A systematic methodology for privacy impact assessments - a design science approach

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Abstract

For companies that develop and operate IT applications that process the personal data of customers and employees, a major problem is protecting this data and preventing privacy breaches. Failure to adequately address this problem can result in considerable damage to the company's reputation and finances, as well as negative effects for customers or employees (data subjects). To address this problem, we propose a methodology that systematically considers privacy issues by using a step-by-step privacy impact assessment (PIA). Existing PIA approaches cannot be applied easily because they are improperly structured or imprecise and lengthy. We argue that companies that employ our PIA can achieve 'privacy-by-design', which is widely heralded by data protection authorities. In fact, the German Federal Office for Information Security (BSI) ratified the approach we present in this article for the technical field of RFID and published it as a guideline in November 2011. The contribution of the artefacts we created is twofold: First, we provide a formal problem representation structure for the analysis of privacy requirements. Second, we reduce the complexity of the privacy regulation landscape for practitioners who need to make privacy management decisions for their IT applications.

Keywords: Privacy impact assessment, privacy-by-design, security risk assessment, design science.

Introduction

Privacy maintenance and control is a social value deeply embedded in our society. A global survey found that 88% of people are worried about who has access to their data; over 80% expect governments to regulate privacy and impose penalties on companies that don't use data responsibly (Fujitsu, 2010). At the same time, we witness a greater number of privacy breaches, including massive leakage of personal data to unauthorised parties. At a fast pace, technical systems are evolving to allow for unprecedented levels of surveillance. These developments demand new approaches to privacy protection.

One of these approaches is to require companies to conduct privacy impact assessments (PIAs). Like security risk assessments (ISO, 2008; NIST, 2002), PIAs require companies to conduct a systematic risk assessment that scrutinises the privacy implications of their operations and personal data handling practices. PIAs aim to identify technical and organizational privacy threats and choose controls that mitigate those threats. Typically, the assessments are completed early in the development of an IT application. Following the principle of 'privacy-by-design' (IPCO, 2011), these assessments aim to detect privacy issues during product development and proactively build privacy-enhancing techniques and measures into systems. Ideally, at least some results of PIAs are publicised on companies' or governments' websites so that institutions can demonstrate their accountability. And data protection authorities can use PIA reports to understand the data handling practices of companies, their privacy efforts and legal compliance. The Madrid Resolution, which was signed by fifty global data protection officers and authorities, encourages organisations to implement PIAs (SDPA, 2009). The European Commission has integrated the concept of PIAs into the new regulation proposal for legal data protection (EC, 2012). And the Article 29 European Data Protection Working Party recently endorsed a PIA Framework for RFID (INFSO, 2011). In the US, the Federal Trade Commission has required both Google and Facebook to regularly conduct PIAs for the next twenty years.

Despite the strong political movement to establish PIA practices, the adoption of PIAs is still rare, especially in Europe. While governments in Canada, Australia and the US use PIAs in sensitive areas such as biometrics, health or homeland security, the private sector has not embraced the concept (Bennett and Bayley, 2007). This inaction can be explained by the fact that, until now, most PIAs have not been mandatory (Wright, 2011). But even if PIAs become mandatory, no standards exist on how to conduct PIAs; in addition, current approaches lack a clear methodology and easy applicability. As we will show, none of the approaches describe a step-by-step process that a company could easily implement and integrate into its risk management processes (Wright et al., 2011).

To address the lack of conceptual completeness and rigorous methodology for existing PIAs, we propose a set of new constructs and a novel process reference model for systematically conducting PIAs. We extend prior work in this research area by transferring experiences and concepts from security risk assessments to the privacy domain. The goal of this PIA methodology is to complement existing risk management techniques and provide data controllers with a formal technique for analysing system-specific privacy requirements. To achieve this goal, we adopt the research approach of design science (Hevner et al., 2004; Gregor, 2006; Hevner, 2007). Based on an existing theoretical knowledge base, design science research typically involves constructing and evaluating new IT artefacts, constructs, models, methods, or instantiations to address organisational IT problems. In this article, we develop constructs for representing and evaluating privacy requirements as well as a new methodology for systematically running a privacy impact assessment.

The next section of this article reviews the knowledge base for PIAs and reflects on the executed relevance and rigor cycles (Hevner, 2007) that provide a contextual research environment. Hereby, we remember Iivari's suggestion to use not only prior research but also practical problems and existing artefacts (Iivari, 2007) to achieve a rigorous constructive research method. We look into current concepts of privacy and data protection, timely privacy assessment procedures and related methodologies for security impact assessment. The third and fourth sections document the executed design cycle (Hevner, 2007) and its iterations of artefact building and evaluation. The third section describes a new PIA methodology we developed and tested. Herein we define constructs, including the representation of privacy requirements in the form of privacy targets, and propose qualitative evaluation techniques to prioritize them with the help of protection demand categories. The fourth section includes evaluations of our proposed methodology and constructs in terms of absolute utility (using action research) and in terms of relative utility (comparing it to other risk assessment approaches). In particular, we apply our PIA process model to the field of RFID technology, where we tested the model and established it through the German Federal Office for Information Security (BSI) as a guideline for the development of privacy-friendly RFID applications. We then discuss the limitations of PIAs, limitations of our approach and needs for future work. We close with a summary of our work, reflecting on its contributions from a design science perspective.

Addressing privacy issues: A review of the current knowledge base

The PIA methodology we present is based on a critical review of existing constructs and procedures. We reflect on the elements that informed our PIA methodology: existing privacy compliance procedures, privacy principles, regulations and assessment procedures such as security impact assessments.

Existing privacy compliance procedures and privacy-by-design

Legal compliance checks are the most commonly used privacy assessment procedures in most countries today. These compliance checks are based on laws that address data protection issues; the checks are conducted by companies' internal data protection officers, national data protection authorities or private auditing businesses. Some privacy compliance institutions also issue a privacy seal to companies; this seal informs consumers about the privacy efforts of that company (i.e. (TRUSTe, 2011), (BBBOnLine, 2011), (EuroPriSe, 2011)). Despite their value, current compliance procedures face some challenges: First, they mostly take place at the end of a system development cycle or even later, when the system is already up and running. Thus, the procedures review existing system designs (Shroff, 2007), which can only be fixed in a bolted-on and often costly fashion. Second, the procedures are not done by the engineers designing the system, but by auditors, lawyers or data protection officials, who just run through a checklist to determine legal compliance. These procedures are unable to influence more 'code-based' and rigorous privacy controls. Third, current compliance checks lack a standard procedure, partially because national data protection laws and privacy seal procedures vary. In addition, most companies do not incorporate privacy management into the quality controls that are ensured by standardised risk procedures.

With mounting public pressure for privacy protection, PIAs are now considered as complements to or replacements for these current procedures (EC, 2009). PIAs emerged during the mid-1990s in Australia, Canada, Hong Kong, New Zealand and the US (Wright et al., 2011). The first European PIA was initiated by the UK in 2007 (ICO, 2009). Stewart (1996) describes a PIA as follows: "In large measure, PIAs are directed not simply towards issues of legal compliance but the policy choices involved in answering the questions 'ought we to do this?" Bennett and Bayley (2007) identified four common PIA requirements: (1) "conduct a prospective identification of privacy issues or risks before systems and programmes are put in place, or modified", (2) "assess the impacts in terms broader than those of legal compliance", (3) "be process rather than output oriented", and (4) "be systematic". Against this background, we define a PIA as **a risk assessment methodology used proactively in the design or upgrade phase of an IT system to make that system privacy friendly *and* compliant with data protection legislation.**

A PIA intends to overcome the shortcomings of legal compliance checks in several ways: First, a PIA accompanies all stages of a system development project, starting at the earliest possible moment and influencing system design decisions throughout the system development lifecycle (Bennett and Bayley, 2007; Clarke, 2009; Wright et al., 2011). Hence, it is not a one-time compliance check at the end of a project but an ongoing requirements-engineering exercise. Second, a PIA typically involves technical and legal personnel and other relevant stakeholders, who can offer perspectives on an IT

system beyond legal compliance (Jeselon and Fineberg, 2011). Third, because it offers a risk management approach that includes standardized procedures for how to assess and mitigate risks (e.g. (NIST, 2002; Seibild, 2006; ISO, 2008; BSI, 2008)), a PIA should lead to concrete technical improvements or design changes to a system. As a result, PIAs overcome the largely qualitative approach of the legal compliance domain.

PIAs are a crucial means to address one of the core concerns of today's privacy community, which is the establishment of privacy-by-design (Jeselon and Fineberg, 2011). *„Privacy by Design is an engineering and strategic management approach that commits to selectively and sustainably minimize information systems' privacy risks through pro-active technical and governance controls."* (Spiekermann, 2012). The term „Privacy by Design" was coined by Ann Cavoukian, the Information and Privacy Commissioner of Ontario, in the 1990s (Cavoukian, 2009a). In her description on how to accomplish privacy by design, she names 7 guiding principles: proactive, by default, embedded, positive sum, lifecycle protection, visibility/transparency, respect for users (Cavoukian, 2009b). These principles were later widely adopted as a resolution by other prominent policymakers, and PIAs strive to follow these seven principles. Privacy-by-design has been further driven by the increasing recognition that a respect for user privacy cannot be realised through bolted-on measures that are added to a system after it is deployed. Due to the rapid change in technology and the resulting inability to foresee all privacy issues, privacy measures must be integrated into the foundations of a system, and PIAs are a key means to do so.

Risk assessment methodologies that tackle security and privacy issues

The core of a PIA is an impact assessment or risk assessment. Risk assessments typically follow a clear process of risk identification and mitigation. Although PIAs are expected to include a similar process, existing PIAs largely fall short. As Figure 1 demonstrates, even the UK PIA handbook (ICO, 2009), which is considered a global "best practice publication" on how to conduct a PIA (Clarke, 2011; Wright et al., 2011), is methodologically not suited to be a process reference model. No input-output factors are described, and process steps are generic ("information gathering", "internal analysis"). As a result, people who conduct PIAs are uninformed about what to do when. No guidelines or conceptual tools support the risk assessment.

To our knowledge, the only PIA guideline with a valid process model is the PIA Framework for RFID, which was endorsed by the Article 29 Working Party and signed by the European Commission on April 6th 2011 (INFSO, 2011). This framework encourages European RFID application operators to run through a four-step PIA process: (1) describe their system landscape, (2) identify privacy risks, (3) mitigate those risks through appropriate controls, and (4) document the analysis and residual risks in a

PIA report. This four-step methodology has been called a "landmark for privacy-by-design" by Ontario's data protection authorities, who invented the concept of privacy-by-design. Yet in comparison to an equivalent security risk assessment (see Figure 2), the PIA Framework for RFID is methodologically weak. We therefore reviewed existing security risk processes to inform the creation of a new PIA methodology.

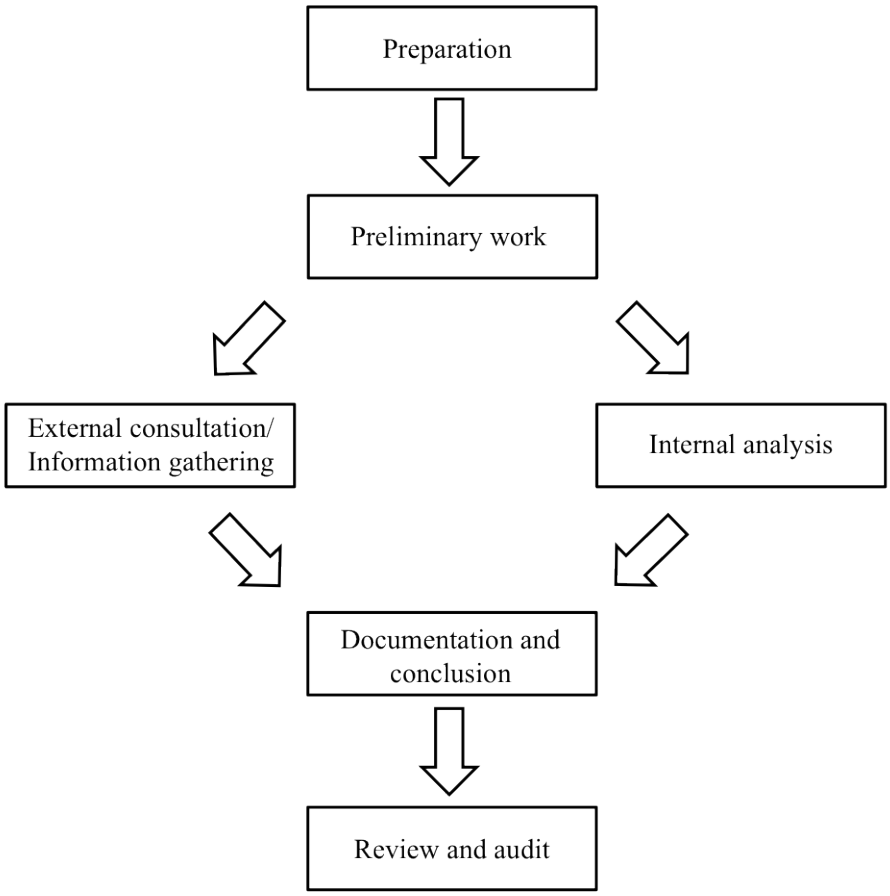

Figure 1. State of the art in PIA methodology: UK PIA process (ICO, 2009)

Standards and guidelines for information security management in organisations have been available for some time. The most prominent are the ISO/IEC 27000 series and NIST Special Publications 800 series. In Germany, the Federal Office for Information Security (BSI) provides industry with an IT Baseline Protection Catalogue ("BSI IT-Grundschutz") (BSI, 2011a). Similar to the NIST example depicted in Figure 2, these standards include interlocked steps that build on each other; to control for all relevant risks, the standards match each system threat with a respective control.

Most importantly, all of these standards offer guidelines that can be integrated into an organisation's risk management processes (see: (ISO, 2008), (NIST, 2002), (BSI, 2008)). The detailed steps and the artefacts of a security assessment enable a company to assess risk coherently. In addition, the

standardised security risk procedures describe when each step should occur in the system development lifecycle. Security issues are considered early in the development and implementation of IT applications. The approach decreases bolted-on security functionality and promotes security-by-design.

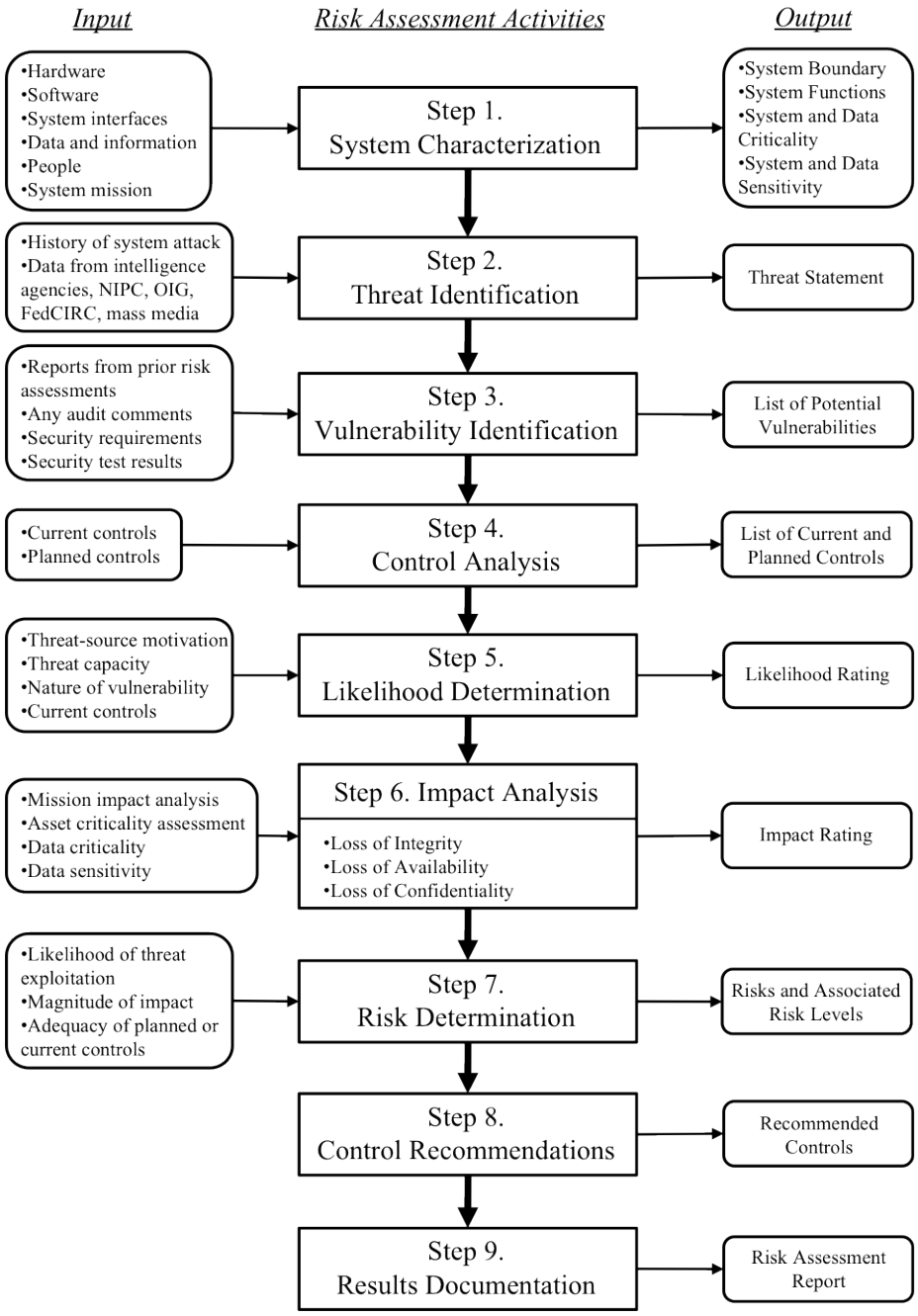

Figure 2. Benchmark for risk assessments: NIST security risk assessment process (NIST, 2002)

Nevertheless, researchers describe problems that are inherent in existing security risk assessments, which we consequently need to consider for our proposed methodology: a focus on process and not on content and its quality (Siponen, 2006), focus on generic security requirements at the expense of company-specific requirements (Siponen and Willison, 2009), and validation based on common practice and not on profound research methods (Siponen and Willison, 2009).

As privacy and security assessments are complementary, it is not surprising that both ISO/IEC 27002 and BSI IT-Grundschutz include privacy protection. However, analysing these standards' privacy details, the ISO standard leaves privacy policies and measures unspecified. Although the BSI IT-Grundschutz applies security risk analysis to privacy principles, it reduces privacy protection to the concepts of anonymity, pseudonymity, unobservability and unlinkability (BSI, 2008). As a result, the standard fails to embrace the wider spectrum of data protection principles inherent in the European Data Protection Directive or the OECD privacy guidelines.

Privacy principles and data protection regulation

To design a privacy analysis or PIA, one must first determine what needs to be protected (Rost, 2011). Unfortunately, *"Privacy is a chameleon-like word, used denotatively to designate a wide range of wildly disparate interests - from confidentiality of personal information to reproductive autonomy - and connotatively to generate goodwill on behalf of whatever interest is being asserted in its name"* (Lillian Bevier cited in (Solove, 2005)). Solove (2002) conceptualized privacy along multiple dimensions: limited access to the self (building on Warren and Brandeis' (1890) concept of the 'right-to-be-let-alone'), secrecy (concealment of certain matters from others), control over personal information (in line with Westin's (1967) emphasis on information privacy), protection of one's personhood (in terms of protection of one's personality, individuality and dignity in the face of surveillance) and interpersonal intimacy. The UK PIA Handbook (ICO, 2009) is more abstract, stating that a PIA should consider not only the privacy of personal information, but also privacy of the person, personal behaviour and personal communications.

Because privacy is a multidimensional construct, many privacy scholars argue that privacy extends beyond the notion of data protection, which the current legal environment focuses on (i.e. (Raab and Wright, 2012)). Scholars note that the OECD privacy guidelines (OECD, 1980) and European regulations often group data protection policies with the term 'privacy' but fall short of embracing privacy as a broader concept. For example, scholars criticize Article 33 of the proposal for a new EU data protection regulation. The article refers only to "*data protection* impact assessments" (EC, 2012), but should mandate *privacy* impact assessments; as a result, the article may not apply to some areas where privacy is at stake.

We aim to resolve this battle of terms by asking whether the data protection rules outlined in the European data protection directive (and its successor regulation), OECD guidelines and Fair Information Practice Principles (FTC, 1998) sufficiently address the full spectrum of privacy threats that can be caused by IT systems. If data protection rules can sufficiently address or mitigate all *privacy* threats known to be caused by IT systems, we can say that - in the context of IT - data protection rules and privacy rules are effectively the same.

To date, Solove (2006) has probably produced the most complete list of privacy threats. This list includes privacy threats observed over a century of US legal history. The threats include: cases of surveillance and false interrogation, cases of abundant and unlawful information processing in the form of data aggregation, personal identification, unprotected data, unwanted secondary data uses or individual exclusion, cases where information dissemination lead to breach of confidentiality, unwanted disclosures, personal exposure, increased accessibility for private and governmental institutions, blackmail or appropriations and distortions, and cases of invasion in the form of physical or virtual intrusion and decision interference. We believe that most privacy scholars would accept this list of issues as a relatively complete picture of the privacy construct.

To further explore the similarities and differences between data protection rules and privacy rules, we combined Solove's list of privacy threats with data protection regulation. We then investigated whether rigorously following the current data protection regulation would sufficiently address all known privacy threats. If the data protection regulation is sufficient, an electronic privacy effort could succeed by following data protection legislation. Appendix A summarises all elements of the current and proposed EU data protection regulation (EC, 1995; EC, 2012) and hence all data protection principles included in the OECD privacy guidelines (OECD, 1980) and Fair Information Practice Principles (FTC, 1998). The table leads to two conclusions: First, if companies take data protection regulation seriously, particularly by introducing high data quality and security standards, then *all* privacy threats identified by Solove (2006) are addressed. Second, data protection regulation provides people with additional self-determination rights for information that go beyond the privacy domain. For our purposes, the first conclusion is the most important one. The table shows that data protection rules support the mitigation of all potential privacy threats. For example, Solove describes how privacy is harmed by data aggregation, which is the creation of a highly revealing and relatively complete profile of an individual from multiple data sources. If data protection rules are followed in the sense that data controllers avoid collecting data (P1.5), adhere to data minimization (P1.6), and restrict processing to pre-agreed legitimate purposes (P2.1 and P2.2), it will be difficult for data controllers to lawfully create the kind of data aggregates that harm peoples' privacy.

Because privacy threats can be addressed through existing data protection regulations, we argue that the PIA methodology we present is indeed a *privacy* impact assessment and not just a *data protection* assessment driven by a need for compliance.

PIA methodology and constructs

Against the background of the described knowledge base (PIA goals, risk assessment benchmarks, privacy constructs), we have developed a 7-step PIA methodology (Figure 3) that is based on the widely adopted BSI risk method (BSI, 2008). A PIA is triggered when a new system is planned or an existing one is upgraded. Thus, although the presented methodology ends with the seventh step and is not depicted as cyclical, it is an ongoing process that occurs in parallel with the system development process. Whenever a system changes, a PIA is triggered, the 7 steps are conducted and existing documentation and resolutions must be updated and checked for their validity. The PIA can refer to a stand-alone application or a programme that is embedded in a wider networked backend infrastructure.

Privacy risk assessments are not necessary in all situations. They are advisable only if a system will use or generate personal data or when it can help to enrich adjacent databases that contain personal profiles. For this reason, the first step of a PIA requires a thorough consideration of the system under scrutiny and its adjacent infrastructure. In line with thought leaders in the privacy design domain (Rost and Pfitzmann, 2011), we suggest that a PIA should include a reflection of privacy principles that could be undermined by the system (Step 2). Or, in engineering terms, the assessment should include an identification of *privacy targets* that need to be reached through system design. Yet as in all system development projects, not all system design targets are equally important. Some privacy targets may be crucial because ignoring them could seriously harm a data subject. But other privacy targets may have less priority, as their neglect would barely affect data subjects or companies. For this reason, Step 3 of our proposed PIA process calls for privacy development targets to be weighed and assigned to *protection demand categories* that reflect their importance. Then, threats to each of the established privacy targets are identified (Step 4). As we have seen in the security risk context, the identification of threats is central to risk assessment because each threat needs to be mitigated by one or several controls. If an explicit and detailed listing of all privacy threats is missing, controls cannot be individually assigned to counter those threats. Setting controls to counter each privacy threat one-by-one is the most important aspect of privacy-by-design (Step 5). This exercise must be well documented in a PIA report (Step 7) because data controllers and processors can use it to prove that they have worked to protect all relevant aspects of a data subject's privacy. Data controllers can also use this exercise to identify the threats that remain uncontrolled; these threats constitute the residual risks (Step 6). The following sections explain each step of the PIA methodology we propose.

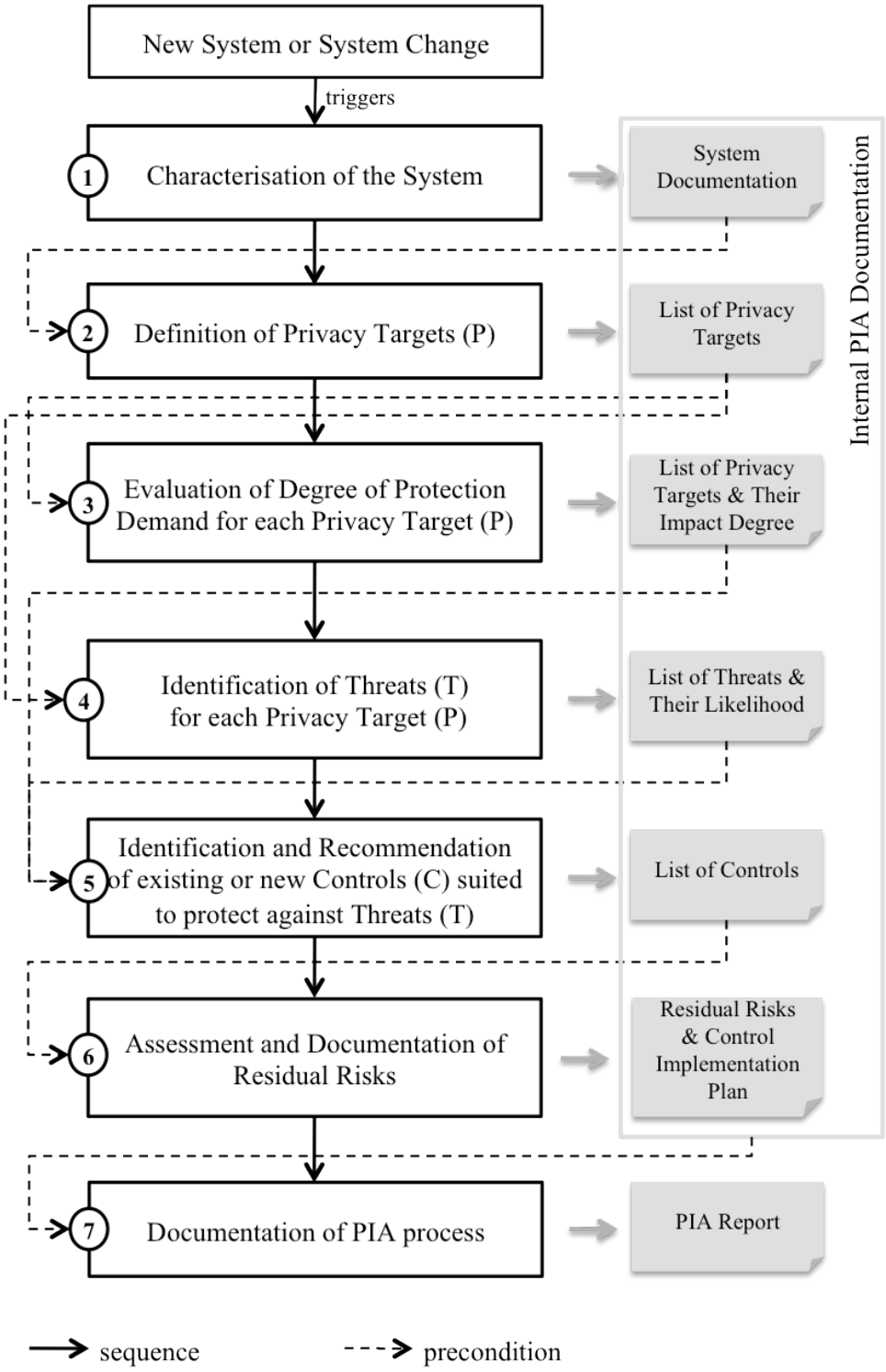

Figure 3. Process definition of PIA methodology

Step 1 – Characterisation of the system

The first step of a PIA aims to describe a system in such a comprehensive and detailed way that potential privacy problems can be detected. To minimize the risk that relevant information goes unnoticed, to facilitate privacy audits and to build on the system characterisation approaches of other risk assessment procedures (NIST, 2002; ISO, 2002; BSI, 2008; ISO, 2008), we recommend documenting a system based on four views:

1. system view: application and system components, hardware, software, internal and external interfaces, network topology
2. functional view: generic business processes, detailed use cases, roles and users, technical controls
3. data view: categories of processed data, data flow diagrams of internal and external data flows, including actors and data types
4. physical environment view: physical security and operational controls such as backup and contingency

To be complete, the characterisation of a system should incorporate these four views and consider all system components and interfaces that are involved in the storage, processing and transfer of personal data. Each interface should be checked for whether it allows personal data to be transmitted to another component; the data flows should contain all relevant actors that are involved in data transmission. Often, such documentation is already available if systems are well designed, are in a requirements-engineering phase or need to undergo security analysis. For a PIA, this documentation might need to be modified slightly to ensure that it emphasizes existing and potential data flows and data types more than system functionality. This emphasis on data flow models has also been outlined by the ISO PIAs in the financial industry (ISO, 2002).

The core challenge in this documentation phase of a PIA is to determine the right system boundaries and thus the assets that will need to be covered in the assessment. For example, if a retailer investigates an RFID-enabled inventory system for privacy implications, the retailer must determine whether to include loyalty program databases in the analysis. For the purpose of privacy analysis, we argue that a system boundary is reached when data flows end or none of the internally or externally adjacent systems are relevant for privacy. Because the RFID inventory system application can easily be linked to a customer loyalty base, RFID data could be personally identified with reasonable effort. Hence a retailer would be well advised to include its loyalty programme in the privacy analysis of the inventory system.

Step 2 – Definition of privacy targets

A risk assessment aims to understand what is at risk. Existing security risk assessments view the assets identified in the system characterisation from Step 1 as security targets that must be protected (e.g. ISO, 2008). Although the assessments offer libraries of security targets, these libraries have just begun to be elaborated for the privacy domain and are not yet standardised. Instead, legal catalogues and guidelines on privacy principles dominate the scene (i.e. FIPPs (FTC, 1998)). These legal principles are not limited to data protection issues, as they embrace the full concept of privacy (see Appendix A). In contrast to the libraries of security targets, legal privacy principles are difficult to use for assessing concrete system functionality or describing the design of systems. Privacy principles are difficult to use because they are semantically different and often more generic than concrete system functions that engineers can build or that can be scrutinized in a PIA. Consider the legal principle of data quality required by Section 1 of the EU's Data Protection Directive (EC, 1995). Engineers think of data quality in much more concrete terms than what the law outlines; concrete terms include data integrity, precision, completeness, timeliness or consistency (Scannapieco et al, 2005). As a result, privacy, security and legal scholars recognise that legal privacy principles must be translated into concrete, auditable and functionally enforceable privacy *targets* and subsequent system functions (Rost and Pfitzmann, 2009; Rost, 2011; ENDORSE, 2011).

For this reason, our PIA methodology embraces 'privacy targets' instead of 'privacy principles'. PIAs must focus on concrete objects of analysis (i.e. system characteristics) and should help engineers identify specific design goals. The term 'privacy targets' supports this effort and is in line with the wording of security assessments that are a complement of and forerunner for PIAs. We acknowledge that both the EU Data Protection Directive (EC, 1995) and the ISO Standard for Privacy Architecture (ISO, 2011) refer to 'principles' where we use the term 'target'. But as Table 1 shows, we also suggest formulating privacy targets as action items, similar to widely accepted modelling techniques like UML (Unified Modelling Language) and ARIS (Architecture of Integrated Information Systems). Formulating targets in this way promotes future action. By thinking in terms of actions that achieve development targets, we clearly depart from thinking in terms of principles when it comes to conducting a PIA.

That said, our privacy targets are directly derived from the established privacy principles formulated in the EU Data Protection Directive (EC 1995) and the EU's proposal for new data protection regulation (EC, 2012). This approach is in line with two official PIA standards we co-authored, namely the PIA Framework for RFID (INFSO, 2011) and the BSI PIA Guideline for RFID Applications (BSI, 2011b). Privacy targets are derived from laws for several reasons: First, deriving privacy targets from laws implies that European companies running through all privacy targets will ensure that they comply with

data protection regulations. Second, because European data protection law is more exhaustive than many other guidelines on this matter (such as FIPPs (FTC, 1998)), deriving privacy design targets from it produces a highly exhaustive list of targets. Laws also reflect accepted standards of morality that society has chosen to accept. As a result, they constitute a more valid and reliable long-term foundation for system design than privacy targets that come out of an ad-hoc stakeholder process.

Many privacy scholars still point to the importance of stakeholder involvement in PIAs when it comes to the identification of privacy targets (Wright and De Hert, 2012). Those critical of the law note that it lags behind technological developments or does not cover all relevant ethical aspects of a specific technology (Van Gorp and de Poel, 2008). By applying established customs, laws, and norms, a PIA runs the risk of creating a "routing ethics" that falls short of addressing the ethical challenges of a particular technology or application (Moor, 1998). We therefore recommend that stakeholders challenge whether targets derived from data protection laws adequately address the privacy issues inherent in a new technology. An example is a stakeholder process we conducted on RFID technology. We found that, in addition to the RFID privacy risks that are covered by the law, such as abundant data collection, consumers are also afraid of being constricted by the automation capabilities of the technology. In their private homes, people consider the ways that they deal with the objects they own to be private. The privacy target list for RFID-enabled consumer goods should therefore include a target such as, 'enabling the final control over automatic system reactions' (Spiekermann, 2008).

The target list in Table 1 does not include technology-specific privacy targets. However, it is complemented by two privacy targets identified by (Rost and Bock, 2011): First, humans must be allowed to dispute machine conclusions (P5.5); second, in their communications with users, companies must uncouple the distinct ways that data is processed (P 1.3). Since these privacy targets are not embedded in most legal frameworks yet, we added them to the list.

To address the second problem with existing security risk assessments, at the outset of this second step, each privacy target must be described against the background of the respective industry or company context. The privacy target list in Table 1 is a good baseline for assessing the privacy impacts of a system. But because the privacy concept covers a wide conceptual spectrum and is addressed by a variety of national laws or industry-specific regulations, more targets can and should be added. Where possible, a stakeholder process should challenge and discuss the applicability, meaning and exhaustiveness of the targets in a specific context.

Privacy Principles		Privacy Targets
P1 - Data Quality		
	P1.1	Ensuring fair and lawful processing through transparency
	P1.2	Ensuring processing only for legitimate purposes
	P1.3	Providing purpose specification
	P1.4	Ensuring limited processing for specified purpose
	P1.5	Ensuring data avoidance
	P1.6	Ensuring data minimization
	P1.7	Ensuring data quality, accuracy and integrity
	P1.8	Ensuring limited storage
P2 - Processing Legitimacy		
	P2.1	Ensuring legitimacy of personal data processing
	P2.2	Ensuring legitimacy of sensitive personal data processing
P3 - Information Right of Data Subject		
	P3.1	Providing adequate information in cases of direct collection of data from the data subject
	P3.2	Providing adequate information where data has not been obtained directly from the data subject (e.g. from third parties)
P4 - Access Right of Data Subject		
	P4.1	Facilitating the provision of information about processed data and purpose
	P4.2	Facilitating the rectification, erasure or blocking of data
	P4.3	Facilitating the portability of data
	P4.4	Facilitating the notification to third parties about rectification, erasure and blocking of data
P5 - Data Subject's Right to Object		
	P5.1	Facilitating the objection to the processing of personal data
	P5.2	Facilitating the objection to direct marketing activities
	P5.3	Facilitating the objection to disclosure of data to third parties
	P5.4	Facilitating the objection to decisions that are solely based on automated processing of data
	P5.5	Facilitating the data subject's right to dispute the correctness of machine conclusions
P6 - Security of Data		
	P6.1	Ensuring the confidentiality, integrity and availability of personal data storage, processing and transmission
	P6.2	Ensuring the detection of personal data breaches and their communication to data subjects
P7 - Accountability		
	P7.1	Ensuring the accountability of personal data storage, processing and transmission

Table 1. Privacy principles and privacy targets

Step 3 – Evaluation of degree of protection demand for each privacy target

Not all of the privacy targets summarized in Table 1 are applicable to all systems. For example, for some systems that collect data, such as sex sites or healthcare databases, people might be extremely sensitive about disclosure of their data to third parties (P5.3). If limitation of disclosure was not ensured and personal information was leaked to the public, the reputation of both the person whose information was publicized and the company that leaked the data could be seriously damaged. In other situations, privacy targets may be legally required but not a priority for customers. For example, a telecommunications operator must facilitate the rectification and erasure of call data records (P1.8); if the operator failed to do so, the damage to the individual's finances and reputation would probably be less grave than in the previous example.

Because the importance of privacy targets depends on context, companies running through PIAs should rank targets and identify priorities for their privacy architectures. To determine the right *level of protection demand,* companies can ask "What would happen if …?". As shown in Table 2, we

propose that companies use damage scenarios to answer this question. Both a system operator and its customers incur damage if privacy targets are not met. System operators might suffer financially or damage their company brand if privacy targets are not met. Data subjects can incur damage to their reputation, freedoms or finances.

The evaluation of privacy targets we propose differs from the more quantitative, asset-driven target evaluation of some security assessments (see e.g. (ISO, 2008)). Our approach differs because the consequences of privacy breaches are often of a 'softer' nature than security breaches; privacy breaches often relate to hurt feelings rather than something like the compromise of a computer system, which has a certain monetary value. For example, how do you quantitatively evaluate the consequences of a leaked body scan? Because it is difficult to quantify the personal consequence of privacy breaches, we distinguish between limited, considerable and devastating consequences for each of five damage scenarios. Depending on the highest level of consequence identified for a scenario, we then call for a corresponding degree of protection demand, which can be low, medium or high. In a later state of the assessment (Step 5), companies use this evaluation to choose privacy controls that are aligned in strength and vigour. This approach is similar to the security assessment procedures prescribed by the German Federal Office for Information Security (BSI, 2008). These procedures are proven to work well in practice because three consequence levels are cognitively more manageable and arguable than more complex scales.

Protection demand required for privacy target	**What could be impacted if privacy target was not met …?**				
	System operator perspective		Data subject perspective		
	Reputation or brand value	Financial situation	Social standing, reputation	Financial situation	Personal freedom
Low – 1	The impact of any loss or damage is **limited and calculable**.				
Medium – 2	The impact of any loss or damage is **considerable**.				
High – 3	The impact of any loss or damage is **devastating**.				

Table 2. Protection demand categories and perspectives

Step 4 – Identification of threats for each privacy target

At the heart of recognised risk assessment methodologies, one typically finds a listing of concrete threats to target assets and the probability that these threats will materialise. The assets under potential attack – in our case, the privacy targets – are analysed to determine why they are vulnerable. The causes of vulnerability and the threats are combined with the likelihood that the threats will occur. The

result is a measure of the risk inherent in a system. For more detail on risk assessment methodologies, see (NIST, 2002; ISO, 2008).

Our PIA methodology follows a similar approach. For each privacy target, we systematically *identify the threats* that could prevent us from reaching them. For example, privacy target P3.1 states that adequate information must be given to data subjects when data is directly collected from them. This target could be threatened in multiple ways: Companies may not give customers a privacy statement and thus fail completely to inform them. But companies may also fail to include the right information in a privacy statement, such as who the data controller is, why the data controller collects the data, whether data is shared, who the data is shared with, who to contact in cases of redress, and so on. In a PIA, threats are primarily failures to comply with privacy laws or sector standards, which are outlined in the privacy targets. In addition, failures might occur when stakeholders are ignorant of practices that have been identified as relevant in the privacy target list. Threats can materialise when technologies do not have adequate privacy functionality or when processes and governance practices fail to protect privacy.

For a threat analysis to be complete and justifiable, the threats in the analysis must match the identified privacy targets. Threats that do not correspond to a privacy target are not justified. If any privacy targets do not have corresponding threats, either the targets are not relevant or the threat analysis may be incomplete. To ensure a high level of methodological control in a PIA, privacy targets and privacy threats can be matched by using a numbering scheme (see Figure 4 for illustration).

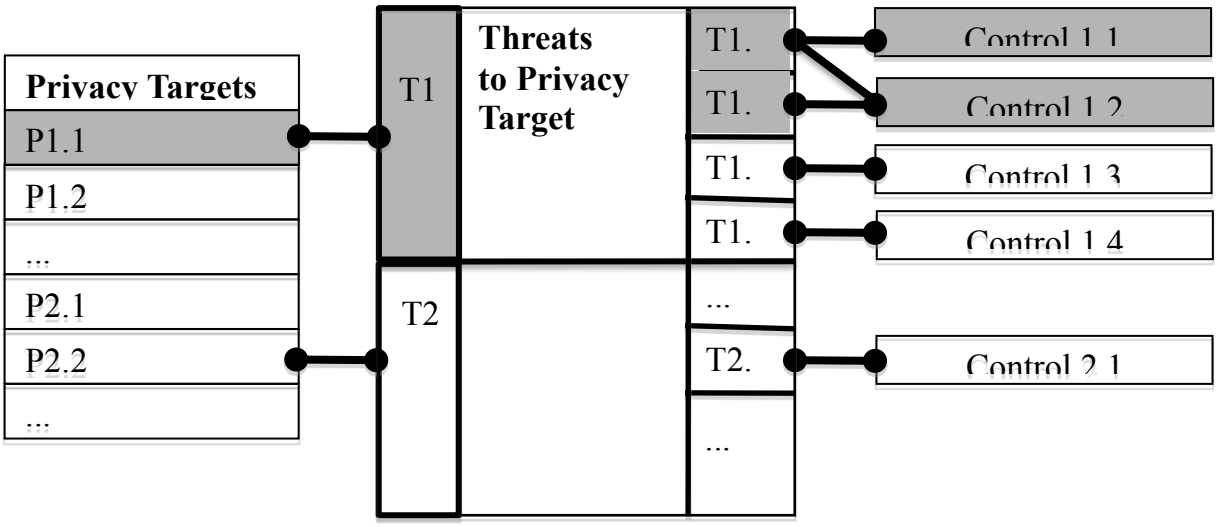

Figure 4. Controlled matching of privacy targets with threats and controls

Finally, not all potential threats are likely to occur. The probability that they become relevant depends on the technology, the IT architecture, the people involved, the information governance of the company, the attractiveness and sensitivity of the personal data involved, the privacy education of employees and many other potential factors. Because so many variables can influence the incidence of a threat, security risk assessments determine threat probabilities. People who use security risk assessments determine what risks to tackle first based on these probabilities and the value of the underlying asset being threatened.

In the privacy domain, we argue that a gradual determination of threat probability as is done in security assessments is not advisable: if a human right such as privacy is threatened, it must be dealt with. We cannot consider the probability of a threat, but rather whether it exists. If the threat is likely to exist, a control must be determined to mitigate it.

Step 5 – Identification and recommendation of controls suited to protect against threats

The crucial step in a PIA is to identify controls that can minimise, mitigate or eliminate the identified threats. Controls can be technical or non-technical. Technical controls are directly incorporated into a system, whereas non-technical controls are management and administrative controls as well as accountability measures. Exemplary controls for each privacy target are summarised in Table 3.

Controls can be categorised as preventive or detective (NIST, 2002). Preventive controls inhibit violation attempts, while detective controls warn operators about violations or attempted violations. Because PIAs are intended to foster privacy-by-design, data controllers should focus on identifying and recommending preventive controls.

Privacy Targets		Controls	
		Technical	**Administrative/Managerial**
P1 - Data Quality			
P1.1	Ensuring fair and lawful processing through transparency		Providing accurate and up-to-date information, Making information accessible, Providing a privacy statement
P1.2	Ensuring processing only for legitimate purposes		Ensuring legitimacy of purpose
P1.3	Providing purpose specification		Providing an accurate and up-to-date purpose specification
P1.4	Ensuring limited processing for specified purpose	authentication, authorization, logging	Ensuring purpose related processing through policies and regular audits
P1.5	Ensuring data avoidance	minimal granularity	Ensuring data avoidance through policies and regular audits
P1.6	Ensuring data minimization	pseudonymisation, anonymisation, obfuscation, automated deletion routines	Ensuring data minimization through policies and regular audits, Providing and enforcing deletion rules
P1.7	Ensuring data quality, accuracy and integrity	data validation	
P1.8	Ensuring limited storage	automated deletion routines	Providing and enforcing deletion rules
P2 - Processing Legitimacy			
P2.1	Ensuring legitimacy of personal data processing		Ensuring obtainment of consent, Checking validity of consent
P2.2	Ensuring legitimacy of sensitive personal data processing		
P3 - Information Right of Data Subject			
P3.1	Providing adequate information in cases of direct collection of data from the data subject		Providing accurate and up-to-date information concerning (a) the identity of the data controller, (b) the purpose of processing, (c) the recipients of the data, (d) optional data
P3.2	Providing adequate information where data has not been obtained directly from the data subject (e.g. from third parties)		
P4 - Access Right of Data Subject			
P4.1	Facilitating the provision of information about processed data and purpose		Providing an interface that allows data subjects to send in a request for information, Ensuring timely processing of data subjects' request for information, Providing accurate and up-to-date information concerning (a) confirmation as to whether or not data relating to the data subject is being processed, (b) the purpose of the processing, (c) the categories of data concerned, (d) the recipients or categories of recipients to whom the data is disclosed, (e) the data undergoing processing and any information as to the data's source, (f) the logic involved in any automatic processing of data and automated decisions.
P4.2	Facilitating the rectification, erasure or blocking of data	authentication, authorization, logging	
P4.3	Facilitating the portability of data	export functionality	
P4.4	Facilitating the notification to third parties about rectification, erasure and blocking of data		Providing adequate and timely information about rectification, erasure and blocking of data to relevant third parties
P5 - Data Subject's Right to Object			
P5.1	Facilitating the objection to the processing of personal data		Providing an interface that allows data subjects to send in an objection, Ensuring timely processing of data subject's objection
P5.2	Facilitating the objection to direct marketing activities		
P5.3	Facilitating the objection to disclosure of data to third parties		
P5.4	Facilitating the objection to decisions that are solely based		
P5.5	Facilitating the data subject's right to dispute the correctness of machine conclusions		
P6 - Security of Data			
P6.1	Ensuring the confidentiality, integrity and availability of personal data storage, processing and transmission	technical information security controls	Administrative/managerial information security controls
P6.2	Ensuring the detection of personal data breaches and their communication to data subjects	technical information security controls	Providing adequate and timely information about personal data breach to data subject
P7 - Accountability			
P7.1	Ensuring the accountability of personal data storage, processing and transmission	authentication, authorization, logging	

Table 3. Privacy targets and exemplary controls

Controls that are more rigorous and extensive are also likely to be more costly and difficult to realize in practice. For this reason, we recommend three levels of rigor for controls: 1 - satisfactory, 2 - strong and 3 - very strong; for each privacy target, the level of rigor that is required depends on the degree of protection demand that was determined in Step 3 of the PIA. For example, high (3) protection demands combined with likely threats should be mitigated with very strong (3) controls, while privacy targets with low (1) impact can be countered with a satisfactory (1) control. As Figure 4 shows, one control can also address and mitigate multiple threats.

Step 6 – Assessment and documentation of residual risks

After the list of controls is written, the controls must be evaluated for feasibility and effectiveness. Organisations can conduct a cost-benefit analysis and invite stakeholders to discuss the acceptability of alternative controls. For example, suppose that a retailer wants to introduce RFID tags on products and has the control alternatives of killing tags at store exits or deactivating them with a password protection scheme. In this case, the retailer can discuss control options with customers to determine which approach is most acceptable for the market.

When potential controls are evaluated, data controllers can produce a control implementation plan that clearly identifies how each threat is mitigated and where threats remain unaddressed. Threats that remain unaddressed constitute the residual risk. A residual risk also exists if an implemented control reduces the impact of a threat but does not eliminate it completely.

Whether a residual risk is acceptable or a control option is postponed to a later stage of system deployment depends on the risk standards and norms of a design team or entire company (Naoe, 2008). In any case, residual risks should be well documented in a PIA report; upper management, corporate risk management and IT staff will be held accountable if privacy breaches occur.

Step 7 – Documentation of PIA process

To date, no standards for good PIA reporting exist. The EU-PIAF project recently compared the main PIA reporting practices that exist (Wright et al, 2011). Extending their findings of what is typically included in PIA reports, we argue that the content of PIA reports should primarily meet target audiences' expectations. Manifold target audiences for PIA reports exist. Internally, a companies' corporate risk management, marketing staff, upper management and IT management must be aware of privacy risks. These groups must understand privacy risks not only because privacy breaches can lead to financial liabilities, but also because privacy breaches can damage a companies' brand and force upper management to quit. At the same time, IT staff will probably be held responsible for any incidents that occur. Therefore, companies should have a strong interest in comprehensively

documenting their privacy targets, threats, controls and residual risks; they should also regularly check their compliance with relevant laws. IT staff will want to have the same information but also must be able to quickly spot a system's weaknesses when a breach occurs. For them, quality documentation of the system and its data flows is essential.

Externally, data protection authorities in many countries have the legal right to review PIA reports. Authorities may need to comprehend the system under scrutiny and judge whether system boundaries, privacy targets and threats have been properly identified and mitigated. Authorities also need to understand residual risks.

Finally, customers and the media might be interested in PIA reports. These groups want to understand the system and its purposes, customer control options and the core conclusions on threats and controls. For both protection authorities and the media, some PIA quality signals could lead to acceptance that privacy work has been done. These signals include the reporting of stakeholder involvement and reporting that a PIA process is part of system development. Finally, when things go wrong, everyone wants to know who is accountable and why a PIA failed to prevent a breach. Leading privacy experts have regularly called for accountability for privacy breaches (Alhadeff et al, 2011). Consequently, people will want to know when the PIA was conducted, how long the assessment took, who conducted it, and who is ultimately responsible for any breaches that occur.

Because PIA reports have such varied target audiences, who in turn have varied expectations, a PIA report should ideally contain the elements outlined in Table 4. As shown in the table, it is advisable to produce two versions of a PIA report. The one for internal and auditing purposes provides much more content, some of which might be confidential; the version for the public can have less detail but should be easy to understand. Furthermore, machine-readable PIA report standards should be developed so that both audits and consumer requests can be administratively facilitated. The P3P standard developed for privacy policies may be a good starting point for this exercise (Cranor et al, 2006).

	Data Protection Authorities	Company Staff	Customers	Media
General System Information				
System Overview	x	x		
System Boundaries	x	x		
System Purposes	x	x	x	x
Assessment Information				
Relevant Privacy Targets Identified	x	x	x	x
Relevant Privacy Threats Addressed	x	x		
Chosen Privacy Controls	x	x	x	x
Residual Risks Encountered	x	x	(x)	(x)
PIA Quality Signals				
Stakeholders involved	x	x		
Legal compliance checked	x	x	x	x
PIA start date/System's start date	x	x		
Accountability				
Person(s) involved in the PIA	x	x		
Organisation who conducted the PIA	x	x	x	x
Person who approved the PIA	x	x		
Privacy responsible in company	x	x	x	x
Date of PIA completion	x	x	x	x
Time frame of PIA validity	x	x		

Table 4. PIA reports and the target audiences' reporting expectations

Most of the steps in our PIA, as well as their sequence, are similar to those in existing risk assessment processes (e.g. (BSI, 2008; ISO, 2002; ISO, 2005; NIST, 2002; Seibild, 2006)); where necessary, we have enhanced the steps with privacy-specific requirements. These enhancements are especially observable in Steps 1 and 3. In Step 1, in contrast to risk assessment processes that require only a description of the system's assets, we provide details about the aspects of a system that need to be characterised and emphasise the description of data categories and data flows. In Step 3, we consider two perspectives – system operator and data subject – for evaluating the degree of protection demand. Existing risk assessment processes do not reflect on different perspectives, implicitly focusing on the system operator's perspective. We introduce the notion of perspectives, especially the consideration of the data subject's perspective, to encourage a comprehensive evaluation of the broad concept of privacy and to highlight affected data subjects. Only Steps 2 and 7 were defined from scratch; they cannot be found in existing risk assessment processes. Similar to the aforementioned privacy-specific enhancements in the other steps, these two steps were introduced to meet the specific concerns of the privacy concept and frame privacy issues in a way that encourages privacy-by-design. In Step 2, where organisations define relevant privacy targets, organisations not only understand and embrace

the broad aspects of the privacy concept, but also specify privacy requirements in a way that allows them to be addressed technically, leading to privacy-by-design. Step 7 outlines PIA-specific requirements to create and publish a report that meets the expectations of different stakeholders concerning the documentation of the PIA.

The seven steps must be followed in sequence because each one builds on the one before. An exception is Steps 1 and 2, which can be executed in parallel; however, in some cases, system characterisation details might be needed to identify and define concrete privacy targets. The nature of Step 7 also allows it to occur in parallel with the other steps. In contrast, Step 3 strongly builds on the results of the previous steps; organisations cannot execute an informed evaluation of protection demand if the system characterisation and the privacy targets are not defined in detail. The results of Step 3 are essential for the following steps because they inform the identification of threats and controls in Step 4 and 5; furthermore, they are the foundation for recommending appropriate controls in Step 5 and assessing residual risks in Step 6. Controls can only be identified in Step 5 if a list of threats has been compiled in Step 4, and residual risks can only be assessed in Step 6 if a list of recommended controls is available.

Finally, although the sequence of the steps is fixed, the process itself is iterative. We highly recommend executing the proposed PIA more than once during the development of a system. Requirements and functional additions or changes to the system, discussions with stakeholders or the further evolution of the privacy concept itself might lead to new privacy targets, a re-evaluation of the protection demand, or new threats and controls.

Utility evaluation of the proposed artefacts

As part of design science research, we must evaluate the proposed artefacts. We used the strategic evaluation framework of (Pries-Heje et al, 2008) to choose evaluation methods, ultimately evaluating the design process (Walls et al, 1992) by seeking opinions from process users (Pries-Heje et al, 2008). The design process is evaluated during the iterations of the design cycle whereby the main iteration is ex post and earlier iterations are ex ante. To demonstrate the utility of our artefacts, we chose a naturalistic evaluation method (Venable, 2006). For the naturalistic evaluation, we used action research as proposed by Venable (2006) in the form of workshops with IT industry experts. By using this evaluation method, we also address the aforementioned problems of existing security risk assessments that mostly focus on process and not on content quality (Siponen, 2006). We avoid a focus on generic security requirements that disregard company-specific requirements (Siponen and Willison, 2009). And we validate our approach based on common business practice. rather than

profound research methods (Siponen and Willison, 2009). We use profound research methods to evaluate the content and quality of our proposed artefacts.

Information systems researchers have developed and adopted different action research approaches (Avison et al, 1999; Baskerville and Wood-Harper, 1996). We follow Baskerville (1999) and use one of the best-known approaches, namely Susman and Evered's (1978) action research cycle. This cycle consists of diagnosing, action planning, action taking, evaluating and specifying learning. The research process was collaborative and iterative.

The approach first requires establishing the research environment: we recruited experts from different backgrounds (retail, public transport and automotive) to conduct and challenge our proposed PIA methodology. We worked with six industry experts with different organisational roles relevant for PIAs: a general risk manager, an IT department manager, a technology innovations manager with a strong background in technical security management and several members of a governmental institution focused on information security, each of whom have a strong background in theoretical risk management. We established an informal researcher-client agreement (Davison et al, 2004; Susman and Evered, 1978) that specified the collaborative approach and the following goals: (1) experimentally implementing and thus challenging the proposed PIA methodology in the form of workshops, (2) completing PIAs for three real-life scenarios and (3) experimentally integrating the seven PIA steps into a system development process.

Diagnosing – Initiation of the collaborative approach

Experts' organisations were highly interested in implementing strategies to systematically consider privacy requirements and issues. Nevertheless, experts reported a lack of knowledge about relevant privacy requirements and a lack of experienced personnel. As a result, we identified a need for a process-oriented PIA guideline, one that contained detailed privacy requirements and could be implemented by existing personnel.

Through interviews, we identified the actual systems and business scenarios that the PIA methodology would be applied to and the related requirements it would need to satisfy. Based on these interviews, we outlined three scenarios: (a) a retail scenario involving an RFID-enabled loyalty card and tagged products, (b) a public transport scenario using RFID-enabled tickets and pay-per-use models, and (c) an automotive scenario involving an RFID-controlled assembly and an RFID-enabled employee access card.

This diagnosing step was only conducted initially, whereas the following steps of the action research cycle were completed during subsequent iterations.

Action planning

Because Step 1 was completed in the diagnosis phase, we conducted Steps 2 to 6 of our proposed methodology in the form of workshops with relevant stakeholders. To ensure that workshop participants would have the information they needed to participate in the PIA, we prepared a description of our proposed methodology and a description of the systems and scenarios from Step 1.

The methodology, scenario descriptions, and related PIA documentation were updated at the end of each iteration as a result of the evaluating and specifying learning steps.

Action taking

During each workshop, we explained our PIA methodology and constructs via a presentation of all seven steps and conducted a questions and answers session to ensure that all participants understood the steps and the overall goal. Second, we conducted a PIA and completed Steps 2 to 6 with both the organisational context of the experts' internal operations and one of the scenarios in mind. Each of the participants had a paper template at hand that depicted each of the steps and could be filled in with the results of the discussion. Third, we asked the participants to suggest potential improvements to our proposed artefacts. Most of the workshops took 6 to 8 hours. The information was captured in the form of result protocols and completed paper templates.

We chose this setup for the workshops to reach our first two goals of the collaborative process, namely implementing and challenging the proposed methodology and completing PIAs for three real-life scenarios.

In a later iteration, we also attempted to integrate the seven PIA steps into the project phases of a system development process. We chose to use the retail case, integrating the seven steps into the current system development process of one of the retail organisations that participated (Figure 5). We conducted the integration based on the current system development process because extensive changes to the current IT project flow only due to privacy requirements would have been undesired. Figure 5 depicts the project stages, stakeholders and when and by whom the steps of our proposed PIA methodology might be conducted.

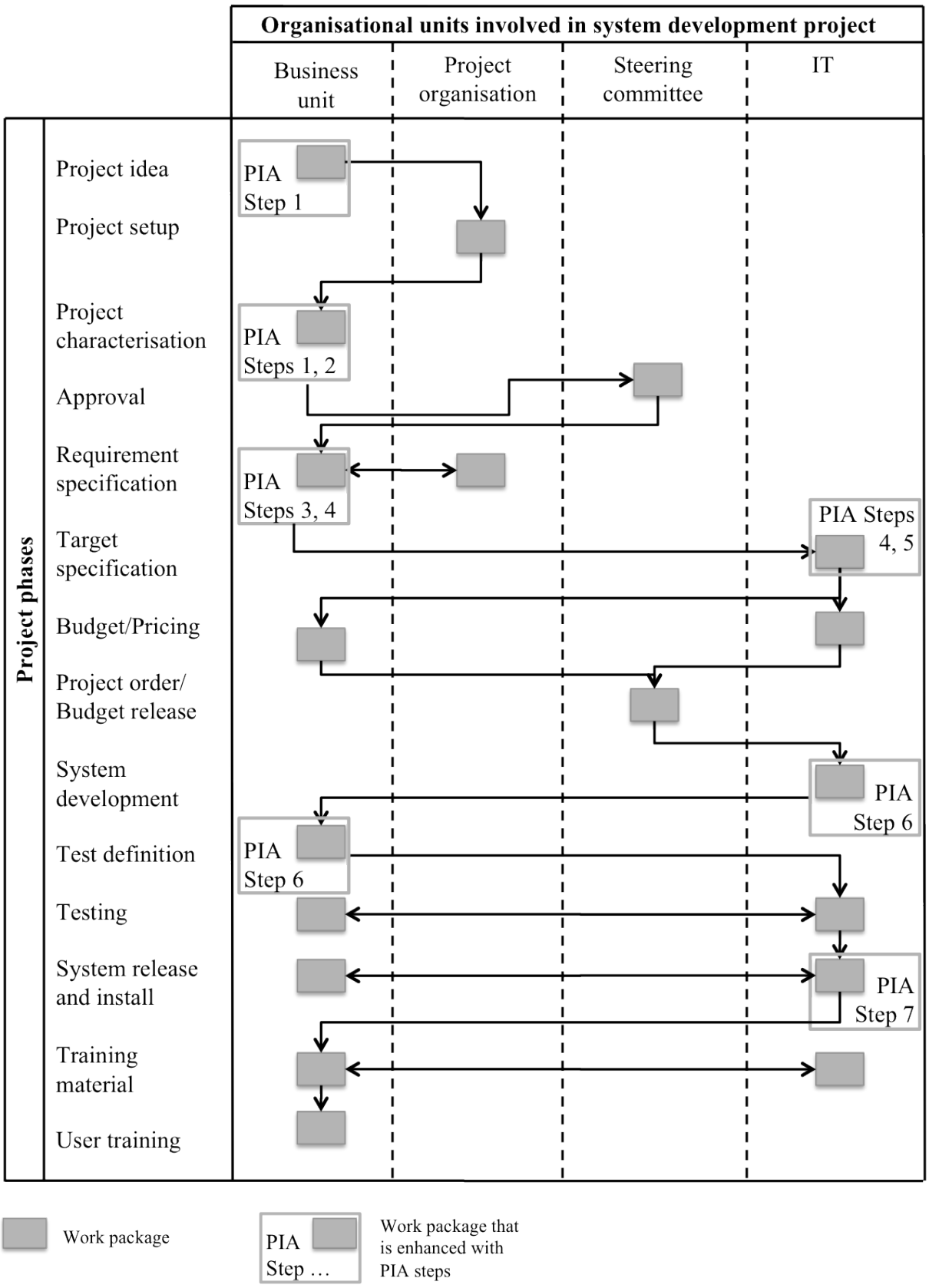

Figure 5. As-is retail case – Stakeholders, project phases and integration of the 7 PIA steps

The figure shows that Steps 1 and 2 can be conducted from the very start of a project and should be completed in the project characterisation phase, which determines the features that will be implemented. All internal stakeholders are involved in Steps 1 and 2; even the steering committee might influence the privacy targets during the approval phase. Step 3 is executed in the requirement specification phase and is thus mainly driven by the responsible business unit, who consequently decides the amount of protection that is required. Steps 4 and 5 must be completed in the target specification phase. Thus, business-oriented personnel from the business unit and technical personnel from the IT unit both identify threats and recommend controls. Step 5 must be completed at this time because budget planning must be based on the planned implementation of recommended controls. Step 6 occurs during system development and test definition, where residual risks can be documented and test routines to validate controls can be defined. As a PIA report (Step 7) should be available at system release time, this is the phase where business unit personnel and IT personnel complete PIA-related documentation and write a PIA report.

In the best-case scenario of a system development project process shown in Figure 5, the integration of the seven PIA steps seems to be seamless and rather sequential. But correctional cycles are typical in such projects, and thus change request processes must be considered too. In the retail case, change requests can happen any time after the approval phase and before the system release phase. In that case, Steps 3 to 7 must be executed again and related documentation must be updated.

Evaluating and specifying learning

Each of the iterations was closed with a collaborative and a researcher-only evaluating step as well as a specifying learning step.

All participants confirmed that the comprehensive documentation of a system, as required in **Step 1,** was necessary to complete a reliable PIA. But participants were concerned about the amount of time and labour needed to create a detailed system characterisation. Participants noted that such comprehensive documentation is not readily available in a typical company, where the main interest lies in producing a running application rather than a well-documented one. It was especially difficult for participants to agree on the system boundaries for documentation and analysis. The best solution to this dilemma that the participants suggested was to focus on the flow of personal data. In this approach, the documentation would describe the system components and interfaces that are part of the personal data flow but stop documenting components at the point where personal data comes to a rest.

In **Step 2**, all of the participants highly valued the privacy targets (see Table 1). The privacy targets systematically structure the confusing and extensive landscape of privacy requirements in a way that IS practitioners feel confident working with. Most importantly, since most of them initially cover the

law, legal compliance is ensured through our PIA methodology. This is important for industry since PIAs are costly and should at least ensure legal compliance. When participants discussed each of the privacy targets in detail (in the context of their personal operations as well as the fictitious scenario), their confidence increased and they viewed the targets as less complex. Nevertheless, the 'correct' interpretation of some of the targets remained a problem. In particular, target P1.1 'Ensuring fair and lawful processing through transparency' resulted in discussions on how to interpret 'transparency' and how transparency can be ensured. This problem of 'correct' interpretation was not considered to be insurmountable; discussions always led to a certain interpretation. All participants admitted that they were not aware of most of the legal requirements coming into the discussion. The participants recognised that they would need to invest in training and additional personnel to foster the understanding of privacy issues throughout their organisations.

In **Step 3**, where the assessment requires data controllers to evaluate how much protection each privacy target requires, participants agreed that a qualitative approach is the most feasible. As noted above, evaluating the impact of a privacy breach is different from evaluating the impact of security breaches; for example, a security breach such as a loss of availability might be quantified in terms of business losses. The two perspectives we propose (operator and data subject; see Table 2) were considered to be very helpful for evaluating the 'soft' factors that are typically affected by privacy breaches. Nevertheless, participants with technical background, who were used to evaluating system failures quantitatively, had more difficulty working through this step than stakeholders with a risk management background. The latter stakeholders mainly considered the operator perspective, focusing on threats like damage to a company's image; technical stakeholders, meanwhile, focused on technical issues and omitted administrative issues. For both sets of stakeholders, significant effort was required to take the data subject perspective and properly evaluate the degree of protection demand needed; this finding emphasises how important it is that stakeholders explicitly adopt the end-user perspective. After discussing some of the privacy targets, stakeholders grew accustomed to the alternative way of thinking and reasoning about privacy issues, and they assigned the three levels of protection more easily.

For the evaluation of the likelihood of threats in **Step 4**, the workshops led us to again adopt a qualitative approach. Although participants considered assigning a quantitative probability to each threat, the nature of most of the threats did not make this approach feasible. Thus, we settled on a simple differentiation in which each threat was labelled "likely" or "unlikely".

Most participants viewed the identification of controls in **Step 5** as straightforward. Although they were not familiar with the concept of privacy-by-design, they agreed that privacy controls should be identified as soon as possible in the system development process. Participants lacked knowledge about

the privacy-enhancing control options and measures that can help to realise a privacy-by-design approach. For example, participants did not know that they could fulfil the data minimisation requirement by implementing pseudonymisation or anonymisation measures (see Table 3). Moreover, interviewees from companies' IS departments recognized that privacy experts had never been part of their project teams; these experts might have brought significant knowledge and perspective to the system development lifecycle.

Participants were confident that they could document residual risks and set up an implementation plan for the controls in **Step 6**; these actions resemble existing risk management processes, and they do not involve any privacy-specific procedures. In contrast, some participants were strongly concerned about the publication of a PIA report as required in **Step 7**. Although they were concerned about revealing detailed and confidential information to the public, they agreed that the results of a PIA should be published. In addition, they agreed that external parties like data protection authorities and customers should be informed about the reasoning that led to the results. Based on the workshops, we concluded that two versions of a PIA report should be written: a detailed report for internal use and audits from data protection authorities and a report that clearly summarises the results for customers and the media (see Table 4).

Results and key findings

After completing the last iteration of the action research cycle, we created PIA reports for all three scenarios as required in Step 7. As a full description of the scenarios and their respective PIAs is not in the scope of this paper, we refer the reader to the BSI's PIA guideline (BSI, 2011b). In the following section, we briefly describe some key findings of the exemplary PIA for the retail scenario. These key findings have consequences for the design of RFID applications in the retail sector and for related business processes. Thus, they lead to adaptations for privacy-by-design in the areas of system design, function and process.

In short, the retail scenario is composed of an RFID-enabled loyalty card, tagged products, added-value services and RFID-enabled shop-floor applications such as smart trolleys, smart shelves, and self-checkout systems. After we considered privacy targets, we generated the following privacy-control recommendations: extensively inform customers about RFID technology, the customer data that is collected and how this data is processed so that customers know that they may be 'scanned' by RFID readers (P1.1); allow customers to choose whether they want to participate in RFID-based services; separate logistical data from customer data (P1.2 and P1.3); implement fine-grained access rights and regularly update assigned access rights (P1.2 and P7.1); implement deletion rules that delete or anonymise customer data that is no longer needed for the specified purpose (P1.5 and P1.3); offer

personalised and pseudonymised loyalty cards to customers (P1.3); kill or deactivate all product tags during checkout, but do not kill a product tag if a customer explicitly requests the ability to use the product in conjunction with added-value services (P1.2 and P7.1).

Quality criteria for a best practice PIA process		UK - PIA Handbook (2009)	ISO 31000 Risk Management - Principles and guidelines on implementation (2009)	Proposed PIA methodology
1. Early start		x	x	x
2. Project description				
	General description of the project	x	x	-
	Information flows	x	x	+
	(Other) privacy implications	x	-	+
3. Stakeholders' consultation		x	x	x
4. Risks management				
	Risks assessment	-	x	+
	Risks mitigation	-	x	+
5. Legal compliance check		x	x	x
6. Recommendations and report				
	Recommendations and action plan	x	x	+
	Decision and implementation of recommendations			
	PIA report	x	x	+
7. Audit and review		-	-	x

x fulfilled
- not fulfilled
+ advanced

Table 5. Overview of the analysis of the relative utility

Limitations of our PIA methodology

The utility evaluation of our artefacts suggests some limitations of our methodology. First, we use a qualitative evaluation approach consisting of three levels (low, medium and high) to evaluate the protection demand level. As a result, we consider only the magnitude of risk, not the probability. We therefore recommend that external and internal stakeholders be involved in every step of the process; stakeholders can contextualise and define privacy targets, evaluate protection demand and identify and evaluate threats. This stakeholder involvement could be supported by introducing expert 'Delphi' technique judgements (Linstone and Turoff, 1975), which are often used in qualitative risk assessments. However, small- and medium-sized companies that lack the resources to accomplish comprehensive Delphi risk analyses could use our current approach.

Second, we do not offer any means or instruments to measure and analyse how well a step has been executed and if the resulting artefact is complete. Like security risk assessment standards, we leave judgement concerning the completeness and quality of the executed assessment to the assessors; we recommend regular audits that can unearth remaining issues and initiate improvements to both the implemented assessment process and the application. However, software tools could help to ensure that the assessment steps and their resulting artefacts are complete. To provide useful tools to practitioners, we already implemented an instantiation of our artefacts in the form of a web application called "intelligentPIA" (iPIA, 2011). We also plan to do case studies to further evaluate the utility of our proposed artefacts.

Third, in this research we focused on the development of a PIA methodology. We did not consider how our step-by-step methodology can be formally integrated into a company's existing risk management and system development process. Although we based our methodology on existing security risk assessments to facilitate seamless integration, we examined if and how such an integration can be realised based on only one retail case. When organisations integrate processes, they may also consider who is responsible for the execution of a PIA as a whole and for each of its steps. Roles that are necessary to conduct a PIA must be incorporated into existing security and data protection management systems. System engineers with profound privacy knowledge are required to conduct successful design-oriented PIAs. Thus, researchers must examine whether existing roles of security and data protection management systems, which are currently defined as either technology-centric (security) or legal-centric (data protection), are sufficient to comply with this requirement. This examination would be an important subject for future work.

Conclusion

Following the design science research paradigm, the major contribution of this research is the development of a new set of artefacts. These artefacts help practitioners and researchers understand the relevant privacy regulation landscape and analyse and assess privacy issues by using a systematic step-by-step process. The PIA methodology helps practitioners realise the concept of privacy-by-design in their system development lifecycle. Specifically, the artefacts provide systematic support for representing privacy requirements in the form of privacy targets, evaluating how much protection these targets require and systematically identifying threats and adequate controls. The proposed privacy targets have been systematically derived from legal data protection requirements and privacy principles. Our PIA methodology is built on prior risk assessment experiences and research, especially in the security risk assessment area. The methodology can be verified because each step of the PIA process produces an artefact. Although the methodology is described on a level of detail that allows

practitioners to reproduce it and transfer it to their operational environment, the methodology has been tested only in a theoretical context.

Because this methodology will be applied in varied contexts, we expect the artefacts to vary as well. We do not anticipate changes to the methodological design itself, but we do expect the methodology to be applied in different ways. In particular, the proposed list of privacy targets can and must be adapted to national or regional legislation and technology or industry-specific regulation. The term context not only refers to different industries or legislation but also implies that the methodology may be applied in different organisational contexts: small start-ups, medium-sized enterprises or big companies. For PIAs to apply in these very different settings, the UK PIA already introduced the notion of small= and large-scale PIAs (ICO, 2009). The notion of scale refers to the assignment of resources to conduct a PIA and the management commitment to release these resources. In particular, the stakeholder processes that are asked for in Steps 2 to 4 might be very expensive and therefore apply only to large companies. For a small enterprise, it might be possible to conduct a small scale PIA with just one employee. Nevertheless, the sequence of the seven steps does not change; only the investment of time and degree of detail differs between small- and large-scale PIAs. The scale of a PIA and thus the amount of invested resources will depend not only on budget restrictions but also on the sensitivity of the processed data, the importance or external visibility of a system or project, corporate culture and the sustainability of a brand; for example, brands that focus on ethical concerns might invest more resources than others.

We tested our proposed methodology and artefacts with the help of industry experts and three comprehensive scenarios. The participants of our workshops challenged our methodology's utility and helped us improve it. To ensure that our methodology could be reproduced by practitioners, we worked with participants to flesh out our description of the methodology and its supporting artefacts. By conducting three exemplary PIAs for the scenarios and thus creating an expository instantiation, we were able to test the methodology's completeness and feasibility. The scenario approach also proved that data controllers can use our methodology to discover privacy issues and appropriate controls early in the design phase of system development, thereby achieving the goal of privacy-by-design.

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Appendix A: Privacy targets and how they address activities that can create harm

Privacy Targets		Sources	Solove 2006, A Taxonomy of Privacy: Activities that affect privacy (and can create harm)																	
			Information collection		Information processing					Information dissemination								Invasions		
			Surveillance	Interrogation	Aggregation	Identification	Insecurity	Secondary use	Exclusion	Breach of confidentiality	Disclosure	Exposure	Increased accessibility	Blackmail	Appropriation	Distortion	Intrusion	Decisional interference
P1 - Data Quality																				
P1.1	Ensuring fair and lawful processing through transparency	(OECD, 1980; EC, 1995; ISO, 2011; Rost and Bock, 2011; EC, 2012),	▨	▨					▨			▨			▨			▨	▨	
P1.2	Ensuring processing only for legitimate purposes	(EC, 1995; ISO, 2011; EC, 2012)	▨	▨								▨						▨	▨	
P1.3	Providing purpose specification	(OECD, 1980; EC, 1995; ISO, 2011; EC, 2012)					▨	▨			▨		▨							
P1.4	Ensuring limited processing for specified purpose	(OECD, 1980; EC, 1995; ISO, 2011; EC, 2012)					▨	▨			▨		▨							
P1.5	Ensuring data avoidance	(EC, 1995; ISO, 2011; EC, 2012)	▨	▨	▨	▨	▨													
P1.6	Ensuring data minimization	(EC, 1995; ISO, 2011; EC, 2012)			▨	▨														
P1.7	Ensuring data quality, accuracy and integrity	(OECD, 1980; EC, 1995; ISO, 2011; Rost and Bock, 2011; EC, 2012),														▨				
P1.8	Ensuring limited storage	(EC, 1995; ISO, 2011; EC, 2012)				▨	▨													
P2 - Processing Legitimacy																				
P2.1	Ensuring legitimacy of personal data processing	(OECD, 1980; EC, 1995; FTC, 1998; ISO, 2011; EC, 2012)			▨															
P2.2	Ensuring legitimacy of sensitive personal data processing	(OECD, 1980; EC, 1995; FTC, 1998; ISO, 2011; EC, 2012)			▨							▨								
P3 - Information Right of Data Subject																				
P3.1	Providing adequate information in cases of direct collection of data from the data subject	(EC, 1995; FTC, 1998; EC, 2012)	▨	▨																
P3.2	Providing adequate information where data has not been obtained directly from the data subject (e.g. from third parties)	(EC, 1995; FTC, 1998; EC, 2012)		▨																
P4 - Access Right of Data Subject																				
P4.1	Facilitating the provision of information about processed data and purpose	(OECD, 1980; EC, 1995; FTC, 1998; ISO, 2011; EC, 2012)							▨											
P4.2	Facilitating the rectification, erasure or blocking of data	(OECD, 1980; EC, 1995; FTC, 1998; ISO, 2011; EC, 2012)							▨							▨				
P4.3	Facilitating the portability of data	(EC, 2012)																		
P4.4	Facilitating the notification to third parties about rectification, erasure and blocking of data	(EC, 1995; ISO, 2011; EC, 2012)														▨				
P5 - Data Subject's Right to Object																				
P5.1	Facilitating the objection to the processing of personal data	(EC, 1995; ISO, 2011; Rost and Bock, 2011; EC, 2012),						▨	▨											
P5.2	Facilitating the objection to direct marketing activities	(EC, 1995; ISO, 2011; Rost and Bock, 2011; EC, 2012),						▨	▨									▨		
P5.3	Facilitating the objection to disclosure of data to third parties	(EC, 1995; ISO, 2011; Rost and Bock, 2011; EC, 2012),									▨		▨							
P5.4	Facilitating the objection to decisions that are solely based on automated processing of data	(EC, 1995; ISO, 2011; Rost and Bock, 2011; EC, 2012),																		▨
P5.5	Facilitating the data subject's right to dispute the correctness of machine conclusions	(Rost and Bock, 2011)														▨				▨
P6 - Security of Data																				
P6.1	Ensuring the confidentiality, integrity and availability of personal data storage, processing and transmission	(OECD, 1980; EC, 1995; FTC, 1998; ISO, 2011; Rost and Bock, 2011; EC, 2012)	▨			▨	▨			▨	▨		▨	▨	▨	▨				
P6.2	Ensuring the detection of personal data breaches and their communication to data subjects	(EC, 2012)					▨			▨	▨	▨								
P7 - Accountability																				
P7.1	Ensuring the accountability of personal data storage, processing and transmission	(OECD, 1980; ISO, 2011; Rost and Bock, 2011)					▨			▨										
▨	The privacy target impedes the given activity and thus reduces the harm that can be be created by the activity.																			

To create a comprehensive overview of privacy targets, we incorporated all relevant regulatory frameworks, at least from a European point-of-view. The resulting list of privacy targets as presented in the table above are based on:

- all elements of the current and proposed EU data protection regulation (EC, 1995; EC, 2012)
- all data protection principles included in the OECD privacy guidelines (OECD, 1980) and Fair Information Practice Principles (FTC, 1998)

- all elements of the ISO/IEC Privacy Architecture Framework (ISO, 2011)
- data protection targets proposed by Rost and Bock (2011) that emphasise individuals' information self-determination rights.

These mostly European legal privacy "targets" are then evaluated concerning their impact on "harming activities" as identified in the American legal system. We ask whether privacy harm is likely to occur if the privacy targets are effectively tackled. The harmful activities in the table originate from Solove's taxonomy of privacy (Solove, 2006), which offers the most comprehensive and structured view on this matter. The concepts that the activities in the table are based on are restricted to the context of *information* privacy. For example, *decisional interference* (P 5.4) is restricted to the consideration of decisions that are derived from collected data. In contrast, governmental interference, which normally incorporates bodily and territorial privacy, is excluded from this table.

Three independent privacy experts judged the relationship between privacy targets and harmful activities. Where such a relationship is given, the intersection is marked. PIA assessors can use the table's judgements to determine whether to consider a privacy target in their context.

Because P4.3 is functionally only an extension of P4.1 and P4.2, it is the only target that is not explicitly assigned to any of the activities.

When conducting a PIA, it might be helpful to choose the activities that are relevant for the system or business case, then identify the privacy targets to consider.

APPENDIX B: ANALYSIS OF METHODOLOGIES RELATIVE UTILITY

After evaluating the methodology's absolute utility using action research, we evaluate the methodology's relative utility by comparing it with other risk assessment approaches.

Although PIAs are only beginning to be used in practice, there are some proposals on how to conduct PIAs. An extensive review of the proposed methodologies can be found in (Clarke, 2011) as well as in the first delivery of the PIAF project that was conducted for the European Commission (Wright et al, 2011). None of the existing PIA approaches has become a recognised standard to date. However, one of the most heralded PIAs in Europe is the UK PIA Handbook (ICO, 2009). We therefore want to compare this UK PIA to our approach. Secondly, we want to compare our proposed methodology with a recognised standard. For this purpose, we use the ISO 31000 risk management standard (ISO, 2009), which describes how to generally handle risks in organisations. The reason why we compare our PIA methodology with this privacy-independent standard is that privacy is just one of several organisational risks. If an organisation regularly addresses privacy as an ethical risk, privacy must become part of an organisation's overall risk management processes. PIAs and our approach should therefore fit into such processes.

Before we dive into the detailed comparison of the different approaches, we must discuss the differences in perspective between the three risk assessments. Both UK PIA and ISO 31000, like other current methodologies, consider a *project* as their subject of analysis. Our methodology, in contrast, focuses on *systems*. We consciously adopt a system-centric perspective for three reasons: First, our PIA methodology aims to lead a project team into privacy-by-design for a new *system*. Therefore we concentrate more on the concrete risks of a system's design and less on the organisational framework of a new project. We take an engineering perspective that is supported by business processes where needed. Because the other two approaches embrace organisational risk reflections, they are detached from system design. The *project*-centric perspective also makes assessors operate within a project's scope. However, in doing so they can overlook the larger context for the systems. For example, personal data flows may go beyond systems considered in the immediate project scope. The flows may therefore be defined as outside of project scope even though they are highly relevant from a privacy perspective. Finally, IT manufacturers develop systems that are initially independent of deployment. Since they should use PIAs in their system development life cycle it also makes sense to focus on a system.

To compare our PIA methodology to the UK PIA Handbook and the ISO 31000 standard, we use seven PIA quality criteria that were recently published by Wright and De Hert (2012):

1. Early start: A PIA process should start as early as possible so that it can influence the design of a project.

2. Project description: A project subjected to a PIA should be adequately described, including: (1) a general description of the project, (2) information flows and (3) requirements of legal data protection instruments and other types of privacy.
3. Stakeholder consultation: An organisation should identify stakeholders, inform them about the project, seek their views and duly take them into consideration.
4. Risks management: The assessor should identify, assess and mitigate all possible risks resulting from a project using (1) risk assessment and (2) risk mitigation approaches.
5. Legal compliance check: The assessor should ensure that the project complies with any legislative or other regulatory requirements.
6. Recommendation and report: The assessor should (1) provide recommendations and an action plan, (2) justify decisions about and implementation of recommendations and (3) provide a PIA report.
7. Audit and review: PIA reports should be audited or reviewed externally.

All three methodological approaches (UK PIA, ISO 31000 and our PIA) agree that an assessment should **start early**. The UK PIA links the assessment to a project lifecycle and recommends that the assessment begin in the initiation phase of a project; it also requires a cyclical approach, meaning that the different phases of the PIA can be re-executed at any time. ISO 31000 sees risk management as an integral part of organisational processes and asks for a "systematic, timely and iterative approach that is responsive to change" (ISO, 2009). Like the two other approaches, our PIA methodology is linked to a process; our methodology is linked to a system's development process, which ensures a systematic and iterative course of action. Timeliness is ensured because our PIA starts at the beginning of system development or when a system is upgraded.

Regarding a description of the overall project and system, both UK PIA and ISO 31000 require a **general description of the project**. The UK PIA Handbook requires a project outline and project plan. ISO 31000 requires a description of the internal organisational context, such as organisational objectives and attitudes towards risk, as well as the context for the risk management process. Our proposed methodology is much more specific because it focuses on in the aspects of a system that raise concrete privacy risks. Our proposed methodology demands a more systematic system characterisation in Step 1, requiring the assessor to take four distinct views on the system and its IT infrastructure context (system, functional, data, physical). Because it is system-centered, our approach does provide less information about the general project and organisational context. We believe that companies can achieve privacy-by-design in a more cost-effective way by focusing on the immediate risks inherent in a system. However, because privacy-by-design includes governance measures and

strategic decisions on personal data asset handling, we acknowledge that our PIA approach should be complemented by reflections on organisational privacy risk attitudes and risk responsibilities. Such reflections can take place before our PIA process begins and can inform later judgements and reports.

Regarding the description of **data flows**, our system-centric perspective gives us an advantage over the two other approaches. We explicitly introduce a 'data view' that requires data categories and data flow diagrams of internal and external data flows, including actors and data types. In contrast, UK PIA's phase 1 contains a background paper that *can* describe flows of personal information. ISO 31000's internal context simply *contains* information flows without further detail.

The recommended description of **privacy requirements** cannot be found in ISO 31000 because it is a general risk management standard and not privacy-specific. In contrast, the UK PIA Handbook extensively explains the concept of privacy and describes four aspects of privacy that *could* be considered in a PIA: privacy of personal information, privacy of the person, privacy of personal behaviour, privacy of personal communications. This categorisation of privacy in four spheres is very intuitive and helps readers understand the "chameleon like" privacy concept (Solove, 2006). We take a different approach though. In our methodology's "definition of privacy targets", we list privacy *targets* that should be used by engineers as their privacy design goals. Our targets are both more concrete and more extensive than the UK PIA's four categories. In contrast to the UK PIA, we also ensure that European legal requirements are covered. Furthermore, in our approach assessors must describe and analyse each privacy target against the background of their respective context. For these reasons, we consider our methodology to be more anchored in the concept of privacy and more practical to apply.

The third quality criterion, **stakeholders' consultation**, is part of all three assessment approaches. The UK PIA Handbook analyses stakeholders and establishes a consultative group during its preparation phase. The Handbook also involves stakeholders in its consultation and analysis phase. ISO 31000 contains an activity called "communication and consultation" that involves communication with internal and external stakeholders and a consultative team approach. The precise input demanded from stakeholders is not specified in these two approaches. Although we again include a less-detailed description of organisational structures, we do include stakeholders in our approach and give them a concrete role. In step 3, for example, where the protection demand for different privacy targets is evaluated, we explicitly recommend involving stakeholders.

For risk management, the UK PIA Handbook does not provide any specific guideline. Its consultation and analysis phase contains only three generic cues: risk analysis, identification of problems and search for solutions. It does not specify how these activities should be concretely pursued. ISO 31000's **risk assessment** includes three activities that offer detailed recommendations: risk identification, risk analysis and risk evaluation. All three activities are reflected in our methodology.

First, ISO 31000 proposes that an organisation apply risk identification tools and techniques that are suited to its objectives and capabilities. In terms of techniques, we chose damage scenarios and considerations of an operator and data subject perspective (Step 3), as well as a systematic identification of threats for each target that uses a numbering scheme (Step 4). Second, ISO 31000 recommends that organisations consider the likelihood that threats will occur and analyse risk qualitatively, semi-quantitatively or quantitatively. Step 4 of our methodology requires that organisations determine the likelihood that each threat will occur. For both the likelihood of a threat and the data protection demand, we chose a qualitative approach. We accept qualitative judgements in our approach because human privacy risks are often harder to describe or quantify than the loss of an asset.

Risk mitigation is described in ISO 31000's activity "risk treatment", which involves selecting risk treatment options, balancing costs against benefits and considering stakeholders. Our methodology treats this aspect of mitigation in steps 5 (identification and recommendation of controls suited to protect against threats) and 6 (assessment and documentation of residual risks). In contrast to ISO 31000, we treat risk mitigation more extensively. We do so not only by specifically addressing privacy concerns, but also by explaining how the mitigation is applied; in our methodology, organisations systematically identify controls for all likely threats, use a numbering scheme, define three levels of rigor, match rigor and protection demand, and provide an implementation plan. We address what ISO 31000 calls for but do so in a more detailed manner.

Considering the fifth quality criterion, it is not entirely clear whether (Wright and De Hert, 2012) and (De Hert et al, 2012) recommend an actual **legal compliance check**, which is conducted later and in addition to a PIA (ICO, 2009), or whether they recommend ensuring legal compliance as part of the assessment. All three approaches aim to achieve compliance with legal and regulatory requirements. The UK PIA Handbook and our methodology emphasise that privacy implications are a fast moving target in the changing technical world and that legal privacy targets may often not address all ensuing challenges.

All three assessment approaches require organisations to provide recommendations and justify their implementation. In the UK PIA's consultation and analysis phase, organisations create an issues register that lists the avoidance measures that were considered, explains why they were rejected or adopted, and identifies any that are not addressed. For ISO 31000's activity "risk treatment," organisations select risk treatment options that balance costs against benefits, recognise stakeholder views, and prepare and implement a risk treatment plan. Similar to these approaches, step 5 of our methodology requires that organisations recommend controls; however, organisations must also choose a justified level of rigor for each control to meet the level of protection demand identified in

Step 3. Furthermore, we offer an extensive list of exemplary technical and non-technical controls for each potential privacy risk. Again, our methodology provides greater specificity, practical applicability and step-by-step guidance. A cost-benefit analysis, a control implementation plan and the documentation of residual risks are then required in our Step 6. All three approaches require documentation of the assessment process. The UK PIA and our methodology call it a **PIA report** and recommend publishing it. Our PIA goes a step further and offers a set of concrete content elements that a PIA report can include for different target audiences (Step 7).

Finally, only our proposed methodology meets the last quality criterion, which recommends that a PIA report should be externally audited and reviewed. To facilitate external **audit and review** of the PIA report, we recommend creating a machine-readable PIA report.

Table 5 shows that our PIA methodology is the most advanced of all three approaches with respect to the given quality criteria for a best practice PIA process.