRM together with relevant standards, frameworks, and research resources. We will further present the conceptual model developed to guide our research and survey design.

2.1. Information Security Management and Information Security Management Systems

While competing definitions for information security can be found, a commonly accepted one is provided by Whitman and Mattord (2011): “Information security is the protection of information and its critical elements, including the systems and hardware that use, store, and transmit that information”. ISM consequently deals with the implementation and monitoring of an organization’s desired information security level. An ISMS is the management tool composed of interrelated and interacting organizational elements (policies, processes, roles, etc.) that supports the preservation of the confidentiality, integrity and availability of information values and information systems (ISO, 2013). These information values and information processing systems are commonly referred to as assets and managing an inventory of all relevant assets is a fundamental requirement for any given ISMS. ISRM techniques are applied to systematically identify security risks of these assets, to analyze and evaluate them and to find proper means to treat the corresponding risks to information security.

In Figure 1 we present a unified, general mode of operation at the heart of any ISMS derived from relevant standards and best practices. Top management will typically set the overarching goals by defining a strategic information security policy and the scope of the ISMS. A broader set of stakeholders will then be responsible for operationalizing the outset goals by conducting a risk analysis, selecting appropriate counter measures to reduce the risk to the agreed level and subsequently implementing and operating them. This all is conducted as part of a continuous improvement cycle with reporting to top-level management and readjustment when necessary.

Recognized ISM standards and best practices are the ISO 27k family of standards (ISO, 2013, 2011), the BSI IT Baseline Protection Methodology (BSI, 2017), the NIST Risk Management Framework (RMF) (NIST, 2018) and COBIT (ISACA, 2012). While conceptually slightly different, these standards follow the described mode of operation and provide enterprises with useful guidelines. The actual implementation of said processes or the methods used for certain ISM and ISRM activities, however, are not mandated. The ISO 27001 standard, for example, list requirements that organizations risk assessment processes must meet (cf. ISO 27001, Section 6.1.2), but leaves the actual decision of the
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2.2. Information Security Risk Management

Information security risk is defined as “potential that a given threat will exploit vulnerabilities of an asset or group of assets and thereby cause harm to the organization” (ISO, 2011). A general approach to systematically manage information security risks is outlined in the ISO 27005 standard (ISO, 2011). The same basic building blocks and processes can be universally identified in nearly all ISRM standards, best practices and many other information security frameworks or risk management approaches. In contrast to many other risk management applications, the actual area of investigation is not restricted to singular domains (e.g., software development, IT service operation) or single projects, but most often covers the whole enterprise or a substantial part of it as strategically defined by the ISMS scope. Figure 2 illustrates this process which generally consists of 5 different activities where (1) context establishment, is followed by (2) risk assessment, with (3) risk treatment (and possibly acceptance of residual risks) concluding each iteration. Risks are further continuously (4) monitored and reviewed and (5) communicated within organizations.

The first step, context establishment, primarily deals with the definition of the scope and boundaries of the risk management initiative as well as providing the organizational principles to conduct ISRM. In context of an ISMS this step will be aligned with the respective activities already mandated by the applied ISMS standard. Risk assessment includes the identification of risks, their estimation and evaluation. Risk identification will typically involve the documentation of relevant assets (i.e. within the scope), the identification of potential threats to and vulnerabilities of these assets. Taking established security controls into account potential consequences can then be identified resulting in a list of incident scenarios that might harm an organization’s information security goals. These risk scenarios require subsequent estimation to assess their actual level of risk where enterprises can choose from a variety of qualitative (subjec-
automated and scale-based, e.g., critical, high, medium, low) and quantitative (calculated, e.g., expected annual financial loss) risk estimation approaches. This step will commonly include the determination of each risk’s consequence and its respective likelihood. Depending on an organization’s risk acceptance criteria, all information security risks above the agreed threshold will require proper risk treatment. If possible and financially reasonable organization will define additional controls to reduce these risks to finally reach a satisfactory residual risk level. The monitoring of information security risks and review of security controls until the next cycle concludes each risk management iteration. The continuous communication of information security risks and all information obtained from risk management activities is of crucial importance to ensure timely coordination between involved stakeholders.

Established general-purpose ISRM standards include ISO 27005 (ISO, 2011), the NIST SP800-30 Guidelines (NIST, 2002) and the RiskIT Framework (ISACA, 2009). Other management standards with a heavy emphasis on ISRM are the BSI IT Baseline Protection Methodology (BSI, 2017), COBIT (ISACA, 2012), Information Technology Infrastructure Library (ITIL) (Long, 2012) and the Common Criteria for Information Security Evaluation (The Common Criteria Recognition Agreement Members, 2006). Additional domain-specific standards cover ISRM practices, although within a more limited scope and typically present a specialization of a general-purpose standard for a given domain.

Research has produced a variety of ISRM techniques. The more established ones with information security focus are ISRAM (Karabacak and Sogukpinar, 2005), CRAMM (Yazar, 2002), OCTAVE (Panda, 2009), CORAS (Lund et al., 2010) and UMLsec (Jürjens, 2002) with the latter ones emphasizing formal model-driven approaches. They require a greater effort to build and maintain adequate system and enterprise models, but simultaneously offer features for formal security analysis. More general-purpose techniques, primarily considered in risk assessment, are Failure Mode and Effect Analysis (FMEA), Preliminary Hazard Analysis (PHA), Fault Tree Analysis (FTA) or Hazard and Operability Study (HAZOP) which all heavily rely on stakeholder expertise and have less stringent documentation and modeling requirements.

Automation in ISRM is researched from different perspectives. An approach to automatically identify adequate security requirements based on an asset model of the system under investigation has been presented by Pasquale et al. (2016). Adaptive ISRM approaches enhance support for dealing with changes of assets as well the threat landscape (Benaceur et al., 2014). Automated risk analysis techniques using data flow analysis in business process models has been proposed by Accorsi and Lehmann (2012) and Berger et al. (2016). A tool-based approach automating threat analysis has been presented by Schaad and Borozdin (2012) but is strictly limited to assess software architectures. Due to the specialized nature of these approaches (either with regard to documentation effort, required stakeholder expertise or general applicability), none of them could have been directly evaluated in context of an organization’s much more expansive ISMS.

### 2.3. Conceptual Model

The goal of our study was the determination of the status quo concerning risk management practices in ISM. As such we need to investigate the different approaches applied by enterprises to tackle risk management activities from multiple viewpoints. We thus developed a model from multiple ISRM and ISMS standards and scientific publications. In addition we consulted multiple well-received practitioner guidelines in the information security management domain such as Disterer (2013); Schou and Hernandez (2015); Calder and Watkins (2012); Watkins (2013) and more. The conceptual model shown in Figure 3 illustrates how we conceptualize major activities, the relevant application environment and relations in between them.

The established ISMS or information security organization defines the scope of all conducted risk management...
activities and will mandate methods to be applied in each step. Each method will require certain documentation artifacts which, in our conceptual model, are any formally or informally documented collections of information required for any given risk management activity. This includes high-level information security management policies (e.g., defining the scope and strategic alignment of an organization's information security activities) provided by the overarching ISMS as well as all information being collected, provided, and potentially enriched by applied risk management methods. To gather a comprehensive picture we further distinguish between application of methods in distinct risk management activities. Expected documentation artifacts for asset documentation will include hardware inventories, process documentation or network plans, whereas risk identification will additionally deal with threats and vulnerabilities and provide documentation artifacts regarding risk scenarios. These will be enriched with a risk rating via risk estimation methods. Risk treatment will finally provide security controls as means to mitigate unacceptably high risks in accordance with an organization’s risk treatment plan.

Different sets of stakeholders conduct risk management activities and utilize tools and data sources to complete their respective tasks. Tools will support one or more tasks and can be used as direct means to perform them (e.g., vulnerability scanner to identify vulnerabilities of an asset) or to orchestrate stakeholder collaboration (e.g., wiki to discuss individual risk ratings and reach a conclusive decision). Various data sources can be either directly used by stakeholders (e.g., vendor-specific security advisories) or interfaced by dedicated tools (e.g., vulnerability scanner integrates vendor-specific vulnerability database). Furthermore, different data sources can be used to store relevant documentation artifacts.

By investigating the concepts in this model – the characteristics of each element and their relationships in actual organizational settings – we can develop an encompassing picture of the current state of ISRM practices in ISM and identify potential challenges to be addressed in future research.

3. Related Work

Several studies have investigated the state of practice regarding ISM and ISRM. Investigations exploring the status quo on a broader setting are limited. Commonly research is restricted to individual aspects or individual risk management practices. In the following, we will thus discuss studies that we deem closely related to our research endeavor. These empirical studies include exploratory investigations, quantitative surveys, qualitative expert interviews, industrial case studies and systematic literature reviews. However, not all of them might necessarily cover the whole area of ISM or all aspects in ISRM.

The very stakeholder-centric point-of-view regarding information security policies, their implementation, perception and impact has been empirically and exploratory investigated in multiple articles. A study analyzing the differences in stakeholder perception regarding security policies has been conducted by Samonas et al. (2020). Compliance with and employees adherence to information security policies was investigated by Ifinedo (2014, 2012) and
Sikolia et al. (2016). Sommestad et al. conducted two noteworthy studies starting with the identification of variables influencing compliance with information security policies of organizations (Sommestad et al., 2014) and a further investigation assessing the theory of planned behavior to explain policy compliance (Sommestad et al., 2015). All listed articles try to shed light into employees willingness to follow information security policies and how to increase their adoption in organizational settings. Theoretical models that have been applied include the Theory of Planned Behavior (TPB) and Protection Motivation Theory (PMT). Apart from Sikolia et al. (2016) most study results have been derived from smaller investigations either covering a singular organization or surveys with small sets of participants. Generalizability of findings has to be considered in need of improvement with studies pointing to heavy influences from distinct organizational settings. Nearly all studies conclude that top-management commitment is one of the most important drivers of information security compliance in organizations.

Research regarding stakeholder participation in ISRM practices and its influence in context of regulatory compliance has been presented by Spears and Barki (2010). Rees and Allen (2008) and Montesdioca and Maçada (2015) conducted surveys to investigate the user satisfaction with information security and risk management practices. Other exploratory studies investigating the role of stakeholder knowledge for assessing data quality of documentation artifacts used in ISRM or for the expanded endeavor of Governance, Risk Management and Compliance (GRC) activities have been conducted by Sillaber and Breu (2015); Sillaber et al. (2019). These studies primarily investigate the satisfaction of various stakeholders with specific ISRM practices or their respective results. They do not provide a substantial investigation of these practices themselves, how they are implemented, which tools are used or which collaboration patterns are applied.

Moreover, a few empirical studies by Sauerwein et al. analyze the use of external and internal security information sources for ISRM processes. For example, Sauerwein et al. (2019) provides a comprehensive analysis of these information security sources used in research and practice. Most of these sources are unstructured and used in an ad-hoc manner by employees as input for critical information security and risk management processes without formal approval. Sauerwein et al. (2018) empirically investigates this phenomenon and describes it as shadow threat intelligence.

Academic studies concerning the overall state of practice in ISMSs are sparse. The influence of organizational culture on ISMS efficiency was analyzed by Chang and Lin (2007). The quality of information security management and implemented controls has been the focus of Baker and Wallace (2007). Several case studies focusing on subtopics of ISRM from an organizational perspective can be identified. These case studies include investigations on how organizations conduct information security assessments based on standards (Shedden et al., 2006), how security risk assessment methods can more efficiently identify and treat the knowledge associated with business processes (Shedden et al., 2011) and the potential for improved asset identification enabled by the Rich Description Method (RDM) (Shedden et al., 2016). A case study based comparison of ISMSs has been conducted by van Wessel et al. (2011) by investigating their implementation and impact in European and Chinese enterprises. Barlette and Fomin (2010) conducted research into general international ISMS adoption and derived corresponding drivers and success factors. These studies at most consider the ISMS standard used by organizations and do not distinguish between differences in their implementation. Overall, we could not identify reliable research regarding actual ISMS implementations, tool utilization and orchestration of stakeholder collaboration. In addition, many of other available studies such as Fitzgerald (2007); Pierce et al. (2008); Hooper and McKissack (2016) primarily focus on the ISMS top-management perspective. They exclusively involve roles such as Chief Information Security Officer (CISO) or Chief Information Officer (CIO) and capture only parts of the ISMS and ISRM activities under direct supervision of these subjects.

Several researchers conducted empirical or literature studies to identify issues and challenges in ISM and ISRM. In this context, Fenz et al. (2014) outline current challenges in ISRM. Wangen and Snekknes (2013) introduce a taxonomy of challenges in ISRM. Wangen (2016) documents several issues concerning the application of qualitative and quantitative methods in ISRM practice, Soomro et al. (2016) argue the need of a more holistic approach for ISM and Webb et al. (2014) highlight deficiencies in the practice of information security risk assessment that lead to poor decision making and inadequate security strategies.

Looking beyond empirical studies performed in academic contexts, we identified several related whitepapers and reports published by IT and management consulting companies such as PWC (2015), Deloitte (2017), Ernst & Young (2018) or Microsoft (2019). Other viable resources are available from common interest groups such as ENISA (2015) or SANS Institute (2019). Considering obvious financial motives behind most of these studies, their conclusions should be critically questioned. However, certain reoccurring subjects in these studies are notable and corroborate academic findings such as challenges in reliably evaluating an organization’s risk exposure and the alignment of business and technical perspectives. The continuous evaluation of systems within information security management and risk assessment is another open and reoccurring challenge that – in light of more flexible supply chains, increase in usage of distributed services and an overall increase in information system complexity – requires further attention.

The available body of academic (and also non-academic) research is inconclusive to fully address our research objectives stated in Section 1. We thus conducted a thorough empirical and exploratory investigation into the current state of practice regarding ISRM practices in ISM. Contrary to available research, a broader study that emphasizes not just
the strategic and top-management roles’ perspective but that draws a conclusive picture of actually implemented risk management practices including used methods, tools, documentation artifacts and collaboration patterns is required to better guide future research in this domain.

4. Research Method

We used an anonymous online survey instrument for the purpose of this exploratory investigation and followed respected guidelines for the design and execution of our research (Pfleeger and Kitchenham, 2001; Kasunic, 2005) and proactively addressed challenges in survey research (Wagner et al., 2019). A pilot questionnaire and a subsequent interview with an experienced ISMS manager were conducted to ensure the validity and content as well as the general usability of the developed survey instrument. Received feedback allowed us to make a few minor changes to some multiple choice answer options. In this section, we present the final results of our study design process.

4.1. Research Questions

Our primary research goal was to gain insight into the current state of risk management practices in ISM and to use this information to further identify practical and directly applicable means for improvement. Considering the sensitive topic at hand we refrained from directly asking study participants to reveal the inner workings of their ISMS and especially their risk management practices. In addition, the expected heterogeneous nature of these processes would have further complicated the design of an efficient online survey.

Instead, we developed an approach to collect vital information regarding our research objectives which will not require study participants to disclose sensitive information. In accordance to our conceptual model (cf. Section 2.3) we set the focal point of our investigation on the considered artifacts, involved roles, methods and tools which further proved to be a more reliable way to collect the desired data during initial pilot interviews. We consecutively derived the following research questions for our survey:

RQ1 What methods and documentation artifacts are considered for risk analysis in ISMS?

RQ2 Which stakeholders are involved in the risk analysis and how do they cooperate?

RQ3 What information sources and tools are used for risk analysis in ISMS?

By investigating these research questions we can gain a better understanding of the current state of practice and identify potential areas for improvement with regard to stakeholder collaboration, artifact documentation and tool usage in ISRM activities.

4.2. Instrument

We structured our online questionnaire in six question blocks. These cover demographics (DE), general information security management practices (IM), asset documentation (AS), risk identification (RI), risk estimation and evaluation (RE) and the documentation of security requirement and controls (SE). Overall, the questionnaire contains 45 questions and was aimed at 20 minutes duration for completion.

Table 1 shows an excerpt of the designed survey, the complete survey instrument is provided in Appendix A. The table’s first column contains the question ID which is superseded by a question block indicator. The second column contains the question itself. The last column shows the type of question: Single choice, Multiple choice, Yes/No, Numeric, Rating, Ranking and Open. Ratings are used to inquiry specific implementation aspects of different ISRM tasks (e.g., “Risk identification is performed automatically.”). We used an ordinal scale of 4 (“Applies fully”, “Applies mostly”, “Applies to some extend”, “Does not apply”) with the additional option “Do not know” to capture when participants were not knowledgeable. Rankings were used to capture the importance of utilized tools following multiple-choice questions where more than 5 options were provided (cf. questions RI003 and RI004 in Table 1). If a single or multiple choice question allowed participants to extend answer options via a dedicated text input it is marked with + and if participant were able to provide an additional comment to a question this marked with * respectively. Both options were used to allow participants to express company-specific deviations and additions.

Due to natural differences between enterprises already operating an ISMS, and those still in the planning phase, as well as participant involvement in and knowledge of dedicated ISM activities we implemented alternative paths in our survey. Questions with subscript “alt” were only shown to participants which answered previous questions to the negative (e.g., IM002alt and IM003alt were shown to participants not operating an ISMS instead of questions IM002 to IM005).

Each question block was further complemented by descriptive text providing additional context for every question. Terms and definitions used throughout the questionnaire and within this descriptive blocks were taken from the ISO 27k family of standards (ISO, 2013). The description for the risk identification block is provided as example below:

This group of questions asks specifics about the Information Security Risk Management (ISRM) approach at your organization. In particular these questions target the way how risks are identified at your organization as part of your ISMS or ISRM initiative. According to ISO 27005 Risk Identification is “[…] the process to find, list and characterize elements of risk”.

Apart from the question block for demographics, each block contains dedicated questions directly linked to our research questions. We ask participants for applied methods and characteristics of documentation artifacts (RQ1), involved
Table 1
Survey Questions (excerpt)

| Id  | Question                                                                 | Type          |
|-----|---------------------------------------------------------------------------|---------------|
| DE001 | What is your organizational role?                                       | Multiple⁺  |
| DE002 | Which of the following personal certifications and qualifications do you have? | Multiple⁺  |
| DE003 | How many years of professional experience in the area of information security do you have? | Numeric  |
| DE004 | What type of industry is your organization in?                          | Single⁺  |
| DE005 | What is the size of your organization?                                  | Single  |
| IM001 | Do you operate an Information Security Management System (ISMS)?         | Single⁺  |
| IM002 | What is the most important driver for Information Security Management in your organization? | Multiple⁺  |
| IM003 | Which Information Security Risk Management (ISRM) methodology does your organization apply? | Multiple⁺  |
| IM004 | How often does your organization conduct an information security risk management cycle? | Multiple⁺  |
| IM005 | Which events additionally trigger information security risk management activities in your organization? | Multiple⁺  |
| IM002ᵃᵤᵗ | What do you consider the most important driver for Information Security Management? | Multiple⁺  |
| IM003ᵃᵤᵗ | Which Information Security Risk Management (ISRM) methodology do you know? | Multiple⁺  |
| RI000 | Does your organization perform Information Security Risk Management (ISRM) or related activities? | Yes/No  |
| RI001 | Rate the following statements with regard to the information security risk identification approach of your organization. | Rating  |
| Stmt1 | Risk identification is performed automatically.                         |              |
| Stmt2 | Every relevant security risk is identified in a timely fashion.         |              |
| Stmt3 | Sharing of relevant security information is conducted via a formal process. |          |
| Stmt4 | Relevant security information is automatically preprocessed and filtered for conducting risk identification. |        |
| Stmt5 | Exchange of security information with other organizations and individuals has been beneficial for risk identification. |          |
| RI002 | Which aspects are considered for information security risk identification in your organization? | Multiple⁺  |
| RI003 | Which EXTERNAL information sources are used for information security risk identification in your organization? | Multiple⁺  |
| RI004 | Which are the three most important EXTERNAL information sources for information security risk identification in your organization? | Ranking  |
| …   | …                                                                         |              |
| RI011 | What are the most pressing challenges during information security risk identification for your organization? | Open  |
| …   | …                                                                         |              |

4.3. Data Collection Procedure

Our target audience were companies and organizations which had already established an ISMS or were planning to do so in the near future. We explicitly did not focus on companies which already operated a certified ISMS since this would greatly decrease our potential survey population without necessarily raising the result quality for this exploratory investigation. Targeted participants were stakeholders being responsible or involved in strategic or operational ISM activities at these companies. Again, we did not exclusively target top management information security roles (e.g., CISO, CIO) as this would have unnecessarily restricted our population and would potentially lead to a more strategic point of view instead of the targeted practical one. Furthermore, top level ISM roles are not guaranteed to be in place at targeted companies, especially the ones who are currently introducing or only planning to implement an ISMS.

Participants were acquired through multiple channels. We invited participants from Austrian research transfer projects Qualifizierungsnetzwerk-West (Q-West), Digital Tourism Experts (DTE) and Digitalisierung und Sicherheit (DuS). These were prime candidates as they attended practical information security management courses covering various risk management practices with the clear intention to either introduce systematic ISM in their organizations or improve their current ISRM practices. In addition we invited German information security experts through a dedicated security common interest group’s mailing list. Finally, we directly contacted and invited respected ISM and ISRM experts from industry. The data collection phase for these participant groups diverged and is shown in the data collection overview in Table 2. In total, 351 participants were invited between November 2017 and July 2019. Invitations were delivered via e-mail and all participants were informed upfront that responses were collected anonymously. The used invitation letter is provided in Appendix B. We used the same self-hosted and administrated survey tool instance (Lime Survey – https://www.limesurvey.org) for all participant groups.
Table 2
Data collection (overview)

| Group       | Country | Invited | Data collection phase |
|-------------|---------|---------|-----------------------|
| Q-West      | Austria | 34      | 2017-11 – 2018-01     |
| DTE         | Austria | 43      | 2018-05 – 2018-10     |
| DuS         | Austria | 46      | 2019-07 – 2019-09     |
| Security    | Germany | ~200    | 2018-05 – 2019-09     |
| Interest    |         |         |                       |
| Group       |         |         |                       |
| Direct      | DACH    | 28      | 2017-11 – 2018-12     |

Table 3
Mapping between research and survey questions

| Research Question | Survey Questions |
|-------------------|------------------|
| RQ1 What methods and documentation artifacts are considered for risk analysis in ISMS? | IM001, IM002, IM003, IM004, IM005, AS001, AS002, RI001, RI002, RI010, RE004, RE005, RE006, RE007, RE009, SE001, SE006 |
| RQ2 Which stakeholders are involved in the risk analysis and how do they cooperate? | RI007, RI008, RI009, RE001, RE002, RE003, SE002, SE003 |
| RQ3 What data sources and tools are used for risk analysis in ISMS? | AS003, RI003, RI004, RI005, RI006, SE004, SE005 |
| — Challenges in respective areas | RI011, RE008, SE007 |

4.4. Data Analysis Procedure

Data analysis was, due to the use of an online questionnaire and export capabilities of the survey tool, straightforward. Responses were exported and briefly checked for completeness and consistency. Obviously incomplete responses were removed. That concerned responses where less than 66% of questions were answered or participants made excessive use of ignoring all non-mandatory questions. Furthermore all responses were discarded where participants showed no knowledge of any concerned ISRM activity (e.g., answering "I do not know" for all statement ratings in multiple question blocks like RI001 shown in Table 1).

We then conducted a qualitative analysis of the remaining responses, created descriptive statistics and examined response patterns. We prepared appropriate graphical presentations. The data was summarized and reported for all questions in the survey to address our research questions. Table 3 shows the mapping between our research and survey questions. Finally, we applied manual blocking to our results. Our main area of interest were differences between enterprises operating an ISMS and those planning to do so.

4.5. Validity Procedure

We performed several steps to check and ensure the validity of our research. Considering the often heterogeneous nature of implemented ISM and ISRM activities and the sometimes ambiguous use of terms, we used the generally accepted ISO 27005 standard (ISO, 2011) as referential basis for our survey. All terms were clarified by additional descriptions for each question block and participant were given ample opportunity to state any issues within free-text comment blocks. We further performed a small pilot study and incorporated received feedback prior to the distribution of our questionnaire. Finally, during data analysis we planned to discard any results of questionable quality where participants made multiple obviously conflicting statements. This quality assurance step was primarily intended for responses where participants stated to operate a certified ISMS or standardizes ISRM approach but would not perform basic mandatory activities, completely neglect required asset types, or resign to manage documentation artifacts demanded by the certified standard (e.g., operate an ISO 27001 compliant ISMS but not document security controls, operating an ISMS but not performing any kind of risk identification).

5. Results

In this section, we present the survey results in relation with our research questions. We additionally address differences between companies with and without an established ISMS.

5.1. Study Population

In total, we collected 64 responses of which 26 were processed for data analysis. The other 38 responses were dropped with the majority having aborted the survey within the first question block (cf. Section 4.4). No responses had to be dropped due to obviously conflicting statements (cf. Section 4.5). Considering the amount of forwarded invitations we reached a response rate of 7% which is comparable to other exploratory surveys (cf. Section 3) in this field. The remainder of this section presents the results derived from the 26 complete responses.

Participants

Of our participants, 8 gave CISO or CIO as their organizational role with additional 4 participants being employed as head of IT department. This amounts to roughly one third of responses from higher-level management. Other participants mainly worked in dedicated security or risk management roles and in software development. Figure 4 shows the overall picture of participant roles as well as their qualifications. 20 participants had obtained a university degree in either science, technology, engineering and mathematics (STEM), system management or business programs. 8 participants had additionally obtained specialized personal security qualifications like Certified Information Systems Security Professional (CISSP) or Certified Information Security Manager (CISM). Participants stated an average of 6.7
years of professional experience in information security (deviation: 4.17, min: 1 year, max 18 years). While we cannot guarantee that multiple participants from one company contributed to our data set, the analyzed responses (and differences in answers) indicate that this was not the case.

**Companies**

The most prominent business domains in our data set were “Information Technology” (9 organizations, 34%) and “Manufacturing” (8 organizations, 31%). Medium-sized (50-250 employees) and large (more than 250 employees) companies made up the majority of responses. Tables 4 and 5 show the results regarding business domain and company size. The majority of responses was provided from Austrian companies (88%), although 20% of them operate internationally with subsidiaries in at least one other EU or non-EU country as well.

When asked about implemented ICT standards, participants of 11 companies (42%) stated that they at least partially implement some standard of the ISO 27k family with another 7 companies (27%) using the BSI IT Baseline Protection Methodology or at least parts of it. COBIT is only used by one internationally operating, large enterprise. Standardized IT service management is a concern for 8 companies (31%) as can be seen by the high adoption rate of the ITIL. Other ICT standards directly named by participants concerned domain-specific requirements for utility or healthcare enterprises. Figure 5 illustrates these results.

**Response Fragmentation**

Our survey was designed in a way that participants were shown alternative questions if they did not implement specific ISRM activities in their organizations. The reasoning behind that step was that not every enterprise performing information security risk analysis would also necessarily operate an ISMS or document their assets in a structured fashion. Furthermore, we wanted to capture the opinion of those who worked in organizations not yet operating an ISMS as well. This design decision ultimately resulted in fragmented responses with different answer counts for individual question

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**Table 4**

Business domains of responding companies (N = 26)

| Business Domain            | Companies |
|---------------------------|-----------|
| Information Technology    | 9 (34%)   |
| Manufacturing             | 8 (31%)   |
| Finance and Insurance     | 3 (11%)   |
| Services                  | 2 (8%)    |
| Utilities                 | 2 (8%)    |
| Healthcare                | 1 (4%)    |
| not disclosed             | 1 (4%)    |

**Table 5**

Sizes of responding companies (N = 26)

| Size                   | Companies |
|------------------------|-----------|
| less than 10 employees | 4 (15%)   |
| 10 - 50 employees      | 1 (4%)    |
| 50 - 250 employees     | 11 (42%)  |
| more than 250 employees| 10 (39%)  |

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**Figure 4:** Participant roles and qualifications (N = 26)

**Figure 5:** ICT Standards being partially implemented (N = 26)
blocks. Figure 6 shows the overall survey structure and the number of responses for each primary or alternative query path (numbers in diamond shapes at transitions between query blocks). Note that 38 respondents canceled the survey before completing the first question block and another respondent did so during the risk identification block. Thus, the reduced total number of responses between respective question blocks. Of the 26 responses 13 answered all questions in the main path of which seven in addition answered the optional block concerning security goals, requirements and controls.

5.2. Information Security Management System Adoption

Within our study population were 10 companies that have already established an ISMS of which 3 achieved a corresponding certification. Another 6 companies were planning to implement an ISMS. Figure 7 shows these results and the stated motivation for doing so. The two most common drivers for implementing an ISMS were customer and regulatory demands, a view also shared by those who refrained from operating an ISMS.

5.3. Methods and Documentation Artifacts

Considered for Risk Analysis in ISM (RQ1)

While not all participants disclosed the ISRM methodologies used in their organization, we identified ISO 27005 (5 companies), BSI IT Baseline Protection Methodology (4 companies) and CRISAM\(^1\) (4 companies) to be the most commonly applied methods. Discipline regarding the regular execution of risk management cycles (as required by all of these standards) is not satisfactory. Although ten companies (38\%) had established an ISMS and should thus regularly conduct risk management, only six (23\%) performed this activities at least on an annual basis. Half of the participating companies do not regularly perform risk management activities or with two or more years in between. Figure 8 shows which events trigger additional risk management cycles. Reported security incidents or vulnerabilities are considered by almost every enterprise operating an ISMS to warrant an unscheduled re-assessment of information security risks. Furthermore, actual attacks on IT infrastructure as well as internal or external audits commonly lead to additional risk management activities. Interestingly, only 4 en-

\(^1\)CRISAM is a popular GRC tool suite in the DACH region. It provides its own best-practice approaches for various ISRM tasks and in addition supports common information security standards.
clearly relates to the still improvable automation of asset documentation and discovery (88% of companies stated that asset documentation is a mostly manual task) and the dominating practice of less-than-annual risk management cycles.

### Risk Identification

Information security risk identification is primarily performed in a manual fashion with only 31% of organizations stating that they at least partially automated some of these activities. Only one organization identifies relevant security risks in a timely fashion, all others stating at least some deficiencies. In addition, a general lack of suitable internal processes to share relevant security information can be derived from the survey responses. Inter-organizational exchange of security information is generally not perceived as beneficial.

The most commonly applied risk identification methods are rather informal ones such as the use of checklists and brainstormings (cf. Table 7). More demanding approaches (with regard to methodological complexity, dedicated stakeholder expertise and documentation requirements) are sparingly used in context of ISM. Seven companies applied a mix of (2 to 5) risk identification technique compared to 5 companies relying on a singular method to identify information security risks.

### Risk Estimation, Evaluation and Treatment

The most common approach to estimate identified information security risks is to rely on qualitative ratings of involved stakeholders (46% of responding companies, additional 23% use semi-quantitative approaches). Only one organization (large internationally operating enterprise, using COBIT) performs quantitative risk estimation. Other responses did not disclose their risk estimation approach.

Concerning the practical implementation of the asset documentation process, we could observe that this crucial activity is in most cases centralized (69% of responses stated that this activity is performed fully or mostly in a centralized manner). However, only 19% of responses stated that they keep records of all individual assets, most others only keeping records of individual assets for certain groups. A similar picture can be observed for the timeliness of the available asset documentation, where only 19% of the enterprises stated that their asset documentation is always up-to-date. This

### Asset Documentation

Table 6 shows the types of assets that organizations conducting ISRM activities document and use. Note that only 16 organizations stated that they document assets at all. It can be observed that technical aspects (e.g., hardware, applications) are emphasized over organizational aspects (e.g., stakeholders, suppliers).

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Table 8
Methods applied for risk prioritization \( (N = 16) \)

| Prioritization                | Applied by |
|------------------------------|------------|
| Risk Matrix                  | 38%        |
| Risk Priority Number         | 38%        |
| Relative Risk Ranking        | 31%        |
| not disclosed                | 13%        |

Table 9
Methods applied for risk treatment decision \( (N = 16) \)

| Decision                              | Applied by |
|---------------------------------------|------------|
| Cost-benefit analysis                  | 38%        |
| Management Decision                    | 38%        |
| Risk acceptance criteria               | 25%        |
| not disclosed                          | 19%        |

5.4. Stakeholder Involvement and Collaboration Patterns (RQ2)

In order to investigate stakeholder involvement we asked participants which roles were involved in ISRM activities and how many people contributed to each step. Table 11 shows how often each role has been declared to be involved in activities of risk identification, risk estimation and the documentation of security requirements and controls. Responses show that top-management roles (CIO, CISO and to a lesser extent CTO) are generally involved in all activities, and that the instantiation of dedicated security and risk management roles is common practice. Furthermore we identified quite strong involvement of software development roles. The second part of Table 11 shows the amount of stakeholders involved in each activity. Although it might be expected that larger organizations with established ISMS invest more manpower in ISRM activities, responses show that this is not universally true. The companies stating that more than 25 people are involved in any of these actions are all large enterprises with more than 250 employees, already operating an ISMS and working in heavily regulated domains (finance and healthcare). In general, responses show a tendency towards smaller teams performing ISRM activities, commonly less than 10 people strong even among larger companies.

The question of how stakeholders collaborate in these activities can be conducted in part from previously discussed applied methods. To get a fuller picture, however, we asked dedicated questions regarding their mode of collaboration and how this is technically realized. Table 12 presents the responses to these questions (e.g., RI009 “How is the collaboration between stakeholders for information security risk identification designed and which tools are used to document identified risks in your organization?”). We can directly infer a heavy emphasis on direct stakeholder interaction during risk identification and risk estimation, whereas dedicated risk management or ISMS tools play a rather minor role.
5.5. Additional Data Sources and Tools used in Risk Analysis (RQ3)

Relevant information for ISRM activities can be retrieved from different data sources and tools. We investigated which data sources are commonly used and which tools enterprises favor. While the previous section emphasized tools used as means to collaborate, this section emphasizes data sources and tools providing input for individual activities and those being used to store respective results and provide them for subsequent activities.

Considering that the documentation of relevant assets is the vital very first step to conduct a high-quality risk analysis we investigated the tools that are used by enterprises for that activity. Responses indicate that general-purpose documentation tools such as spreadsheets or schematic diagrams and charts are more commonly used than dedicated information security tools (cf. Table 13). Specialized documentation and modeling software like CMDBs or EAM tools are typically used in conjunction with general purpose documentation tools. On average an enterprise uses 2.9 ($s = 1.2$) different tool types to document its assets.

Tables 14 and 15 list external and internal information sources used during risk identification. The column Ranking relates to how often each information source has been named as being one of the three most important information sources for a company. On average, each company used 5.2 ($s = 2.0$) external and 4.6 ($s = 2.4$) internal data sources during risk identification. Enterprises heavily rely on vendor-specific advisories and vulnerability databases. Newspapers, wikis and exploit database, although regularly used, are of lesser importance in risk identification processes. Security policies, incident management as well as (penetration) test reports are the most relevant internal information sources during risk identification. Checklists and security reviews on the other hand are generally considered to be of lesser importance.

The most viable information source for information security requirements and controls are standards and industry best practices (both used by two-thirds of responding companies). Dedicated software tools and the involvement of external security consultants are other applied methods to identify security controls as means of reducing information security risks. The most common tool to document them are written reports and spreadsheets, both a rather static medium. Dedicated document management systems or wikis are of...
less concern. Only one organization responded that it uses a dedicated risk management tool to document security requirements and controls.

5.6. Notable Differences between Companies with and without ISMS

Due to the small sample we refrained from quantitative statistic analysis (\(N_{\text{ISMS established}} = 10\), \(N_{\text{ISMS planned}} = 6\)) of differences between those groups. Instead we conducted a qualitative analysis and interpretation of notable differences in responses. Furthermore, we present results from respondents whose organizations did not plan to establish an ISMS or which did not perform certain activities (e.g., enterprises planning to implement an ISMS but not conducting asset documentation yet). Those respondents were guided through the alternate survey path where their perception and general knowledge of ISRM activities was captured.

In general we observed that ISRM practices are also performed by organizations not committed to the implementation of an ISMS. Of the seven responses that did not plan to establish an ISMS, three did in fact already document assets, perform risk analysis and document security requirements and controls. Those, however, showed a significant lower maturity in ISRM practices with less stakeholder involvement and overall smaller scope and documentation discipline.
Table 13
Tools used to document assets \((N = 16)\)

| Asset Documentation Tools               | Used by |
|----------------------------------------|---------|
| Spreadsheets                           | 50%     |
| Configuration Management Database (CMDB)| 44%     |
| Enterprise Architecture Modeling (EAM),| 38%     |
| Schematic diagrams/charts              |         |
| ISMS Tool, ISRM Tool                   | 25%     |
| not disclosed                          | 25%     |

Table 14
External information sources used during risk identification \((N = 17)\)

| External Information Source                | Used by | Ranking |
|--------------------------------------------|---------|---------|
| Newspapers                                 | 59%     | LOW     |
| Wikis                                      | 47%     | LOW     |
| Blogs                                      | 35%     | LOW     |
| Mailinglists                               | 65%     | MEDIUM  |
| Social Media                               | 29%     | LOW     |
| Exploit Database                           | 59%     | LOW     |
| Vulnerability Database                     | 65%     | HIGH    |
| Vendor-specific Advisories                 | 71%     | HIGH    |
| Threat Intelligence Sharing Platforms      | 29%     | LOW     |
| Special Interest Groups                    | 29%     | LOW     |
| not disclosed                              | 6%      |         |

Table 15
Internal information sources used during risk identification \((N = 17)\)

| Internal Information Source               | Used by | Ranking |
|-------------------------------------------|---------|---------|
| Security Policy                           | 41%     | HIGH    |
| Checklists                                | 47%     | LOW     |
| Best Practices                            | 47%     | MEDIUM  |
| Issue Tracker                             | 59%     | MEDIUM  |
| Incident Management                       | 53%     | HIGH    |
| Internal (Security) Reviews               | 41%     | LOW     |
| Audit Protocols                           | 35%     | MEDIUM  |
| (Penetration) Test Reports                | 53%     | HIGH    |
| Security Monitoring Tools                 | 53%     | MEDIUM  |
| not disclosed                             | 0%      |         |

Organizations who did not document their assets had a slightly different view of what constitutes as a relevant asset for ISRM activities. Whereas organizational units, suppliers and stakeholders were considered relevant assets by a third of organizations performing this step (cf. Table 6), they were generally not considered by organizations not performing this practice. Another distinguishing fact was the usage of asset documentation tools. Organizations not documenting assets would favor the use of dedicated documentation tools (e.g., EAM Tool, CMDBs) and not use spreadsheets or schematic diagrams at all. Reality, however, was that actual asset documentation practices primarily relied on the use of these tool types (cf. Section 5.3).

Respondents from companies which do not perform certain ISRM practices or are still in the process of planning an ISMS introduction showed a generally good knowledge of available methods, tools and corresponding standards. Questions targeting preferred ISRM practices showed a somewhat idealistic view that deviates from actual practice, preferring perceived one-stop solutions (e.g., ISRM or dedicated modeling tools) over those that are predominantly employed in practice.

5.7. Perceived Challenges
Although not the focal point of our investigation, we did ask participants concerning current challenges in information security risk assessment. As initially expected responses to these open questions were sparse but since all of them were given from respondents who were actively involved in their organization’s ISMS operation we deem them to be still of value for our overarching research objectives. Recurring themes in mentioned challenges were (1) insufficient management support and availability of stakeholders, (2) effort required for formal establishment of ISRM processes, and (3) ensuring that required information is up-to-date. Apart from (1), these challenges clearly relate to our survey results regarding applied, rather informal ISRM practices and the neglectable usage of automation facilities or dedicated tools. The lack of top-level management support was mentioned by two respondents from smaller companies (less than 25 employees) operating an ISMS.

6. Discussion
The conducted study investigated ISRM practices applied in larger organization-wide information security management settings with an emphasis on organizations operating or planning to introduce an ISMS. We constructed a conceptual model to explore the status quo of risk management activities, involved stakeholders, their collaboration patterns as well as utilized tools and data sources. Our analysis used data provided by 26 participants who shared information pertaining aspects of our conceptual model. In this section, we will discuss the results, their potential implications with regard to our research objectives and potential limitations of our research.

6.1. Interpretation of Results
In general our respondents closely followed respective standards and best practices when choosing methods and providing documentation artifacts within their ISRM activities. Starting with the first step, the documentation of assets, results show that relevant aspects and groups of assets are well represented in general. However, a greater emphasis on purely technical aspects, especially within small or medium sized...
enterprises is present. This further indicates that more complex aspects in information security risk management such as securing the availability of critical organizational knowledge are currently underrepresented. The preferred use of general purpose documentation tools such as spreadsheets or diagrams in favor of tools dedicated to manage asset inventories has multiple implications. It leads to higher manual involvement and introduces potential errors due to non-timely updates, even when asset inventories are mostly managed in a centralized fashion. Furthermore, the granularity and quality of asset catalogs can be improved by a more thorough consideration of individual assets instead of groups of assets and the documentation of potential dependencies between assets.

A similar reliance on manual processes was found throughout all subsequent risk assessment activities. The amount of involved stakeholders and the heterogeneity of involved business roles would ideally require the use of focused practices and close monitoring which was not the case. Instead neither applied risk assessment methods nor means of stakeholder collaboration can be considered satisfactory in terms of repeatability and overall output quality. Our results point to the typical risk identification practice involving face-to-face meetings supplemented by telephone calls and emails between stakeholders who rely on brainstorming techniques and checklists to identify information security risks. Accordingly, these practices limit the traceability and documentation of decisions which might result in a lack of transparency. That is not only far from utilizing readily available more structured or even formal approaches, but also burdens involved stakeholders with scheduling issues for required meetings or results in non-availability of key stakeholders (cf. Section 5.7). The primarily qualitative risk estimation approaches applied by respondents bear the same pitfalls especially when paired with predominantly unstructured documentation of the results of performed ISRM activities. Overall, our results suggest that ISRM practices are conducted in a fashion that strongly impedes their reliability – especially when key personnel is replaced or otherwise not available.

Considering the heterogeneity of involved stakeholders it is not surprising that a diverse set of information sources are used during ISRM activities as well. Information sources perceived as more important typically provide data points that are directly applicable to ISRM activities such as vendor-specific advisories which can easily be distilled to retrieve the assets being subject to a certain vulnerability and additionally provide a preemptive risk analysis. Still, less structured information sources (e.g., newspaper articles, mailing lists, wikis) are commonly used by stakeholders. Reliably analyzing these resources for relevant information is an elaborate task that would not only involve extensive scanning of unstructured material but in addition require stakeholders to convey retrieved information to their organizational setting as well. Moreover, research on shadow threat intelligence showed that the informal use of less structured information might result in several risks like limited traceability, information loss or waste of resources (Sauerwein et al., 2018). This situation might be improved through the introduction of NLP-supported threat intelligence (sharing) platforms that provide relevant information tailored to the specific information security needs of an organization and the respective demands of involved stakeholders.

The definition, documentation and subsequent management of security requirements and controls leaves room for improvement as well. Especially technical security controls could favor more automation and shorter re-assessment cycles regarding the review of their fulfillment. Various solutions are available to automatically monitor the fulfillment of certain security controls and integrating them in organizational ISRM practices would greatly benefit the timeliness of available compliance information. Especially in light of the thorough documentation practices applied for security controls – they are commonly documented with links to addressed risks – this could generally improve other ISRM activities as well and could potentially lead to a more timely re-evaluation of information security risks.

6.2. FAIR Guidelines

Concerning potential future ISRM research and framework development in organizational ISRM and ISMSs we propose the following guidelines for better applicability of developed solutions in light of the reported status quo:

 Favor structured over strictly formal approaches. ISRM practices are currently dominated by informal approaches. A direct leap to more demanding formal practices – especially for risk analysis in general organizational settings – will not be widely adopted. Research should thus focus on providing structured approaches with easy-to-follow guidelines and clear instructions for result documentation.

 Address heterogeneous stakeholder landscape. Information security initiatives heavily rely on inclusion and collaboration of different stakeholders (security experts, process owners, etc.) from various domains. Any successful approach will have to proactively address collaboration patterns and potential issues due to differences in stakeholder knowledge and expertise.

 Incorporate established documentation practices. Independent of applied practices and standards, ISRM activities utilize various information sources and storage facilities, in many cases relying on general purpose documentation tools. Enterprises will not be forced to abandon these established documentation practices and new approaches should aim at seamless integration of what is present and working.

 Respect scareness of resources. Operating an ISMS is a costly business endeavor due to high reliance on manual decision processes and overall lack of automation. The complex enterprise spanning scope thus requires provision of technical, financial and human re-

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sources often outside an enterprises’ dedicated security organization. Risk management approaches should thus provide a transparent cost-benefit model to show that scarce resources are used beneficially and that automation facilities are effectively implemented.

These guidelines were derived from the previously presented interpretation of results and cover the major reoccurring themes found in our survey responses. We argue that by following our proposed guidelines, researchers can develop more directly applicable ISRM solutions that substantially improve the current state of practice without overburdening enterprises with additional efforts. While the process discipline and overall maturity of ISM is expected to raise in the coming years, solutions adhering our guidelines should aid organizational transitions until formal approaches are becoming the norm as security experts have been advocating for decades.

6.3. Implications

Our results provide researchers with a more comprehensive picture of currently applied ISRM practices in organizations. Since our investigation emphasized organization-wide practices applied within ISMSs we explored what techniques enterprises use in heterogeneous intra-organizational settings instead of secluded risk management activities performed in specialized application domains. We provide new insight into involved roles and collaboration patterns within these activities including preferred tool usage and incorporated information sources.

We provide the basis for the development of ISRM practices that are less disruptive of the current organizational practice and thus have a greater chance to be actually adopted by enterprises. Furthermore, our proposed guidelines can help researchers to successfully transfer available conceptual tools or approaches to larger, practical, closer-to-life settings for evaluation purposes and critical reflection of their own works applicability.

Three common deficiencies in ISRM practices were identified by Webb et al. (2014): (1) information security risk identification is commonly perfunctory, (2) information security risks are commonly estimated with little reference to the organization’s actual situation, and (3) information Security risk assessment is commonly performed on an intermittent, non-historical basis. The general focus on technical aspects in asset documentation practices as well as the insufficient consideration of dependencies between assets and risks shown by our results largely support deficiency 1. A similar issue regarding proper identification and inventory of information technology assets was stated in challenge 1 by Fenz et al. (2014). The organizational reality regarding risk estimation as illustrated by our study responses highlights the general refusal of applying quantitative approaches in favor of rather interpretative practices with high reliance on stakeholders’ expertise and limited reproducibility of results. This compares to deficiency 2 by Webb et al. (2014) and is partially captured by challenge 3 regarding failed predictions in risk in Fenz et al. (2014). In alignment with deficiency 3 our responses support the notion of primarily intermittent non-historical risk assessments. This is obvious in the malpractice of performing risk management activities irregularly with two or more years in between cycles. Which is made even worse by manual and non-formal risk assessment methods generally used in practice and a heavy reliance on general purpose documentation tools with questionable abilities to reliably portrait historical developments to involved stakeholders.

Regarding ISRM research in general, Wangen and Snekkenes (2013) constitute various challenges, repeatedly stating a common lack of empirical research and good data, especially concerning the validation and verification of existing methods. We argue that without a better alignment between proposed risk management approaches and the current industrial practice – as well as organizational capabilities – this gap can not be sufficiently addressed on a broader scale. Our survey design and results contribute a solid basis for further empirical research and provides a viable starting point to tailor academic efforts to a wider base of organizations.

Overall, with our contribution, we support researchers with a solid picture of the current industrial practice and a repeatable survey instrument to periodically re-assess the status quo. Additionally, the proposed guidelines should help academic endeavors and information security practitioners alike to develop applicable solutions for the iterative improvement of current ISRM practices.

6.4. Limitations

Our survey has been developed in accordance with respected best practice guidelines and we performed several measures to control the validity of presented results as outlined in Section 4. However, there are still limitations present that need further consideration.

Most notably, the number of responses that we received and that could ultimately be used is limited, thus potentially affecting the external validity of our findings. It is, however, reasonably high for the performed qualitative analysis and descriptive statistics presented in this work. A larger set of responses would ultimately yield more reliable results and allow the application of quantitative statistical analysis methods.

Currently, we do not have any means to establish the representativeness of our study population since no reliable figures regarding ISRM or ISMS adoption in the DACH region are available. This, naturally, restricts the generalizability of our findings. We presume for example that the actual business domain and corresponding regulatory demands influences applied ISRM practices and their actual implementation. Since only a fraction of responses belongs to these do-
the identification of patterns in responses is arguably a creative process and thus potentially influenced by expectations and prior experiences of involved researchers. We mitigated this threat by involving multiple researchers in data analysis.

The design of our survey instrument raises potential threats to construct validity of our results. First, the online survey was aimed at a maximum duration of 20 minutes and was thus comparably more extensive than other information security surveys. This poses the risk of participants preemptively aborting our survey or quickly ending it via extensive use of default options and ignoring non-mandatory questions. Responses showed that participants commonly required around 19 minutes to complete the survey and that those who prematurely aborted the questionnaire did so during early questions regarding demographics. We additionally analyzed the timespan participants required for individual questions as well as the usage of default answer options. From that we could not identify any tendency that later questions were not as thoroughly considered and answered as early ones. However, based on our results we plan to streamline the survey instrument for future iterations by merging several questions regarding stakeholder collaboration and tool usage.

The second potential issue regarding the survey instrument arises from ambiguities in applied terms and definitions. We counteracted this largely by choosing the well-established ISO 27k family of standards as referential basis and by providing additional clarifications and definitions with each question. Furthermore, participants were given ample opportunity to express deviations via commendatory input blocks present in most questions. Together with the results of a conducted pilot survey and subsequent interviews with pilot participants we are confident that the design of our online questionnaire did not negatively influence the validity of our research.

Finally, our decision to use the ISO 27k family of standards as referential basis of our survey instrument poses a threat to the validity of our findings and has a potentially negative influence the generalizability of our results. This affects primarily participants not familiar with the ISO standards that are operating an ISMS based on conceptually different approaches such as the BSI IT Baseline Protection Methodology (BSI, 2017) or the NIST RMF (NIST, 2018) for example. These standards put a stronger emphasis on documentation and classification of processed information and utilized systems together with the provision of baseline security controls to reach the desired level of information security. Typical ISRM activities are thus not procedurally represented in the same fashion as in the ISO 27k family of standards which might confound the aforementioned group of study participants. The received responses and comments from participants – even those that aborted the study and were subsequently discarded for analysis – did not provide any indication that this has been an issue.

7. Summary and Future Work

We presented an exploratory survey concerning the status quo of risk management practices in information security. We based our investigation on a conceptual model exploring different aspects such as the applied ISRM methodology, patterns of stakeholder collaboration, utilized tools as well as involved information sources and considered documentation artifacts. We identified that the current state of practice in the DACH region has a strong emphasis on manual data collection, direct stakeholder communication and non-formal approaches for risk identification and estimation as well as complex but unstructured decision processes. In addition, our findings suggest that the use of general purpose documentation tools is preferred over using dedicated risk management or ISMS tools. Finally, we derived guidelines for the development of ISRM frameworks better suiting the current state of practice and thereby enhancing their chance for contemporary industrial application.

Our own research in the area of continuous information security management and the development of the corresponding ADAMANT framework already benefited from early findings (Brunner et al., 2018, 2019) and we will continue to improve our approach. Following our guidelines we will emphasize the integration of established documentation practices and investigate potential means to reduce efforts for the introduction and operation of ISMSs using ADAMANT. In addition, we are currently designing a study to empirically analyze the proposed guidelines and their potential impact on stakeholder perception of ISRM approaches regarding their usefulness, applicability and implementation effort. Future research will additionally target small and medium-sized enterprises, investigating different ISRM approaches to establish and support smaller scale ISMSs.

Another important direction of future research will be the iterative enhancement and replication of the presented study. We thus want to invite information security researchers to join us in our effort to draw a more precise picture of the current state of ISRM practices used by enterprises to manage information security – not only in the DACH region but also on a global scale.

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References

Accorsi, R., Lehmann, A., 2012. Automatic information flow analysis of business process models, in: International Conference on Business Process Management, Springer, pp. 172–187.

Aguirre, I., Alonso, S., 2012. Improving the Automation of Security Information Management: A Collaborative Approach. IEEE Security & Privacy 10, 55–59.
Risk Management Practices in Information Security: Exploring the Status Quo in the DACH Region

Baker, W., Wallace, L., 2007. Is Information Security Under Control? Investigating Quality in Information Security Management. IEEE Security & Privacy J. 5, 36–44.

Barlette, Y., Fomin, V.V., 2010. The adoption of information security management standards: A literature review, in: Information Resources Management: Concepts, Methodologies, Tools and Applications. IGI Global, pp. 69–90.

Beckers, K., 2015. Supporting ISO 27001 Establishment with CORAS, in: Pattern and Security Requirements. Springer, pp. 139–194.

Beckers, K., Heisel, M., Solhaug, B., Stulen, K., 2014. ISMS-CORAS: A Structured Method for Establishing an ISO 27001 Compliant Information Security Management System, in: Computer Safety, Reliability and Security. Springer International Publishing, pp. 315–344.

Benaïm, A., Bandara, A.K., Jackson, M., Liu, W., Montrieux, L., Tan, T.T., Yu, Y., Nuseibeh, B., 2014. Requirements-driven mediation for collaborative security, in: Proceedings of the 9th International Symposium on Software Engineering for Adaptive and Self-Managing Systems, ACM, pp. 37–42.

Berger, B.J., Sohr, K., Koschke, R., 2016. Automatically extracting threats from extended data flow diagrams, in: International Symposium on Engineering Secure Software and Systems, Springer, pp. 56–71.

Brunner, M., Mussmann, A., Breu, R., 2018. Introduction of a Tool-Based Continuous Information Security Management System: An Exploratory Case Study, in: 2018 IEEE International Conference on Software Quality, Reliability and Security Companion (QRS-C). IEEE, pp. 483–490.

Brunner, M., Mussmann, A., Breu, R., 2019. Enabling change-driven workflows in continuous information security management, in: Proceedings of the 7th ACM/SIGAPP Symposium on Applied Computing, ACM, pp. 1924–1933.

Brunner, M., Stillaber, C., Breu, R., 2017. Towards Automation in Information Security Management Systems, in: 2017 IEEE International Conference on Software Quality, Reliability and Security (QRS), IEEE, pp. 160–167.

BSI, 2017. BSI-Standard 200-1: Managementsysteme für Informationssicherheit. Technical Report. German Federal Office for Information Security (BSI).

Bulgurcu, B., Cavusoglu, H., Benbasat, I., 2010. Information security policy compliance: an empirical study of rationality-based beliefs and information security awareness. MIS Quarterly 34, 523–548.

Calder, A., Watkins, S., 2012. IT Governance: an international guide to data security and ISO27001/ISO27002. Kogan Page Publishers.

Chan, S.E., Liu, C.S., 2007. Exploring organizational culture for information security management. Industrial Management & Data Systems 107, 438–458.

Conforti, R., La Rosa, M., Fortino, G., ter Hofstede, A.H.M., Recker, J., Adams, M., 2013. Real-time risk monitoring in business processes: A sensor-based approach. Journal of Systems and Software 86, 2939–2965.

Council of European Union, 2016a. Directive (eu) 2016/1148 of the european parliament and of the council of 6 july 2016 concerning measures for a high common level of security of network and information systems across the union. Official Journal of the European Union 194, 2016.

Council of European Union, 2016b. Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). Official Journal of the European Union L119/59.

Deloitte, 2017. Global Risk Management Survey. Technical Report. Deloitte.

Disterer, G., 2013. ISO/IEC 27000, 27001 and 27002 for Information Security Management. Journal of Information Security 4, 92–100.

ENISA, 2015. State-of-the-Art of Secure ICT Landscape. Technical Report. NIS Platform.

Ernst & Young, 2018. Global Information Security Survey 2018 -2019. Technical Report. Ernst & Young.

Fenz, S., Heurix, J., Neubauer, T., Pechstein, F., 2014. Current challenges in information security risk management. Information Management & Computer Security 22, 410–430.

Fitzgerald, T., 2007. What You Told Us: A CISO Survey, in: CISO Leadership. Auerbach Publications, pp. 37–62.

Fulford, H., Doherty, N.F., 2003. The application of information security policies in large UK-based organizations: an exploratory investigation. Information Management & Computer Security 11, 106–114.

Hooper, V., McKissack, J., 2016. The emerging role of the ciso. Business Horizons 59, 585–591.

Ilinedo, P., 2012. Understanding information systems security policy compliance: An integration of the theory of planned behavior and the protection motivation theory. Computers & Security 31, 83–95.

Ilinedo, P., 2014. Information systems security policy compliance: An empirical study of the effects of socialisation, influence, and cognition. Information & Management 51, 60–79.

ISACA, 2009. The Risk IT Framework. ISA.

ISACA, 2012. COBIT 5: A Business Framework for the Governance and Management of Enterprise IT. ISA.

ISO, 2011. ISO/IEC 27005: Information technology – Security Techniques – Information security risk management. ISO/IEC Standard 27005:2011. International Organization for Standardization.

ISO, 2013. ISO/IEC 27001: Information technology – Security techniques – Information security management system – Requirements. ISO/IEC Standard 27001:2013. International Organization for Standardization.

Jurjens, J., 2002. UMLsec: Extending UML for secure systems development, in: International Conference on The Unified Modeling Language, Springer, pp. 412–425.

Karabacak, B., Sogukpinar, I., 2005. Isram: information security risk analysis method. Computers & Security 24, 147–159.

Kasunic, M., 2005. Designing an effective survey. Technical Report. Carnegie-Mellon Univ Pittsburgh PA Software Engineering Inst.

Kong, J., Xu, Y., Nuseibeh, B., 2014. Requirements-driven mediation for collaborative security. Technical Report. German Federal Office for Information Security (BSI).

Kasunic, M., 2005. Designing an effective survey. Technical Report. Carnegie-Mellon Univ Pittsburgh PA Software Engineering Inst.

Montesdioca, G.P.Z., Maçada, A.C.G., 2015. Measuring user satisfaction with information security practices. Computers & Security 48, 267–280.

Montesino, R., Fenz, S., 2011. Automation possibilities in information security management, in: 2011 European Intelligence and Security Informatics Conference, IEEE, pp. 259–262.

NIST, 2002. SP 800-30. Risk Management Guide for Information Technology Systems. NIST Special Publication 800-30, Revision 2. National Institute of Standards & Technology (NIST).

NIST, 2018. SP 800-37. Risk Management Framework for Information Systems and Organizations. NIST Special Publication 800-37, Revision 2. National Institute of Standards & Technology (NIST).

Panda, P., 2009. The OCTAVE® approach to information security risk assessment. Information Systems Control Journal.

Pasquale, L., Spolletini, P., Salehie, M., Cavallaro, L., Nuseibeh, B., 2016. Automating trade-off analysis of security requirements. Requirements Engineering 21, 481–504.

Pfleeger, S.L., Kitchenham, B.A., 2001. Principles of survey research: Parts 1 to 6. ACM SIGSOFT Software Engineering Notes .

Pierce, B., Venables, P., Venkitas, K., Johnson, E., 2008. Cso perspective-evaluating and communicating information risk., in: WEIS.

PWC, 2015. The Global State of Information Security® Survey 2016. Technical Report. PricewaterhouseCoopers (PwC).

Rees, J., Allen, J., 2008. The State of Risk Assessment Practices in Information Security: An Exploratory Investigation. Journal of Organizational Computing and Electronic Commerce 18, 255–277.

Samonas, S., Dhillon, G., Almusharraf, A., 2020. Stakeholder perceptions of information security policy: Analyzing personal constructs. International Journal of Information Management 50, 144–154.

SANS Institute, 2019. SANS 2019 State of OT/ICS Cybersecurity Survey. Technical Report. SANS Institute.

Sauerwein, C., Pekaric, J., Felderer, M., Breu, R., 2019. An analysis and classification of public information security data sources used in research and practice. Computers & Security 82, 140–155.
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Sauerwein, C., Sillaber, C., Breu, R., 2018. Shadow cyber threat intelligence and its use in information security and risk management processes, in: Multikonferenz Wirtschaftsinformatik (MKWI) 2018, pp. 1333–1344.

Schaad, A., Borozdin, M., 2012. TAM2: automated threat analysis, in: SAC’12: Proceedings of the 27th Annual ACM Symposium on Applied Computing, ACM Request Permissions, New York, New York, USA. pp. 1103–1108.

Schou, C., Hernandez, S., 2015. Information Assurance Handbook: Effective Computer Security and Risk Management Strategies. McGraw-Hill Education Group.

Shedden, P., Ahmad, A., Smith, W., Tscherning, H., Scheepers, R., 2016. Asset identification in information security risk assessment: A business practice approach. Communications of the Association for Information Systems 39, 15.

Shedden, P., Ruighaver, T., Ahmad, A., 2006. Risk management standards or the perception of ease of use.

Shedden, P., Scheepers, R., Smith, W., Ahmad, A., 2011. Incorporating a knowledge perspective into security risk assessments. Vine 41, 152–166.

Sikolia, D., Twitchell, D., Sagers, G., 2016. Employees’ Adherence to Information Security Policies: A Partial Replication, in: Proceedings of the Twenty-second Americas Conference on Information Systems.

Sillaber, C., Breu, R., 2015. Using stakeholder knowledge for data quality assessment in information security risk management processes, in: Proceedings of the 2015 ACM SIGMIS Conference on Computers and People Research, ACM, pp. 153–159.

Sillaber, C., Mussmann, A., Breu, R., 2019. Experience: Data and Information Quality Challenges in Governance, Risk, and Compliance Management. Journal of Data and Information Quality (JDIQ) 11, 6–14.

Sommestad, T., Ekstedt, M., Holm, H., 2013. The Cyber Security Modeling Language: A Tool for Assessing the Vulnerability of Enterprise System Architectures. Systems Journal, IEEE 7, 363–373.

Sommestad, T., Hallberg, J., Lundholm, K., Bengtsson, J., 2014. Variables influencing information security policy compliance. Information Management & Computer Security 22, 42–75.

Sommestad, T., Karlzén, H., Hallberg, J., 2015. The sufficiency of the theory of planned behavior for explaining information security policy compliance. Information & Computer Security 23, 200–217.

Soomro, Z.A., Shah, M.H., Ahmed, J., 2016. Information security management needs a more holistic approach: A literature review. International Journal of Information Management 36, 215–225.

Spears, J.L., Barki, H., 2010. User participation in information systems security risk management. MIS quarterly 34, 503–522.

The Common Criteria Recognition Agreement Members, 2006. Common Criteria for Information Technology Security Evaluation.

Tracy, R.P., 2007. IT Security Management and Business Process Automation: Challenges, Approaches, and Rewards. Information Systems Security 16, 114–122.

Wagner, S., Mendez, D., Felderer, M., Graziotin, D., Kalinowski, M., 2019. Challenges in Survey Research. arXiv:1908.05899.

Wangen, G., 2016. An initial insight into information security risk assessment practices, in: 2016 Federated Conference on Computer Science and Information Systems (FedCSIS), IEEE, pp. 999–1008.

Wangen, G., Snekkenes, E., 2013. A taxonomy of challenges in information security risk management, in: Proceeding of Norwegian Information Security Conference/Norsk informasjonssikkerhetskonferanse-NISK 2013-Stavanger, 18th-20th November 2013, Akademika Forlag.

Webb, J., Ahmad, A., Maynard, S.B., Shanks, G., 2014. A situation awareness model for information security risk management. Computers & Security 44, 1–15.

van Wessel, R., Yang, X., de Vries, H.J., 2011. Implementing international standards for Information Security Management in China and Europe: a comparative multi-case study. Technology Analysis & Strategic Management 23, 865–879.

Whitman, M.E., Mattord, H.J., 2011. Principles of information security. Cengage Learning.

Yazar, Z., 2002. A qualitative risk analysis and management tool–cramm. SANS InfoSec Reading Room White Paper 11, 12–32.

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Appendix

The following presentation of the survey instrument is content-complete and a faithful recreation of the online questionnaire used for our research. It does not aim at accurately portraying the look-and-feel of the resulting webpages which is hardly possible in print.

A. Survey Instrument: RiskFlows Exploratory Study (Online)

The RiskFlows explorative study investigates the current practice and shortcomings in information security risk management workflows. The study is conducted by the <AUTHOR-AFFILIATION>. The findings will provide ample information on viable approaches for novel risk-driven information security management workflows that will additionally address the areas of risk treatment and monitoring.

Thank you for considering to participate in our study. If you work in the line of strategic or operational information security (risk) management you are the prime candidate for this questionnaire. We will ask specifics about the current state of affairs regarding information security management and risk assessment in your company.

All responses are stored anonymously, none of the responses will be connected to identifying information, the results will be used for statistical purposes and will be reported only in aggregated form. The survey will take approximately 20 minutes to complete.

A.1. General

This group contains general questions regarding your enterprise and your organizational role.

**DE001: What is your organizational role?**

(Multiple+)

- □ Chief Information Officer
- □ Chief Information Security Officer
- □ Chief Technology Officer
- □ Head of IT Department
- □ Security Manager
- □ Security Analyst
- □ Security Engineer
- □ Security Consultant
- □ Risk Manager
- □ Quality Manager
- □ Compliance Manager
- □ Software/Systems/Network Engineer
- □ Software/Systems/Network Architect
- □ Software Developer
- Other: ________________________

**DE002: Which of the following personal certifications and qualifications do you have?**

(Multiple+)

- □ CISM
- □ CISSP
- □ CEH
- □ CCNP
- □ CISA
- □ University degree in Computer Science
- □ University degree in Information Systems
- □ University degree in Business or Economics
- Other: ________________________

**DE003: How many years of professional experience in the area of information security do you have?**

(Numeric)

**DE004: What type of industry is your organization in?**

(Single+)

- □ Information Technology
- □ Services
- □ Manufacturing
- □ Retail
- □ Finance and Insurance
- □ Public Administration
- Other: ________________________

**DE005: What is the size of your organization?**

(Single)

- □ < 10 employees
- □ 10 - 50 employees
- □ 50 - 250 employees
- □ > 250 employees
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DE006: Where is your organization located?
(Single*)
◦ Germany
◦ Austria
◦ Switzerland
◦ Liechtenstein
◦ Other EU Country
◦ Non EU Country
Subsidiaries in: ________________________________________________

DE007: Which ICT Standards and frameworks are (partially) implemented in your organization?
(Multiple+)
□ ISO/IEC 27000 family of Standards
□ COBIT
□ ITIL
□ ValIT
□ BSI Baseline Protection Methodology
□ Other: ________________________

A.2. Information Security Management
This short group of questions aims at understanding basic notions of information security management in your organization. According to the international ISO 27000 standard an Information Security Management System (ISMS) "[...] consists of the policies, procedures, guidelines, and associated resources and activities, collectively managed by an organization, in the pursuit of protecting its information assets."

IM001: Do you operate an Information Security Management System?
(Single*)
◦ No, and we do not plan to implement an ISMS
◦ No, but we plan to implement an ISMS
◦ Yes, we operate a non-certified ISMS
◦ Yes, we operate a certified ISMS (please provide certification information in the comment)
Comment: ________________________________________________

IM002: What is the most important driver for Information Security Management in your organization?
(Single*)
◦ Higher degree of information security
◦ Customer demands
◦ Shareholder demands
◦ Regulatory demands
◦ Other: ________________________

IM003: Which Information Security Risk Management (ISRM) methodology does your organization apply?
(Multiple+)
□ ISO 27005
□ ISO 31000
□ BSI IT Baseline Protection Methodology
□ NIST SP 800 30
□ CRAMM
□ OCTAVE
□ AS/NZS 4360
□ CRISAM
□ Other: ________________________

IM004: How often does your organization conduct an information security risk management cycle?
(Single)
◦ Never
◦ At least twice a year
◦ At least once a year
◦ At least once every two years
◦ Occasionally (more than two years between cycles)
◦ No answer

IM005: Which events additionally trigger information security risk management activities in your organization?
(Multiple+)
□ Change of the operational Environment (Process, IT Infrastructure, ...)  
□ Reported Security Incident or vulnerability (external)
□ Attack of IT infrastructure, applications or services (internal)
□ Internal Audit
□ External Audit
□ Other: ________________________
**IM002:** What do you consider the most important driver for Information Security Management?
(Single*)
- Higher degree of information security
- Customer demands
- Shareholder demands
- Regulatory demands
- Other: ________________________

**IM003:** Which Information Security Risk Management (ISRM) methodology do you know?
(Multiple*)
- ISO 27005
- ISO 31000
- BSI IT Baseline Protection Methodology
- NIST SP 800 30
- CRAMM
- OCTAVE
- AS/NZS 4360
- CRISAM
- Other: ________________________

**A.3. Considered Assets**
This group of questions asks specifics about the way your organization documents and manages assets relevant for information security. An Asset is "... any tangible or intangible thing or characteristic that has value to an organization". ISO 27001 demands that all assets "... associated with information and information processing facilities shall be identified and an inventory of these assets shall be drawn up and maintained."

Even if your organization does not operate an ISMS or does not perform Information Security Risk Management (ISRM), you might keep records of relevant assets (such as IT services, IT infrastructure elements, data, business processes).

**AS000:** Do you document assets in your organization in any way, shape or form?
(Yes/No)

**AS001:** Rate the following statements with regard to the asset documentation of your organization.
(Rating)

| Statement                                      | Applies fully | Applies mostly | Applies to some extent | Does not apply | Do not know | No answer |
|------------------------------------------------|---------------|----------------|------------------------|----------------|-------------|-----------|
| Asset documentation is orchestrated in a centralized manner. | ◦ ◦ ◦ ◦ ◦       |                |                        |                |             |           |
| We keep records of all individual assets.          | ◦ ◦ ◦ ◦ ◦       |                |                        |                |             |           |
| Asset documentation is always up-to-date.          | ◦ ◦ ◦ ◦ ◦       |                |                        |                |             |           |
| We document dependencies between assets.           | ◦ ◦ ◦ ◦ ◦       |                |                        |                |             |           |
| Asset discovery/documentation is performed automatically. | ◦ ◦ ◦ ◦ ◦       |                |                        |                |             |           |

**AS002:** Which assets are considered for the ISMS and ISRM activities in your organization?
(Multiple*)
- Business Processes
- Organizational Units
- Suppliers
- Stakeholders
- IT Services
- Applications
- Cloud Services (external)
- Server Hardware
- Workstations
- POI/POS Terminals
- Network Infrastructure
- Premises
- Rooms
- Other: ________________________
AS003: Which tools do you use to manage the considered assets in your organization?

(Multiple+)

- Enterprise Architecture Management (EAM)
- Configuration Management Database (CMDB)
- ISMS Tool
- ISRM Tool
- Spreadsheets
- Schematic diagrams/charts
- Other: ________________________

AS002: Which assets would you consider relevant for ISMS and ISRM activities?

(Multiple+)

- Business Processes
- Organizational Units
- Suppliers
- Stakeholders
- IT Services
- Applications
- Cloud Services (external)
- Server Hardware
- Workstations
- POI/POS Terminals
- Network Infrastructure
- Premises
- Rooms
- Other: ________________________

AS003: How would you prefer to manage considered assets?

(Multiple+)

- Enterprise Architecture Management (EAM)
- Configuration Management Database (CMDB)
- ISMS Tool
- ISRM Tool
- Spreadsheets
- Schematic diagrams/charts
- Other: ________________________

A.4. Risk Identification

This group of questions asks specifics about the Information Security Risk Management (ISRM) approach at your organization. In particular these questions target the the way how risks are identified at your organization as part of your ISMS or ISRM initiative. According to ISO 27005 Risk Identification is "[…] the process to find, list and characterize elements of risk".

RI000: Does your organization perform Information Security Risk Management (ISRM) or related activities?

(Yes/No)

- Yes
- No

Please choose Yes, if your organization has established ISRM processes or conducts any kinds of tasks in support of information security risk management (identification, estimation or evaluation of information security risks, treatment of information security risks, assessment of protection levels for assets, etc.).

Only choose No, if your organization does NOT perform any kind of Information Security Risk Management (ISRM).

RI001: Rate the following statements with regard to the information security risk identification approach of your organization.

(Rating)

| Statement                                                                 | Applies fully | Applies mostly | Applies to some extent | Does not apply | Do not know | No answer |
|---------------------------------------------------------------------------|---------------|----------------|------------------------|----------------|-------------|-----------|
| Risk identification is performed automatically.                          | o             | o              | o                      | o              | o           | o         |
| Every relevant security risk is identified in a timely fashion.           | o             | o              | o                      | o              | o           | o         |
| Sharing of relevant security information is conducted via a formal process.| o             | o              | o                      | o              | o           | o         |
| Relevant security information is automatically preprocessed and filtered for conducting risk identification. | o             | o              | o                      | o              | o           | o         |
| Exchange of security information with other organizations and individuals has been beneficial for risk identification. | o             | o              | o                      | o              | o           | o         |
RI002: Which aspects are considered for information security risk identification in your organization?
(Multiple+)

☐ Assets ☐ Consequences
☐ Threats ☐ Security Goals
☐ Vulnerabilities ☐ Required Protection Level of Assets
☐ Existing or Planned Controls and Countermeasures Other: ________________________
☐ Security Incidents

RI003: Which EXTERNAL information sources are used for information security risk identification in your organization?
(Multiple+)

☐ Newspapers ☐ Vulnerability Database
☐ Wikis ☐ Vendor-specific Advisories
☐ Blogs ☐ Threat Intelligence Sharing Platforms
☐ Mailinglists ☐ Special Interest Groups
☐ Social Media Other: ________________________
☐ Exploit Database

RI004: Which are the three most important EXTERNAL information sources for information security risk identification in your organization?
(Ranking)

RI005: Which INTERNAL information sources are used for information security risk identification in your organization?
(Multiple+)

☐ Security Policy ☐ Audit Protocols
☐ Checklists ☐ (Penetration) Test Reports
☐ Best Practices ☐ Security Monitoring Tools
☐ Issue Tracker Other: ________________________
☐ Incident Management
☐ Internal (Security) Reviews

RI006: Which are the three most important INTERNAL information sources for information security risk identification in your organization?
(Ranking)

RI007: Which stakeholders are involved in information security risk identification in your organization?
(Multiple+)

☐ Chief Information Officer ☐ Risk Manager
☐ Chief Information Security Officer ☐ Quality Manager
☐ Chief Technology Officer ☐ Compliance Manager
☐ Head of IT Department ☐ Software/Systems/Network Engineer
☐ Security Manager ☐ Software/Systems/Network Architect
☐ Security Analyst ☐ Software Developer
☐ Security Engineer Other: ________________________
☐ Security Consultant

RI008: How many stakeholders are involved in information security risk identification within your organization?
(Single+)

○ < 5 Employees ○ > 25 employees
○ 5 - 10 employees ○ No answer
○ 20 - 25 employees

Comment: __________________________________________
RI009: How is the collaboration between stakeholders for information security risk identification designed and which tools are used to document identified risks in your organization?

(Multiple+)

- [ ] Email
- [ ] Chat
- [ ] Forum
- [ ] Telephone
- [ ] Face-to-Face Meetings
- [ ] Threat Intelligence Sharing Platform
- [ ] Task Management System
- [ ] Risk Management Tool
- [ ] ISMS Tool
- [ ] Governance, Risk Management and Compliance (GRC) Tool
- [ ] Document Management System
- [ ] Wiki
- [ ] Reports
- [ ] Spreadsheets
- [ ] Other: ________________________

RI010: Which methods are used for identifying information security risks in your organization?

(Multiple+)

- [ ] Brainstorming
- [ ] Checklists
- [ ] Structured What If Technique (SWIFT)
- [ ] Preliminary Hazard Analysis (PHA)
- [ ] Failure Mode and Effect Analysis (FMEA)
- [ ] Hazard and Operability Study (HAZOP)
- [ ] Cause and Consequence Analysis (CCA)
- [ ] Reliability Availability, Maintainability Analysis (RAM)
- [ ] CCTA Risk Analysis and Management Method
- [ ] Information Security Risk Analysis Method (ISRAM)
- [ ] Consultative, Objective and Bi-functional Risk Analysis (COBRA)
- [ ] Operationally Critical Threat, Asset, and Vulnerability Evaluation (OCTAVE)
- [ ] Other: ________________________

RI011: What are the most pressing challenges during information security risk identification for your organization?

(Open)

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

RI003 alt: Which EXTERNAL information sources supporting the identification of information security risks do you know?

(Multiple+)

- [ ] Newspapers
- [ ] Wikis
- [ ] Blogs
- [ ] Mailinglists
- [ ] Social Media
- [ ] Exploit Database
- [ ] Vulnerability Database
- [ ] Vendor-specific Advisories
- [ ] Threat Intelligence Sharing Platforms
- [ ] Special Interest Groups
- [ ] Other: ________________________

RI005 alt: Which INTERNAL information sources supporting the identification of information security risks do you know?

(Multiple+)

- [ ] Security Policy
- [ ] Checklists
- [ ] Best Practices
- [ ] Issue Tracker
- [ ] Incident Management
- [ ] Internal (Security) Reviews
- [ ] Audit Protocols
- [ ] (Penetration) Test Reports
- [ ] Security Monitoring Tools
- [ ] Other: ________________________
RI009: How would you prefer to design the collaboration between stakeholders for information security risk identification and which tools would you prefer to use to document identified risks?

(Multiple+)

- Email
- Chat
- Forum
- Telephone
- Face-to-Face Meetings
- Threat Intelligence Sharing Platform
- Task Management System
- Risk Management Tool
- ISMS Tool
- Governance, Risk Management and Compliance (GRC) Tool
- Document Management System
- Wiki
- Reports
- Spreadsheets
- Other: ________________________

RI010: Which methods for identifying information security risks do you know?

(Multiple+)

- Brainstorming
- Checklists
- Structured What If Technique (SWIFT)
- Preliminary Hazard Analysis (PHA)
- Failure Mode and Effect Analysis (FMEA)
- Hazard and Operability Study (HAZOP)
- Cause and Consequence Analysis (CCA)
- Reliability Availability, Maintainability Analysis (RAM)
- CCTA Risk Analysis and Management Method (CRAMM)
- Information Security Risk Analysis Method (ISRAM)
- CORAS Method
- Consultative, Objective and Bi-functional Risk Analysis (COBRA)
- Operationally Critical Threat, Asset, and Vulnerability Evaluation (OCTAVE)
- Other: ________________________

A.5. Risk Estimation, Evaluation and Treatment

This group of questions asks specifics about the Information Security Risk Management (ISRM) approach at your organization. In particular these questions target the the way how risks are estimated/evaluated at your organization as part of your ISMS or ISRM initiative and how your organization decides which treatment options of risks are pursued. According to ISO 27005 Risk Estimation is "[...] the process to assign values to the probability and consequence of a risk" whereas Risk Evaluation is defined as "[...] the process of comparing the results of risk analysis [...] to determine whether the risk and/or its magnitude is acceptable or tolerable."

RE001: Which stakeholders are involved in information security risk estimation and evaluation in your organization?

(Multiple+)

- Chief Information Officer
- Chief Information Security Officer
- Chief Technology Officer
- Head of IT Department
- Security Manager
- Security Analyst
- Security Engineer
- Security Consultant
- Risk Manager
- Quality Manager
- Compliance Manager
- Software/Systems/Network Engineer
- Software/Systems/Network Architect
- Software Developer
- Other: ________________________

RE002: How many stakeholders are involved in the estimation of information security risks in your organization?

(Single+)

- < 5 Employees
- 5 - 10 employees
- 20 - 25 employees
- > 25 employees
- No answer

Comment: ___________________________
RE003: How is the collaboration between stakeholders for information security risk estimation and evaluation designed and which tools are used to document the risk estimation results in your organization?
(Multiple+)

- Email
- Chat
- Forum
- Telephone
- Face-to-Face Meetings
- Threat Intelligence Sharing Platform
- Task Management System
- Risk Management Tool
- ISMS Tool
- Governance, Risk Management and Compliance (GRC) Tool
- Document Management System
- Wiki
- Reports
- Spreadsheets
- Threat Intelligence Sharing Platform
- Task Management System
- Risk Management Tool
- ISMS Tool
- Governance, Risk Management and Compliance (GRC) Tool
- Document Management System
- Wiki
- Reports
- Spreadsheets
- Other: ________________________

RE004: Your organization’s risk estimation approach is ...
(Single+)

- Qualitative (Subjective and scale-based, e.g., critical, high, medium, low)
- Semi-Quantitative
- Quantitative (Calculated, e.g., expected annual financial loss)
- Don’t know
- No answer

Comment: __________________________________________

RE005: Which methods are used for estimating information security risks in your organization?
(Multiple+)

- Brainstorming
- Structured What If Technique (SWIFT)
- Preliminary Hazard Analysis (PHA)
- Failure Mode and Effect Analysis (FMEA)
- Hazard and Operability Study (HAZOP)
- Fault Tree Analysis (FTA)
- Event Tree Analysis (ETA)
- Cause and Consequence Analysis (CCA)
- Monte-Carlo Simulation
- Reliability Availability, Maintainability Analysis (RAM)
- CCTA Risk Analysis and Management Method (CRAMM)
- Information Security Risk Analysis Method (ISRAM)
- Consultative, Objective and Bi-functional Risk Analysis (COBRA)
- Operationally Critical Threat, Asset, and Vulnerability Evaluation (OCTAVE)
- Other: ________________________

RE006: Rate the following statements with regard to the information security risk estimation approach in your organization.
(Rating)

| Dependencies between ASSETS (e.g., between business processes and the IT infrastructure to deliver them) are considered when estimating security risks. | Applies fully | Applies mostly | Applies to some extent | Does not apply | Do not know | No answer |
|---|---|---|---|---|---|---|
| Dependencies between RISKS (e.g., between risk of a reduced availability of a virtualized server and the risk of reduced availability of the hardware node it is running on) are considered when estimating security risks. | | | | | | |
| The estimation of the PROBABILITY of a single risk to materialize takes related risks into account. | | | | | | |
| The estimation of the LIKELIHOOD of a single risk to materialize takes related risks into account. | | | | | | |
| Risk estimation is performed automatically. | | | | | | |
RE007: Which methods are used to prioritize estimated information security risks in your organization?
(Multiple+)
☐ Risk Matrix  ☐ Failure Mode Effect and Criticality Analysis (FMECA)
☐ Risk Priority Number  Other: ________________________
☐ Relative Risk Ranking

RE008: What are the most pressing challenges during information security risk estimation and evaluation for your organization?
(Open)
__________________________________________________________________________________
__________________________________________________________________________________
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RE009: How do you decide whether information security risks are accepted or treated in your organization?
(Multiple+)
☐ Defined risk acceptance criteria  ☐ Management Decision
☐ Cost-benefit analysis of treatment options  Other: ________________________

RE003:alt: How would you prefer to design the collaboration between stakeholders for information security risk estimation and evaluation and which tools would you prefer to use to document risk estimation results?
(Multiple+)
☐ Email  ☐ Governance, Risk Management and Compliance (GRC)
☐ Chat  Tool
☐ Forum  ☐ Document Management System
☐ Telephone ☐ Face-to-Face Meetings  ☐ Wiki
☐ Threat Intelligence Sharing Platform  ☐ Reports
☐ Task Management System  ☐ Spreadsheets
☐ Risk Management Tool  ☐ ISMS Tool
☐ ISMS Tool  Other: ________________________

RE004:alt: I would prefer to utilize a ... risk estimation approach.
(Single+)
◦ Qualitative (Subjective and scale-based, e.g., critical, high, medium, low)
  ◦ Don’t know
◦ Semi-Quantitative
◦ Quantitative (Calculated, e.g., expected annual financial loss)
  ◦ No answer
Comment: ________________________________________________

RE005:alt: Which methods for estimating information security risks do you know?
(Multiple+)
☐ Brainstorming  (CRAMM)
☐ Structured What If Technique (SWIFT)
☐ Preliminary Hazard Analysis (PHA)
☐ Failure Mode and Effect Analysis (FMEA)
☐ Hazard and Operability Study (HAZOP)
☐ Fault Tree Analysis (FTA)
☐ Event Tree Analysis (ETA)
☐ Cause and Consequence Analysis (CCA)
☐ Monte-Carlo Simulation
☐ Reliability Availability, Maintainability Analysis (RAM)
☐ CCTA Risk Analysis and Management Method  Other: ________________________

A.6. Security Goals, Requirements and Controls
This additional group of questions asks specifics about the way that security goals, requirements and controls are defined and documented at your organization. According to ISO 27000 a security control is defined as "[...] measure that is modifying risk", a requirement is a "[...] need or expectation that is stated, generally implied or obligatory" and goals typically describe "[...] results to be achieved".
**SE000: May we ask you additional questions regarding the definition and documentation of security goals, requirements and controls.**

(Yes/No)

- ○ Yes
- ○ No

Thank you for answering the previous questions. If you can spare another 5 minutes, we would like to ask you about the definition and documentation of security goals, requirements and controls.

**SE001: Rate the following statements with regard to the elicitation and documentation of security goals, requirements and controls within your organization.**

(Rating)

| Statement                                                                                     | Applies fully | Applies mostly | Applies to some extent | Does not apply | Do not know | No answer |
|---------------------------------------------------------------------------------------------|---------------|----------------|------------------------|----------------|-------------|-----------|
| We do NOT define or document security goals, requirements or controls.                       | ○ ○ ○ ○ ○ ○    |                |                        |                |             |           |
| We distinguish between security goals, requirements and controls.                            | ○ ○ ○ ○ ○ ○    |                |                        |                |             |           |
| Documentation of security goals, requirements and controls is orchestrated in a centralized manner. | ○ ○ ○ ○ ○ ○    |                |                        |                |             |           |
| Security goals, requirements and controls are evaluated with regard to their degree of fulfillment on a regular basis. | ○ ○ ○ ○ ○ ○    |                |                        |                |             |           |
| The elicitation of security controls is performed automatically.                            | ○ ○ ○ ○ ○ ○    |                |                        |                |             |           |
| The fulfillment of security controls is automatically evaluated.                            | ○ ○ ○ ○ ○ ○    |                |                        |                |             |           |

**SE002: Which stakeholders are involved in defining security requirements and controls to treat relevant security risks in your organization?**

(Multiple+)

- □ Chief Information Officer
- □ Chief Information Security Officer
- □ Chief Technology Officer
- □ Head of IT Department
- □ Security Manager
- □ Security Analyst
- □ Security Engineer
- □ Security Consultant
- □ Risk Manager
- □ Quality Manager
- □ Compliance Manager
- □ Software/Systems/Network Engineer
- □ Software/Systems/Network Architect
- □ Software Developer
- Other: ________________________

**SE003: How many stakeholders are involved in the definition of security requirements or controls in your organization?**

(Single+)

- ○ < 5 Employees
- ○ 5 - 10 employees
- ○ 20 - 25 employees
- ○ > 25 employees
- ○ No answer

Comment: __________________________________________________________

**SE004: Which EXTERNAL information sources are used in finding appropriate security goals, requirements and controls in your organization?**

(Multiple+)

- □ Standards
- □ Industry Best Practices
- □ Security Control Catalogues
- □ Software Tools
- □ Security Consultants
- Other: ________________________
SE005: Which tools are used to document security requirements and controls in your organization?
(Multiple+)

- Reports
- Spreadsheets
- Wiki
- Document Management System
- Risk Management Tool
- ISMS Tool
- Governance, Risk Management and Compliance (GRC) Tool
- Other: ________________________

SE006: Which attributes and aspects are documented for security goals, requirements and controls in your organization?
(Multiple+)

- Description
- Rationale
- Current Degree of Fulfillment
- History of Changes of the Degree of Fulfillment
- Responsible, Accountable, Consulted, Informed (RACI) Stakeholders or Organizational Units
- Audit Procedures
- Adressed Risks
- Associated Assets
- History of Changes (excl. Degree of Fulfillment)
- Other: ________________________

SE007: What are the most pressing challenges regarding the definition and documentation of security requirements and controls for your organization?
(Open)

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

B. Invitation Mail

Dear <PARTICIPANT-NAME>,

We are writing to request your participation in our explorative risk management study of information security risk and compliance experts in the D.A.CH. area. This study investigates the current practice and shortcomings in information security risk management workflows. The study is conducted by the <AUTHOR-AFFILIATION> and the findings will provide ample information on viable approaches for novel risk-driven information security management workflows that will additionally address the areas of risk treatment and monitoring.

All responses are stored anonymously, none of the responses will be connected to identifying information, the results will be used for statistical purposes and will be reported only in aggregated form. The survey will take approximately 20 minutes to complete.

To participate, please click on the following link: <SURVEY-URL>

If you have any questions about this survey, or difficulty in accessing the site or completing the survey, please contact <AUTHOR-URL>.

Thank you in advance for participating in this survey.

Sincerely, <AUTHOR>