Specification of the XKatalog as a national E-Catalogue standard for Public E-Procurement in Germany

Masterarbeit

zur Erlangung des akademischen Grades eines
Master of Science im Studiengang

Wirtschaftsinformatik

vorgelegt von

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Koblenz, den 31.01.2025

Erklärung

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Kurzfassung

Das öffentliche Beschaffungswesen umfasst mehr als ein Drittel der Staatsausgaben in Deutschland. Die Reduzierung dieser Ausgaben erfordert den Einsatz elektronischer Mittel, um den öffentlichen Beschaffungsprozess optimieren zu können. Derzeitig sieht sich die öffentliche elektronische Beschaffung jedoch mit einer Vielzahl von Barrieren konfrontiert, beispielsweise einem unregulierten Übergang zwischen den Phasen vor und nach der Zuschlagserteilung sowie einem Mangel an strukturierten und wiederverwendbaren Beschaffungsdaten. Ziel dieser Arbeit ist es, einen nationalen elektronischen Katalog-Standard in Form des „XKatalogs" für die öffentliche elektronische Beschaffung zu spezifizieren, der zur Überwindung bestehender Barrieren beitragen und somit die Transaktionskosten und Staatsausgaben reduzieren kann. Ein solcher E-Katalog-Standard, der mit vor- und nachgelagerten Beschaffungsstandards kompatibel ist, existiert in Deutschland bisher nicht. Zu diesem Zweck werden Design Science Research (DSR) und das Framework for Interoperable Service Architecture Development (FISAD) als übergeordnete Methodiken eingesetzt. Im Rigor Cycle des DSR wird Literatur über Herausforderungen des öffentlichen E-Beschaffungswesens sowie standardisierte E-Kataloge analysiert, um die wissenschaftliche Grundlage der Thesis zu schaffen. Im Relevance Cycle des DSR werden Workshops und Interviews durchgeführt, um den relevanten Anwendungskontext von E-Katalogen in der öffentlichen E-Beschaffung zu erfassen. Zusammen bilden sie die rigorosen und relevanten Grundlagen für weitere Architekturüberlegungen in FISAD, um Basis- und Zielarchitektur des XKatalogs iterativ nach der Design Science Research Methodology (DSRM) innerhalb des Design Cycles zu entwickeln und in Workshops zu demonstrieren und zu evaluieren. Folglich können die Anforderungen an den XKatalog aus der Anwendung von DSR und FISAD synthetisiert werden, wodurch ein ganzheitliches Verständnis der erforderlichen Interoperabilität für die technologieneutrale Spezifikation des XKatalogs mittels Simple Semantic Data Modeling in XML (SeMoX) in weiteren Design-Review-Workshops der DSRM gewährleistet wird. Durch das Aufsetzen auf den Peppol Catalogue als Basis des XKatalogs und die Ergänzung nationaler Erweiterungen können alle relevanten Anforderungen realisiert werden. Insbesondere wird Interoperabilität zum Peppol pre-award Catalogue und zur XBestellung erreicht, sodass eine Migration strukturierter Daten über die Zuschlagserteilung hinweg möglich ist und ein nahtloser Prozessübergang zwischen den Phasen erreicht wird. Somit können perspektivisch Transaktionskosten gesenkt und der Wettbewerb gestärkt werden. Die Validierung von XKatalog-Nachrichten erfolgt mithilfe eines Validators, der diese auf Einhaltung von Schema, Kardinalitäten und Regeln prüft.

Abstract

Public Procurement constitutes over one-third of government expenditures in Germany. Reducing these expenditures necessitates the use of electronic means to streamline and optimize the Public Procurement process, thereby transitioning it into Public Electronic Procurement. Currently, Public E-Procurement faces a variety of issues, including an unregulated transition between pre- and post-award phases and a lack of structured and reusable procurement data. The objective of this thesis is to specify a national electronic catalogue standard for Public E-Procurement, the “XKatalog”, that contributes towards overcoming these barriers to reduce transaction costs, and thus, public expenditures. Such an E-Catalogue standard, compatible with productively used pre- and post-award procurement standards, does not yet exist in Germany. For this purpose, Design Science Research (DSR) and the Framework for Interoperable Service Architecture Development (FISAD) are employed as methodologies. In the DSR’s rigor cycle, literature on Public E-Procurement’s problem environment and the status quo of standardized E-Catalogues is analysed to provide the scientific foundation for this thesis. In the DSR’s relevance cycle, workshops and interviews are conducted to capture the relevant application context of E-Catalogues in Public E-Procurement, supplemented by grey literature such as legal texts and ongoing research articles. Together, the rigorous and relevant foundations for further architectural considerations in FISAD are laid. The XKatalog’s baseline and target architecture is iteratively designed, demonstrated and evaluated in accordance with the Design Science Research Methodology (DSRM) within the DSR’s design cycle in design review workshops. Consequently, requirements are synthesized from both DSR and FISAD application, thereby providing a holistic understanding of required interoperability for the XKatalog’s technology neutral specification via Simple Semantic Data Modeling in XML (SeMoX). Further design review workshops in line with the DSRM and the DSR’s design cycle facilitate the iterative validation of the XKatalog’s SeMoX specification against its solution objectives and requirements. By choosing the Peppol Catalogue as the XKatalog’s base and specifying national extensions on hierarchical product trees, product configurability and price allowances and charges, all relevant requirements can be realized. Most notably, interoperability with both the Peppol pre-award Catalogue and XBestellung is achieved, thus enabling the migration of structured data from pre- to post-award and achieving a seamless process transition between phases. As a result, the XKatalog’s integration into the Public E-Procurement procedure can potentially reduce transaction costs and enhance competition. Finally, the XKatalog’s validation environment offers insights into illustrative test cases alongside technology neutral validation files that assert the XKatalog’s schema, cardinalities and rules on an XML message.

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Acknowledgement

Ich widme diese Arbeit Kathi, ohne die ich all das niemals geschafft hätte, und Björn, der das Highlight jeder Nachtschicht war.

„Lasst uns nicht müde werden, Gutes zu tun, denn zur rechten Zeit werden wir ernten, wenn wir nicht aufgeben.“ – Galater 6:9

1 Introduction

The digital transformation of the public sector aims to modernize government and public service provisioning through the integration of information and communication technologies (ICT) [1]. It is a central concept within the overarching domain of electronic government (E-Government), which may also be referred to as Digital Government [1]. Notably, E-Government encompasses the concept of transactions between public administrations and businesses [2], which are an integral part of Public Electronic Procurement (Public E-Procurement). According to Uyarra and Flanagan [3], public procurement is defined as the acquisition of goods, works and services by public sector organizations, whereas Public E-Procurement is understood as the digitalization of this process through the utilization of electronic means such as web-based applications [4]. In the European Union (EU), the Public E-Procurement process is divided into the pre-award and post-award phases, where the first denotes the part of tendering where Economic Operators (EO) submit their offers, and the award winning EO is awarded with a contract by the contracting authority [5], [6]. Public E-Procurement accounts for about 14% of the European Union's gross domestic product[1] and around 29% of its member states' national government expenditures, with Germany spending as much as 36% on procuring products, works and services[2]. As such, there is a major interest in saving costs and increasing process efficiency [7], especially through an increase in interoperability [8]. The public sector has a particularly high need for interoperable solutions and open standards that foster digitalization endeavours [9]. For this reason, the European Commission has proposed the European Interoperability Framework (EIF) as a means to provide guidance for facilitating interoperability and thus enhancing European public services [10]. The EIF is especially relevant for this work to ensure the electronic catalogue standard's interoperable design and open nature.

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[1] https://single-market-scoreboard.ec.europa.eu/business-framework-conditions/public-procurement_en#:~:text=Public%20procurement%20is%20the%20process,gross%20domestic%20product%20(GDP). Last access: 19.06.2024

[2] https://data-explorer.oecd.org/vis?tm=public%20procurement&pg=0&snb=33&vw=tb&df[ds]=dsDisseminateFinalDMZ&df[id]=DSD_GOV%40DF_GOV_PPROC_2023&df[ag]=OECD.GOV.GIP&df[vs]=1.0&dq=A.DEU%2BEUOECD.GPROC....&pd=2022%2C&to[TIME_PERIOD]=false last access: 14.01.2025

To successfully leverage the potential benefits of Public E-Procurement, several challenges must be overcome. Some of the most significant challenges in Public E-Procurement procedures are a lack of structure in parts of the pre-award phase [11], [12], an unregulated transition between pre- and post-award [11], [12], [13] and a variety of barriers for small and medium-sized enterprises (SMEs) to participate in public procurement [11], [14], [15]. Recent publications have indicated the potential of electronic catalogues to overcome these barriers by enabling a seamless process and data transition between pre- and post-award phases [13], [16]. The integration of standardized E-Catalogues allows efficient transfer of data from pre- to post-award phases. Moreover, it also allows more efficient data re-use in downstream processes such as ordering and invoicing. Consequently, transaction costs can be reduced [17], [18], [19], SME participation increased [20], and a higher overall competition achieved [13], [16], [20]. As such, the aim of this thesis is to develop a national standard for electronic catalogues in Germany, the "XKatalog". The standard shall enable Economic Operators to accurately describe and present their product information in an XML-based data standard and serve as the basis for designing fully automated purchasing flows across the post-award phase. More specifically, in line with both national [12] and international[3] proposals, the XKatalog is to be utilized within the first process step of the post-award, the catalogue management. This facilitates the migration of data from the last transaction of the pre-award, the Peppol pre-award Catalogue[4], to the XKatalog. Subsequently, relevant data may be migrated from the XKatalog into the remaining post-award transactions, such as orders (in the form of the German "XBestellung" [21]) and invoices (in the form the German "XRechnung" [22]). These German procurement standards are developed and maintained by the Coordination Office for IT-Standards (KoSIT)[5] via the "Simple Semantic Data Modeling in XML (SeMoX)" standardization approach [23]. As such, specifying the XKatalog as an electronic catalogue standard in Germany is essential to not only overcome issues within the catalogue management process, but to also lay the foundation for addressing overarching issues within the E-Procurement process and enable a holistic and comprehensive data transformation from the specification of a procurement need to the receipt of an invoice [16]. Currently, because such an interoperable standard - compatible with both the productively used pre- and post-award standards for national and

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[3] https://docs.peppol.eu/poacc/upgrade-3/profiles/1-catalogueonly/ last access: 20.06.2024

[4] https://test-docs.peppol.eu/pracc/Pre-Award_Catalogue/profiles/p035/index.html last access: 20.06.2024

[5] https://www.xoev.de/ last access: 24.06.2024

international procurement procedures - is still missing in Germany [12], the electronic catalogue standard developed in this thesis will serve to fill that gap.

In order to achieve the research objective of specifying the XKatalog as a national E-Catalogue standard, this thesis formulates four research questions and applies Design Science Research (DSR, see section 2.2.1) [24] in the form of the Design Science Research Methodology (DSRM) [25] and the three-cycle view on DSR [26]. Upfront, scientific literature is reviewed in the DSR's rigor cycle to facilitate an understanding of relevant concepts and thereby establish the theoretical foundation of this thesis (see chapter 2) [27]. Afterwards, the status-quo of research on and implementation of E-Catalogues (see section 3.5) is analysed by conducting a Structured Literature Analysis (SLA, see section 2.3.1) [28], [29] within the DSR's rigor cycle and workshops (see section 2.3.2) [30] within the DSR's relevance cycle. The results of the SLA comprise a concept matrix (see Table 8), a literature spreadsheet (see Table 18) and a synthesis of the status of electronic catalogues from both literature and practice (see section 3.6). In order to analyse how standardized E-Catalogues can overcome current challenges in Public E-Procurement, this thesis performed an additional SLA and conducted further workshops in accordance with the DSR's rigor and relevance cycles in the context of research question two. Consequently, the XKatalog's problem environment and solution objectives are discussed (see section 4.1), and results entered into the concept matrix and literature spreadsheet. To answer the third research question on the optimal specification of an electronic catalogue standard for Public E-Procurement in Germany, the concept of interoperability is extensively analysed through a holistic lens, by addressing all layers and adhering to core principles [10]. The synthesized rigorous and relevant findings of research questions one and two serve as input for the application of the Framework for Interoperable Service Architecture Development (FISAD, see 2.2.2) [31]. Applying FISAD in accordance with the DSRM within the DSR's design cycle results in significant considerations on and requirements for the XKatalog from all architectural perspectives (see chapter 4) that are iteratively developed and validated in various design review workshops. As a result, the XKatalog can be specified alongside its technical components in SeMoX via the DSRM and validated in design review workshops by addressing these requirements in order to improve the process and data flow of Public E-Procurement (see chapter 5). Finally, XKatalog messages can be validated using an XKatalog-Validator and a Testsuite, also developed within the DSRM and validated in workshops, to assert schema and rules. To conclude the thesis, recommendations and a conclusion are discussed in chapters 6 and 7.

2 Research Design

This chapter contains the proposed research questions that characterize this thesis (see section 2.1) as well as the methodology (see section 2.2) and further methods employed in the research design (see section 2.3) to answer them. Furthermore, the methodology and methods are mapped onto the research questions to illustrate their expected results in a methodological synthesis (see section 2.4).

2.1 Research Questions

In order to develop a scientific sound as well as useful national Catalogue standard, these four research questions are within the scope of this thesis:

1. What is the current status of research on and implementation of standardized E-Catalogues in Public E-Procurement?

The first research question aims to capture the status-quo of standardized E-Catalogue research and implementation. It involves the analysis of both traditional foundations as well as current trends for E-Catalogues in Public E-Procurement across different countries, standards and systems from both literature and practice. This is achieved through conducting a structured literature analysis alongside workshops with experts from practice to gain an understanding of how and why E-Catalogues are currently utilized in Public E-Procurement. As a result, section 3.6 synthesises scientific (see section 3.5.1) and legal foundations (see section 3.5.2), actors and systems (see section 3.5.3) and relevant E-Catalogue standards (see section 3.5.4).

2. How can standardized E-Catalogues help to address and overcome current challenges in Public E-Procurement?

The second research question involves a structured literature analysis to holistically identify and categorize current challenges in Public E-Procurement (see section 3.2.3). Consequently, identified barriers are narrowed down to the applicable context of standardized E-Catalogues (see section 4.1.1) and section 4.1.2 analyses how they can be overcome. The resulting requirements for the XKatalog are subsequently derived (see section 4.1.3) and serve as fundamental considerations on the XKatalog’s specification .

3. What is the optimal specification of an electronic catalogue standard for Public E-Procurement Germany?

The third research question necessitates the application of the Framework for Interoperable Service Architecture Development (FISAD) to consider requirements towards the XKatalog from all architectural layers (see chapter 4) in order to achieve an optimal specification of an electronic catalogue standard for Public E-Procurement in Germany. Consequently, baseline and target architecture are analysed from foundational- (see section 4.1), business- (see section 4.2), data- (see section 4.3), application- (see section 4.4), and technical- (see section 4.5) perspectives. Synthesizing these considerations and requirements (see section 4.6) results in a robust scientific and relevant foundation for the optimal specification of the XKatalog (see section 5) that provides insights into the necessary Semantic Datatypes (see section 5.2.1), Codelists (see section 5.2.2), Business Terms (see section 5.2.3), Structure (see section 5.2.4), Rules (see section 5.2.5), and Syntax Binding (see section 5.2.6).

4. How could messages of such an electronic catalogue standard be validated?

For the fourth and final research question, a validation environment for instances of the XKatalog standard must be developed (see section 5.4). This requires the implementation of several XML-Schema and Schematron files into an XKatalog-Validator to check whether a filled-out catalogue is in line with the XKatalog's specification (see section 5.4.1) and a Testsuite (see section 5.4.2) that includes two comprehensive technical test cases and one minimal business test case. As such, the Testsuite illustrates positive test cases that foster understanding about the XKatalog's specification and can be used to incrementally test all validation asserts of the XKatalog-Validator by manually changing the messages in accordance with expected test behaviours.

A synthesis of all research questions in line with the applied methodology and methods to answer them is placed in section 2.4.

2.2 Methodology

This section covers the research methodology that is utilized to answer the research questions described in section 2.1. First, the Design Science Research Methodology is elaborated upon in conjunction with the Design Science Research Cycles (2.2.1) as a superordinate research design for this thesis. Afterwards, the application of the

Framework for Interoperable Service Architecture Development is discussed in the context of this work (2.2.2).

2.2.1 Design Science Research Methodology

This work is characterized by necessitating both a rigorous scientific foundation and relevant evaluations from a diverse array of stakeholders to incrementally design and develop several artifacts related to the electronic catalogue standard along the thesis. As such, the Design Science Research Methodology (DSRM) by Peffers et al. [25], based on the Design Science Research (DSR) approach for information systems by Hevner et al. [24], is used as the overall research paradigm. The DSRM proposes an iterative, sequential six-step process to design and develop information system artifacts. It begins with the identification of a problem scope and motivation before objectives and solutions are defined. Afterwards, a highly iterative process loop starts with the initial design and development of an artifact; this can be any designed object that holds a research contribution. It is subsequently demonstrated in its relevant application context to solve the specified problem and, based on this demonstration, its performance is evaluated against its initial solution objectives, which may also be subject to changes depending on the context. Depending on the evaluation results, potential improvements may occur and thus lead back to another iteration of design, demonstration and evaluation. Once the evaluation deems an artifact as sufficient regarding its solution objectives, the artifact and its contribution are communicated to relevant practitioners alongside several other factors such as the initial problem scope and motivation as well as the rigor of its design. This communication includes both scholarly and professional publications. In each process step, further methods are utilized to guarantee relevant and rigorous results of the designed artifact (see section 2.3).

The DSRM is supplemented by Hevner’s specification of a three-cycle-view on Design Science Research (DSR) [26]. Hevner extends upon the initial DSR approach [24] by specifying a three-cycle view of DSR that incorporates a rigor, a relevance and a design cycle. In short, the three closely related cycles describe the iterative processes of ensuring scientific rigor through grounding theories and methods within the rigor cycle, ensuring relevancy through contextual requirement engineering and field testing within the relevance cycle and designing and evaluating artifacts within the design cycle [26]. The supplementation of Peffers’ DSRM through Hevner’s three-cycle view is essential for the purpose of this work, because it emphasizes the importance of viewing the rigor, relevance and design processes as separate, modular instances that are each iterative on their own, but that also keep clear and close connections to each other to ensure a successful superordinate design science process.

2.2.2 Framework for Interoperable Service Architecture Development (FISAD)

The design and evaluation of technical artifacts along the E-Catalogue standard's development requires a sound methodological foundation that ensures both rigor and interoperability. As such, the Framework for Interoperable Service Architecture Development (FISAD) [31] is utilized throughout this work to aid in the development of E-Catalogue related artifacts by supplementing architectural considerations and requirements. The FISAD defines seven phases that integrate the EIF's four interoperability layers and the architectural design phases of The Open Group Architecture Framework's (TOGAF)[6] Architecture Development Method (ADM)[7]. It is depicted in Figure 1.

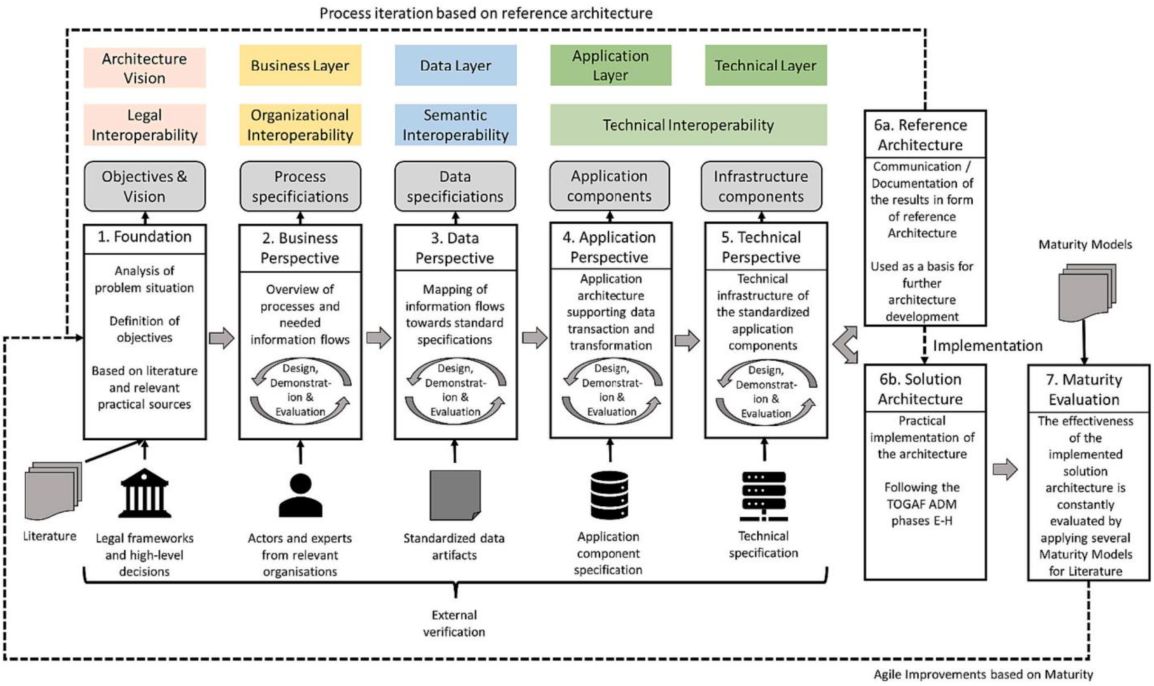

Figure 1: Framework for Interoperable Service Architecture Development (FISAD), retrieved from [31]

In the first phase, the architecture foundation is laid by considering scientific literature and legal frameworks to analyse the problem situation and define solution objectives. Afterwards, in the business, data, application and technical perspectives, baseline and target architecture components are iteratively designed, demonstrated and evaluated, especially through external verification, until they are deemed to be sufficient enough for fulfilling the solution objectives. In the context of this thesis, the data perspective is

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[6] https://pubs.opengroup.org/architecture/togaf92-doc/arch/ last access: 24.06.2024

[7] https://pubs.opengroup.org/architecture/togaf92-doc/arch/ see chapter 4, last access: 24.06.2024

especially important for developing the XKatalog as one of the main artifacts is the standard’s data specification. As it is an electronic data exchange standard between heterogeneous systems that requires a seamless integration into the current E-Procurement landscape, several other electronic procurement standards must be evaluated to design its data architecture (see section 4.3). After positively evaluating all of the perspectives, in line with the initial solution objectives, the developed architecture artifacts are either used as a reference architecture or a solution architecture. The solution architecture requires a practical implementation of the solution architecture following the TOGAF phases E-H and a maturity evaluation by applying maturity models from the literature. On the other hand, the reference architecture is documented and communicated as such to be used as the basis for further architecture development. The focus of this thesis, in consultation with the Coordination Office for IT-Standards (KoSIT), lies on developing a reference architecture for the XKatalog as an electronic catalogue standard for public procurement that is to be used by the KoSIT for further architecture development via expert group workshops.

As a result of the FISAD application, architectural considerations and requirements of the standard’s foundation (see section 4.1), business (see section 4.2), data (see section 4.3), application (see section 4.4), and technical perspective (see section 4.5) are deduced to lay the foundation for the XKatalog’s specification.

2.3 Further Methods employed in the research design

In the following, a thorough overview of all further methods employed in the research design is illustrated. In line with the DSR’s rigor cycle, section 2.3.1 describes how the Structured Literature Analysis is conducted to build the scientific foundation for this thesis. Afterwards, in line with the DSR’s relevance cycle and the DSRM’s iterative design process, section 2.3.2 explains the use of workshops as a research method to demonstrate, validate and subsequently improve the design artifacts of this work. As described in section 2.3.3, two problem-centred expert interviews supplement the DSR’s relevance cycle with insights into the KoSIT’s standardization and validation approach in practice. Furthermore, Business Process Model and Notation (BPMN, see section 2.3.5), Unified Modeling Language (UML, see section 2.3.6) and Archimate (see section 2.3.8) are employed to specify architectural artifacts as a result of FISAD application. Finally, section 2.3.7 discusses the Simple Semantic Modeling in XML (SeMoX) approach for developing the XKatalog’s specification.

2.3.1 Structured Literature Analysis

To ensure this work's scientific foundation, especially in the context of the DSR's rigor cycle, a structured literature analysis (SLA) based on the systematic approach of Carrera-Rivera et. al. [29] and Kitchenham & Charters [28] is conducted. The SLA process is divided into the three phases of planning, implementation and results, and it is carried out with Parsifal[8], an online tool to support structured literature analyses. Additionally, in line with Webster and Watson [27], a concept matrix (see Table 8 in section 3.6) is utilized to map the relevant literature to the concepts of this work; an overview of a more detailed literature spreadsheet is also provided in the appendix (see Table 18). The scientific literature is further supplemented with grey literature such as legal texts and various directives and reports of the European Union in order to guarantee a comprehensive understanding of the concepts. As a result of the SLA, several literature artifacts contribute to answering research questions one and two while simultaneously providing the scientific foundation for answering research question three. The search and selection strategy for relevant literature is developed in line with the proposed methodology of Carrera-Rivera et al. [29]. It consists of three separate process phases that are conducted successively and depicted in Figure 2.

[8] https://parsif.al/ last access: 19.12.2024

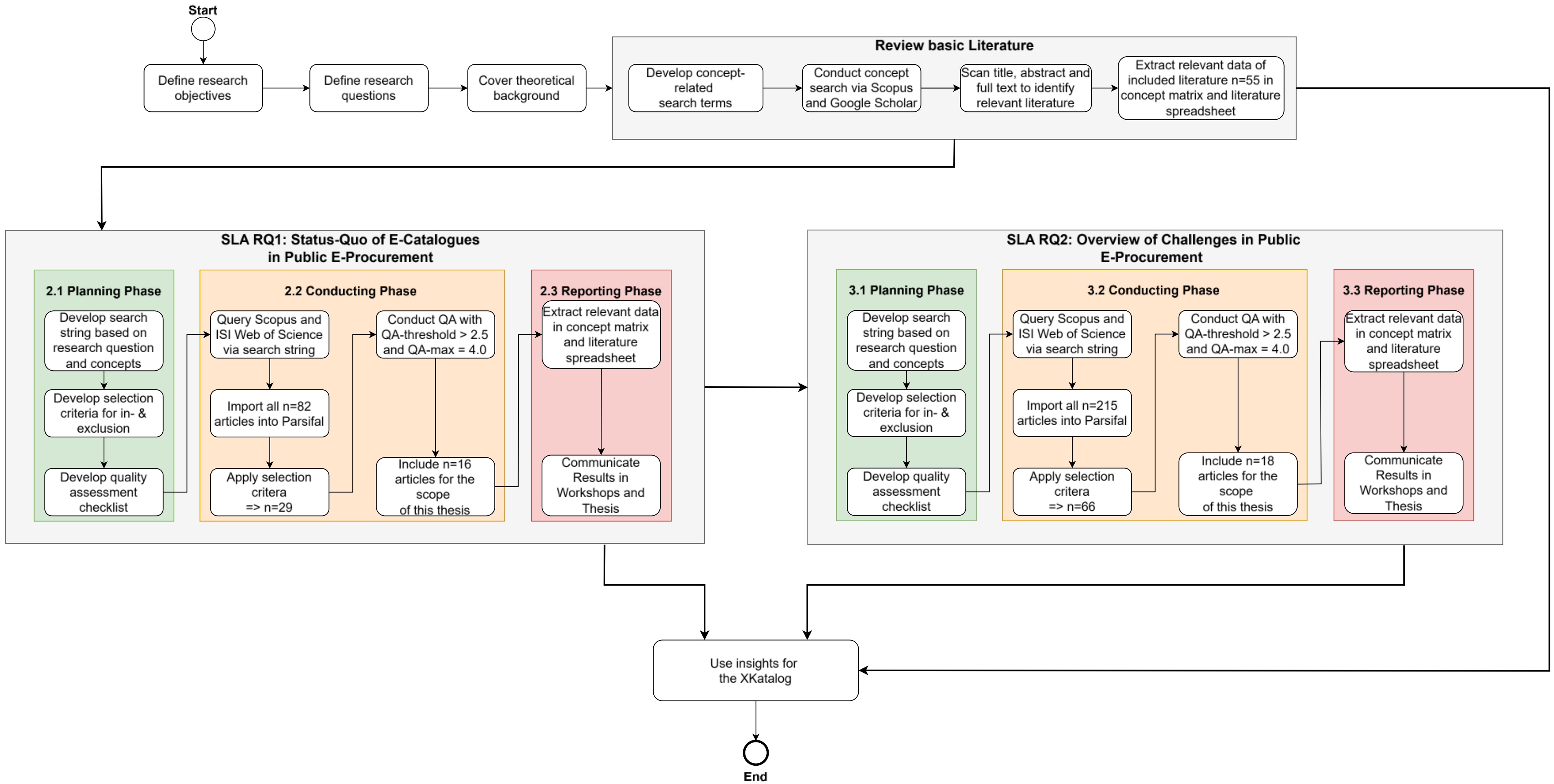

Figure 2: Overview of the SLA-Process, own depiction

In the first phase, general definitions of fundamental concepts such as E-Procurement, Interoperability and Standardization as well as methodology-related literature artifacts are searched by querying relevant databases such as Scopus and search engines such as Google Scholar with several concept and methodology-related keywords. As such, the SLA's first part aims to cover basic concepts and methods of this thesis. Some of the keywords queried to find significant literature include:

"Digital Transformation" AND "Public"
"E-Government"
"Public Procurement"
"E-Procurement" AND "Public"
"Interoperability" AND "Public"
"Standardization"

After querying via these keywords, the found literature's title, abstract, conclusion and full text are scanned successively to determine whether it matches one of this thesis' concepts. Subsequently, literature evaluated as relevant for this thesis is then extracted into the concept matrix and literature spreadsheet and further used for forward and backward searching. Lastly, the scientific literature is supplemented by grey literature.

In the second phase, to answer research question one on the status-quo of E-Catalogues in Public E-Procurement (see section 2.1), a search string for querying the preselected literature databases of Scopus and ISI Web of Science is developed during the SLA's planning phase to find relevant literature. Both Scopus and ISI Web of Science are selected as databases for the SLA because of their reputation for providing access to high-quality, interdisciplinary papers in the field of information systems and due to their overall size. The resulting search string aims to encompass the status-quo of E-Catalogues in Public E-Procurement as the main research objective of research question one and reads as follows:

procurement AND (public OR government) AND (catalog AND ((electronic OR product OR standard) OR "e-catalog*"))*

Additionally, literature selection criteria are defined within the SLA's planning phase. These criteria provide guidance as to which articles are included for further analysis or excluded from the scope of this work. If an article fulfils the inclusion criteria and does not meet any exclusion criteria, it will be considered for the next literature evaluation step; in any other case, it is discarded. Table 1 provides an overview of the second phase's preliminary in- and exclusion criteria.

Table 1: Preliminary in- and exclusion criteria for RQ1

Category	Inclusion Criteria	Exclusion Criteria
Source	Article is a peer-reviewed journal or conference paper	
	Article is a significant ongoing-research paper/report/grey literature	Article is an insignificant ongoing-research paper/report/grey literature
Language	Article is in English or German	Article is any other language than English or German
Content	The abstract shows that the article's full text deals with electronic catalogues in the field of Public E-Procurement	The abstract does not indicate that the full content is about electronic catalogues in the field of Public E-Procurement
Duplication		No identical articles from different databases

Finally, a checklist of quality assessment criteria, used to assess the quality of a preliminarily accepted paper, is defined. For this purpose, a total of four criteria are defined, which can be rated with "0" (No), "0.5" (Partially) or "1" (Yes) per article, depending on the degree of fulfilment of the criterion. The maximum score per reference is therefore four points. If a preliminarily included literature achieves at least 3.0 points, it will be mapped to the relevant concepts of this paper. If it achieves a score of exactly 2.5 or lower, it will be excluded from the scope of this work. Table 2 illustrates the second phase's quality assessment criteria.

Table 2: Quality assessment criteria checklist for RQ1

Criterion	Possible Rating
Are research objectives or research questions clearly defined?	Yes = 1.0 Partially = 0.5 No = 0
Do the authors discuss electronic catalogues in the context of Public E-	Yes = 1.0

Procurement?	Partially = 0.5 No = 0
Do the authors discuss use-cases from practice for electronic catalogues?	Yes = 1.0 Partially = 0.5 No = 0
Do the authors discuss limitations in regard to the validity of the paper's results?	Yes = 1.0 Partially = 0.5 No = 0

Lastly, to provide a comprehensive overview of E-Catalogues in the field of procurement, the scientific literature is supplemented with standard specifications and legal documents.

The SLA's third process instance repeats the second instance's process steps but adjusts the search string, the in- and exclusion criteria and the quality assessment checklist to provide the scientific foundation towards answering research question two, E-Catalogues as a solution component to overcome current challenges in Public E-Procurement (see section 2.1). More specifically, this SLA provides insights into the comprehensive problem landscape of Public E-Procurement from a scientific perspective; together with insights from the second SLA process instance on the status quo of E-Catalogues and the insights from Workshops (see 2.3.2), RQ2 can be answered. The resulting search string for the third phase is as follows:

((("electronic procurement" OR "E-Procurement") AND "public") OR ("electronic government procurement" OR "e-GP")) AND ("challenges" OR "barriers" OR "issues")

The preliminary in- and exclusion criteria for the further analysis of literature are slightly adjusted in the "Content" category to be in line with the second research question. Table 3 provides an overview of the third phase's preliminary in- and exclusion criteria.

Table 3: Preliminary in- and exclusion criteria for RQ2

Category	**Inclusion Criteria**	**Exclusion Criteria**
Source	Article is a peer-reviewed journal paper	Article is not peer-reviewed
	Article is a peer-reviewed conference paper	Article is an ongoing-research paper/report/grey literature
Language	Article is in English or German	Article is any other language than English or German

Content	The abstract shows that the article's full text deals with challenges in the field of Public E-Procurement	The abstract does not indicate that the full content is about challenges in the field of Public E-Procurement
Duplication		No identical articles from different databases

Lastly, the checklist of quality assessment criteria, used to assess the quality of a preliminarily accepted paper, is adjusted slightly as well. The ratings of "0" (No), "0.5" (Partially) or "1" (Yes) per article remain the same with the maximum score per reference being four points and a final inclusion requiring at least 3.0 points. Table 4 illustrates the quality assessment criteria for the SLA's third phase.

Table 4: Quality assessment criteria checklist for RQ2

Criterion	Possible Rating
Are research objectives or research questions clearly defined?	Yes = 1.0 Partially = 0.5 No = 0
Do the authors discuss issues, barriers or challenges for Public E-Procurement?	Yes = 1.0 Partially = 0.5 No = 0
Do the authors discuss use-cases from practice for these issues, barriers or challenges?	Yes = 1.0 Partially = 0.5 No = 0
Do the authors discuss limitations in regard to the validity of the paper's results?	Yes = 1.0 Partially = 0.5 No = 0

To provide a holistic overview of E-Catalogues in the field of procurement, the scientific literature is once again supplemented by grey literature such as legal documents and reports to incorporate insights from the relevant application context.

2.3.2 Workshops

To ensure the relevance of this thesis in the context of the DSR's relevance cycle and incrementally improve the design of developed artifacts, workshops are conducted with relevant stakeholders from the field of Public E-Procurement. The workshops aim to, in line with Ørngreen and Levinsen [30], fulfil participants' expectations regarding project advancements and deliverables in E-Procurement related projects, while simultaneously fulfilling the research purpose of producing relevant, reliable and valid input data for this thesis.

In line with the DSRM's [25] and FISAD's [31] iterative design, demonstration and evaluation process and the DSR's design and relevance cycles [26], the workshops mostly act as design review meetings for several design artifacts. For this purpose, design artifacts and related discussion topics are prepared before each workshop and then assigned to a certain timeslot that all participants agree on once the workshop begins. Afterwards, the artifacts and related topics are demonstrated, evaluated and discussed in line with the DSRM's iterative design steps. Each workshop is then recorded by documenting all comments, live changes, change requests and further tasks for each of the design artifacts and their related discussion topics [30]. Once all participants are satisfied with the state of an artifact and it is evaluated as positive against its initial solution objectives, it is deemed to be sufficient for its relevant application context in line with the DSR's relevance cycle [26] and can thus be used in this thesis; this procedure can also be mapped to the DSRM steps three to five. In contrast to this, some of the workshops aim to coordinate and evaluate requirements (see section 2.3.4), strategic decisions and responsibilities.

While most of the workshops were held digitally, Workshop W14 was held in person in Bremen. The total attendees for the workshops include the Coordination Office for IT-Standards (KoSIT), the University of Koblenz, the Free Hanseatic City of Bremen, the State Administration for Mobility in Rhineland-Palatinate (LBM), the European Standardization Committee TC 440 for Electronic Public Procurement and neusta enterprise services GmbH; not all members were present during each workshop. An overview of all workshops with their respective date, type, participants, topic, and results is illustrated in Table 5.

Table 5: Overview of Workshops

ID	Date	Type	Participants	Topic	Results
W1.	10.04.2024	Strategic Coordination	Free Hanseatic City of Bremen, Coordination Office for IT-Standards (KoSIT), University of Koblenz	First discussion about the XKatalog-Project and its objectives	The University of Koblenz receives and accepts the official proposal to specify the XKatalog. This task has formerly been assigned to Neusta enterprise services GmbH until a substantial delay of required deliverables led Bremen to consider terminating their contract with the service provider. The objective is to specify a national electronic post-award catalogue standard for Public Procurement. The design artifacts should be demonstrated to and evaluated by the Coordination Office for IT-Standards that maintains most of the productive German Public Procurement standards.
W2.	26.04.2024	Strategic Coordination	Bremen, neusta enterprise services GmbH, KoSIT, Uni Koblenz,	Official handover between Bremen, Neusta enterprise services GmBH and the Uni Koblenz to specify the XKatalog.	The University of Koblenz is tasked with creating a concept and specification for the XKatalog in collaboration with the KoSIT. The KoSIT may use the University's reference architecture to release a productive XKatalog standard in the future. Neusta is tasked with creating a small pilot implementation tool for the XKatalog once the specification is finished.

W3.	30.04.2024	Strategic Coordination	Neusta, Uni Koblenz	Discussion about the status-quo, responsibilities and existing artifacts for the handover	There are little to no usable artifacts for the XKatalog-Specification that Team Neusta can provide for the handover. The University of Koblenz is thus required to start the XKatalog conceptualization and (reference architecture) specification from scratch.
W4.	08.05.2024	Requirement Engineering	State Administration for Mobility in Rhineland-Palatinate (LBM), Uni Koblenz	Definition of requirements for the XKatalog in regard to the LBM's user needs and other productive E-Catalogue procurement standards.	The XKatalog should bridge the gap between pre- and post-award via interoperability with pre-award standards and post-award standards. Definition of several requirements for the XKatalog in regard to productive standards and systems: a) Peppol pre- and post-award Catalogues b) BMEcat c) Kaufhaus des Bundes (KDB) d) The joint committee on electronics in the construction industry (GAEB) catalogue e) Vergabemanagementsystem (VMS) f) XBestellung/XRechnung Using Peppol as a foundation for the XKatalog is advised to bridge the gap between pre- and post as XBestellung and XRechnung are also Peppol based. However, the productive German standards must be considered for national extensions to Peppol. Hierarchical product trees

					and configurable products are possible in the BMEcat but not in Peppol and should thus be considered as national extensions. A detailed discussion of these requirements can be found in sections 4.3.3 and 4.6.
W5.	15.05.2024	Design Review	KoSIT, Uni Koblenz	First review of the XKatalog's foundation, business and data architecture	Most parts of the XKatalog's data model fulfil the requirements as specified in Workshop W4. The configurability option for different characteristics of a single product is changed within the XKatalog's UML Class Diagram to better fit the requirement. This is achieved through the specification of an "Item Attribute Characteristic" business group inside the "Item Attribute Configuration" business group within the "Catalogue Item Information" that allows for the definition of characteristic values and their impact on the price (see section 5.2.4).
W6.	17.05.2024	Design Review	Uni Koblenz	Second review of the XKatalog's foundation, business and data architecture	Problem and Target Vision (see section 4.1), Use-Case Diagrams, and BPMNs (see 4.2) are discussed and evaluated. While the core XKatalog process is evaluated positively, the BPMN should highlight the context of a now streamlined Public E-Procurement process more. As a whole, the business layer is evaluated as OK for now. Some aspects of the data model require further improvements that are to be discussed in more detail in the

					next workshop (see W7).
W7.	28.05.2024	Design Review	KoSIT, Uni Koblenz	Third review of the XKatalog's foundation, business and data architecture	The XKatalog enables Economic Operators to build hierarchical product trees. Currently, this product tree is built by defining itself recursively. This is unnecessary and should work more in line with the BMEcat's hierarchical trees through an initial tree definition and subsequent referencing to the tree on an item level. As a result, the data model is changed accordingly to implement this change request. The GTIN should be considered for unique item classification as it is a productively used identifier for products. Thus, the XKatalog's commodity classification now considers GTIN identifiers as a valid classification.
W8.	24.07.2024	Design Review	Uni Koblenz	First (internal) review of the XKatalog's initial SeMoX specification	Change request for the XKatalog's "Price Discount" business group. To achieve a more seamless transition between the XKatalog and the XBestellung & XRechnung, the "Price Allowances and Charges" business group from XBestellung and XRechnung must strictly be adopted in the XKatalog. The specification of discounts and surcharges helps EOs in describing their products and CAs in deciding on which products to procure. The XKatalog specification requires at least a mandatory

					syntax binding to the Peppol Catalogue and, if possible, a syntax binding of all possible elements to Peppol. The Peppol Catalogue's line level solution for building product trees, which is adopted from the UBL Catalogue, is extremely unideal. Therefore, change requests to Peppol should be formulated. Although out of scope for the XKatalog, Public E-Procurement standards need a universal identifier across standards that allows for the unique identification of the procurement procedure as whole from start to finish.
W9.	31.07.2024	Design Review	KoSIT, Uni Koblenz	Second review of the XKatalogs's SeMoX specification	There is an overarching issue in regard to how the KoSIT wants to handle bilingualism across all XEinkauf-Standards. For the XKatalog, all names of codelists, business terms & groups should be illustrated in English, whereas all elements used to describe and explain elements should be provided in both English and German. Business rules should be handled in the same way they were grouped and written in the XRechnung.
W10.	07.08.2024	Design Review	KoSIT, Uni Koblenz	Third review of the XKatalogs's SeMoX specification	All business terms should be annotated with a reference to their Peppol equivalent. The syntax binding must target the Peppol catalogue and include all parts of the XKatalog-structure that can be

					bound to it. In general, a syntax binding that targets the UBL-Catalogue (which the Peppol catalogue is based on) directly is much more preferred and advised for the future because it covers all extensions and thus the whole XKatalog-structure.
W11.	14.08.2024	Design Review	KoSIT, Uni Koblenz	Fourth review of the XKatalogs's SeMoX specification	Integrity rules should be handled implicitly rather than explicitly, which means that most integrity rules of Peppol are not expressed through integrity rules in the XKatalog. In practice, this is possible through annotating relevant parts of the XKatalog message with a reference to their corresponding Peppol integrity rules. Only conditional mandatory rules should be stated explicitly in the rules section. Codelists should be annotated with a reference to the terms they apply on. Missing Codelists should be added to the XRepository in the future.
W12.	21.08.2024	Design Review	KoSIT, Uni Koblenz	First review of a possible test-case	In terms of the XML design for building hierarchical tree structures, the first XKatalog example aligns with the BMEcat. This leads to a suboptimal XML design that does not utilize the natural recursion of XML and opts to use a solution that requires ID-crutches for all parts of the tree. Instead, in line with SeMoX's own design as a semantic

					XML-modelling approach, the solution should focus on: 1. Building a flat list of all product groups 2. Building a flat list of all articles 3. Reference each associated article in its product group 4. Build the structure, aka. the hierarchical product tree, by referencing all product groups in their respective layer of the tree, thus utilizing XML's natural recursion
W13.	04.09.2024	Design Review	KoSIT, Uni Koblenz	Fifth review of the XKatalogs's SeMoX specification	Further input on the correct use of xml:lang for differentiating English and German descriptions to enable bilingualism in the XKatalog. The XKatalog should serve as a starting point for an XEinkauf-Glossary that standardizes the way in which certain (legally relevant) terms and phrases are translated. Although out of scope for this thesis, this is a major, overarching issue in practice that requires further addressing in the future (see also W14).
W14.	11.- 13.09.2024	On-premises Design Review Workshop in Bremen	KoSIT, Uni Koblenz	Sixth review of the XKatalog's SeMoX specification	On-premises design and design review workshop in Bremen. Peppol BIS Invoice/Billing's AllowanceCharge BG must be used on line-level to guarantee interoperability with XBestellung and XRechnung. Addition of the same AllowanceCharge to the item configurability BGs to express how prices can be impacted negatively or positively. Also,

					discussion on how components can be referenced. In the future, direct references via m:component should be possible, however, for now, a direct path with a note shall describe it. Due to Bilingualism, a lot of further issues arise that must be dealt with AFTER the thesis. All language must be kept gender-neutral (and generally neutral) in the future. A joint glossary for Public E-Procurement standards (definitions and translations of certain terms) should be developed in the future. The XKatalog's SeMoX specification is in a satisfying state and no major changes are required; however, some generation bugs exist due to bilingualism.
W15.	16.10.2024	Coordination and Design Review	CEN/TC 440, KoSIT, Uni Koblenz	Coordination and Review of CEN/TC 440 EN 17015 for E-Catalogues and the XKatalog	Existing standards are not used that often in practice, including the Peppol Catalogues. Thus, among several other reasons, EN17015 is needed. The XKatalog generally aligns with the efforts of CEN/TC 440 for the European Norm 17015 draft. The Price Allowances and Charges might be subject to changes in the XKatalog as the EN utilizes a more abstract Tax Information Business Group to model such price changes. An in-depth review from all involved standardization bodies during the next weeks is required to harmonize the E-

					Catalogue efforts. The XKatalog aims to consider all data model proposals made in EN17015 that align with its solution objectives and requirements. Notably, the EN also incorporates the four related items classes from Peppol. Semantics unfortunately remain unclear and their adoption into the XKatalog is seen as questionable in their current state.
W16.	23.10.2024	Coordination and Design Review	KoSIT, Uni Koblenz	Coordination and Review of CEN/TC 440 EN 17015 for E-Catalogues and the XKatalog	The EN17015 transaction model for the post-award catalogue incorporates findings from the now established E-Procurement ontology[9]. Therefore, the XKatalog could consider incorporating findings from the ontology as well; however, the XKatalog will wait for the EN's draft to complete, opting to base changes to its data model directly on the EN and not the ontology. For now, the EN uses neither hierarchical product trees nor product configurability. The absence of both features is seen as an issue from a German perspective and will be discussed in detail in the next Workshop. Also, related item BGs are specified in a semantically unclear way. Both

[9] https://docs.ted.europa.eu/EPO/4.2/index.html last access: 22.11.2024

					Peppol and the EN must indicate their purpose in a suitable manner; until then, these BGs are NOT adopted in the XKatalog. A similar issue arises for the price allowances and charges. This BG is represented as “Tax Information” in the current draft, but the BG is incomplete and requires further information; this is decided to also be discussed in the next week.
W17.	24.10.2024	Coordination and Design Review	neusta, Uni Koblenz	Scoping and review of possible application architecture for piloting, development of a minimal business test case	To gain better insights into the feasibility of the target architecture, a small process is to be piloted. This process includes creating and validating an XKatalog, browsing and shopping the catalogue and transforming an XBestellung out of the XKatalog. To test this process, target application solution components are identified in the form of any kind of catalogue management tool and, more importantly, the Lieferantencockpit (see also W23). In line with this, a minimal test case of the XKatalog is adjusted to cover all relevant business information required in the process. Notable design choices include the inclusion of an accurate German VAT-number for the EO, an accurate LeitwegID for the CA and ECLASS for the standard item identifiers (see section 5.4.2).

W18.	30.10.2024	Coordination and Design Review	CEN/TC 440, KoSIT, Uni Koblenz	Coordination and Review of CEN/TC 440 EN 17015 for E-Catalogues and the XKatalog	In the German BMEcat, the product configurability feature - although important from a theoretical point of view - sees such little usage in practice (due to its complexity) that users have started to use older versions to avoid dealing with the potential feature altogether. Based on this and other factors, CEN/TC 440 has decided to not include this feature in the EN. Instead, the EN specifies an external punch-out-system (based on UBL/EHF) for product configuration to be used if needed. This is discussed in detail in section 5.2.4. CEN/TC440 acknowledges the XKatalog's hierarchical product tree feature as a noteworthy solution for a currently uncovered feature in the EN (catalogue group systems). The features inclusion will be voted upon and discussed internally in the next CEN/TC 440 Workshop.
W19.	13.11.2024	Scoping and Coordination	KoSIT, Uni Koblenz	Scoping and resource planning for the XKatalog-Validator	XKatalog instances must be validatable via Schematron. Therefore, an XKatalog-Validator should be developed as a singular Schematron file that follows an agile development cycle. In line with the KoSIT and Neusta, a minimal piloting use-case must serve as the starting point for validation development (see W17). Afterwards, through continuous updates, the Validator must be able to validate a coherent

					business test case and a full technical test-case for the XKatalog.
W20.	20.11.2024	Coordination and Design Review	CEN/TC 440, KoSIT, Uni Koblenz	Coordination and Review of CEN/TC 440 EN 17015 for E-Catalogues and the XKatalog	The expansion of the EN17015's post-award catalogue transaction with the XKatalog's catalogue and product tree feature is still in internal CEN/TC 440 discussion. In theory, the EN could use semantic indications on line-level via the component item BG to mimic hierarchical trees; however, this is not completely suitable in practice since it only works on line-level. As such, an internal agreement between KoSIT, Uni Koblenz and a member of the CEN/TC 440 is made to try and convince other CEN/TC 440 members in the next project workshop. For this reason, a member of the Uni Koblenz will take part in the next CEN workshop and present the use-case of a configurable computer to illustrate the added value of catalogue and product group systems.
W21.	04.12.2024	Design Review	Uni Koblenz	Further suggestions for the integration of supporting architectural artifacts	The solution objectives should also describe how structured data may be reused in further procurement procedures to help specify needs and requirements (see section 4.1.2). In the business perspective, a decision tree should illustrate that the XKatalog is mostly suitable for product

					procurements. The technical perspective should be supplemented by internal documents in the form of N296 from CEN/TC 440 to illustrate that a usage of the Peppol eDelivery Network (4-Corner Model) is recommended for the XKatalog (see section 4.5.2).
W22.	11.12.2024	Design Review	KoSIT, Uni Koblenz	Schematron Review	The Schematron code of the XKatalog-Validator is complete for the minimal business test case and works as expected. The existence of optimizations for Peppol's Schematron code is not technically necessary; however, it highlights that Peppol's Schematron code is suboptimal and does not incorporate best-practices. As such, these optimizations should be illustrated in the thesis (see section 5.4.1). Furthermore, Peppol's Schematron code should be modified slightly and directly incorporated into the main Schematron validation file in the next update.
W23.	12.12.2024	Pilot and Design Review	neusta, Uni Koblenz	Execution of the pilot process, review of target architecture feasibility	The pilot process of W17 is successfully piloted in a controlled testing environment. The minimal XKatalog business case can easily be created, validated and transformed into an XBestellung through the use of a catalogue management tool, the XKatalog-Validator and

					the Lieferantencockpit. As such, the target application architecture (see section 4.4) is feasible in the near future when reduced to the scope of these specific solution component. Therefore, for the scope of this thesis, all other target architecture perspectives are adjusted slightly to include these solution components.
W24.	18.12.2024	Design Review	KoSIT, Uni Koblenz	External validation of all pre-final architectural considerations from KoSIT	A pre-final validation for all architectural considerations is conducted with the KoSIT. In terms of requirements, more technological neutrality is advised; although the target architecture utilizes specific solutions, requirements should exclude specific systems and solutions unless the environment dictates that a certain solution must be used. Furthermore, all architecture artifacts related to the catalogue management process should be more specific in their illustrations.
W25.	19.12.2024	Design Review	Uni Koblenz	Internal validation of all pre-final architectural considerations	A pre-final validation for all architectural considerations is conducted internally. The foundation's problem scope and solution objectives should emphasize the data transformation/validation flow clearly. The target BPMN should include a visual indication for the core XKatalog-related process. Supplementing the mandatory XKatalog <-> XBestellung mapping with a graphical mapping that

					illustrates overall transformation capabilities is advised (see Figure 46). A full syntax mapping would exceed the current scope of the XKatalog and this thesis and is recommended for the future after the standard has consolidated itself more.
W26.	08.01.2024	Design Review	KoSIT, Uni Koblenz	Final validation of all architecture artifacts, the SeMoX specification and the Schematron code	A final validation of all relevant artifacts used within this thesis is conducted. In practice, productive data standards such as the XRechnung still get sent over mail. While this is not part of any target vision, it must be considered for the XKatalog's requirements. As such, technical requirements should clearly state that the XKatalog can be used within the Peppol eDelivery Network (which is recommended) but also outside of it (which is not recommended, but possible). Furthermore, the target technical architecture may be more complex when employed in practice but sufficient for the context of this thesis regardless. Apart from that, all architecture artifacts, the XKatalog's SeMoX-Specification, and its validation environment (consisting of the XKatalog-Validator's Schematron code, one minimal business case and two technical test cases), are evaluated positively against their solution objectives and thus do not require further changes, deeming them as final.

2.3.3 Problem centred Expert-Interviews

In line with the proposed approach of Döringer [32] and the DSR's relevance cycle, two problem centred expert interviews are conducted in this thesis to investigate implicit expert knowledge of relevant actors. The expert interviews aim to produce valuable insights into the standardization approach for designing data exchange standards between heterogenous systems of the German Coordination Office for IT-Standards (see section 5.1), and the Coordination Office's validation and testing environment for such standards (see section 5.4) [32]. Both interviews are held in German to prevent participants from facing any language barriers during their thought processes and answers. However, their analysis and evaluation are conducted and presented in English.

The Questionnaires are designed by harmonizing Döringer's semi-structured interview guideline for problem centred expert interviews with the sequence for expert oriented questionnaire design by Sreejesh et al. [33]. Therefore, each interview begins with an open-ended question, the "Lead in Question", that breaks the ice and stimulates the participant's narration [32], [33]. Second, "Qualifying Questions" begin to slowly guide the participant towards the interview's research objectives by exploring the participant's role, qualification and knowledge of their organizational context [33]. Afterwards, the "Warm-up Questions" aim to make participants focus their mind on recollecting experience and knowledge that is relevant to the upcoming explorations within the interview [33]. Once this introduction to the interview has finished and the participant is ready to be inquired about their expert knowledge, "Specific Questions" aim to start discussions and openly explore the participant's implicit knowledge [32], [33]. As such, these questions serve as starting points for general explorations that turn into specific explorations over time due to further, deductive questioning by the interviewer [32]. The "Specific Questions" are directly derived from the research objectives and hence represent the problem centred expert interview's core [32], [33].

The Audio of both interviews is recorded after confirming permission from the participants and, once again with permission from the participants, pre-transcribed via the Whisper transcription service[10] of the University of Koblenz. Afterwards, the transcription rules of Kuckartz [34, Fig. 8.1] are applied manually to ensure high quality transcripts. Demographic sections are removed to prevent sensitive data from being disclosed; the

[10] https://whisper.uni-koblenz.de/ last access: 31.12.2024

permission to mention both members of the KoSIT by name and position in this thesis was explicitly granted by both participants.
The analysis and evaluation of the transcripts is conducted in line with the recommendation for an open coding approach by Döringer [32]. In this work, both interviews are unique, singular instances that are conducted to investigate specific expert knowledge which helps to understand the optimal approach towards specifying the XKatalog as well as developing its validation environment. Therefore, the focus of the open coding approach is not on achieving comparability between different interviews of an interview series but rather on structuring and summarizing the interview results for the relevant parts of this thesis. As such, the interviews contribute to the DSR's relevance cycle for research questions three and four.

The first interview was conducted with Dr. Renzo Kottmann from the Coordination Office for IT-Standards, an expert on data standardization, the scholar behind developing SeMoX [23] (see section 5.1) and one of the responsible leads for coordinating the German XEinkauf standards for Public E-Procurement in Germany. Additionally, he is also tasked with representing Germany's standardization interests in the European pre-award community. The main research objective was to capture the KoSIT's general approach to standardizing electronic data exchange standards for Public E-Procurement. The KoSIT's standardization philosophy, their common standardization process, and their experience on the most common benefits and challenges aid in understanding how an electronic catalogue standard can be optimally specified in Germany.
As such, these insights contribute towards answering research question three. A detailed analysis of the interview results regarding standardization can be found in section 5.1. Additionally, through the open exploration of implicit expert knowledge during the interview, a confirmation of how electronic catalogues can be used in practice to overcome current issues in Public E-Procurement was discovered. While not within the main research scope of this interview, the results of the spontaneous discussion on electronic catalogues contribute towards answering research question two and are hence placed in section 4.1.2. Table 6 shows the first interview questionnaire.

Table 6: Interview questionnaire on standardization

Lead in Question
1. Wie siehst du die aktuellen Entwicklungen zur öffentlichen Beschaffung in Deutschland? Bist du eher enthusiastisch oder skeptisch eingestellt?
Qualifying Questions
1. Was ist die Aufgabe der Koordinierungsstelle für IT-Standards (KoSIT)? 2. Welche Aufgaben umfasst deine Tätigkeit bei der KoSIT aktuell?
Warm-up Questions
1. Welche elektronischen Beschaffungsstandards hat die KoSIT bisher spezifiziert? 1.1. Welche elektronischen Beschaffungsstandards stehen aktuell noch in Aussicht?
Specific Questions
1. Welche Dinge müssen vor dem Beginn eines Standardisierungsprozesses für elektronische Beschaffungsstandards beachtet werden? 2. Mit welchen Prozessschritten beginnt der eigentliche Standardisierungsprozess für elektronische Beschaffungsstandards? 2.1. Welche Tätigkeiten umfasst der Kern des Prozesses? 2.2. Wie sehen finale Prozessschritte aus? 2.3. Wie funktioniert die Pflege bzw. Maintenance der Standards? 3. Wie lange dauert der Standardisierungsprozess für elektronische Beschaffungsstandards ungefähr? 4. Welche konkreten Mehrwerte schafft die Spezifikation bzw. Profilierung eines elektronischen Beschaffungsstandards? 5. Gibt es wesentliche Herausforderungen bei der Spezifikation von elektronischen Beschaffungsstandards? 5.1. Wie kann diesen Herausforderungen entgegengewirkt werden? 6. Gibt es weitere Punkte, die für die Spezifikation von elektronischen Beschaffungsstandards relevant sind? 7. Möchtest du sonst noch etwas ergänzen?
Demographic Questions
1. Seit wann arbeitest du bei der Koordinierungsstelle für IT-Standards? 2. Wie lautet deine derzeitige Jobbezeichnung? 3. Wie alt bist du? 4. Was ist dein Geschlecht?

The second interview was conducted with Barbara Dewein from the Coordination Office for IT-Standards, one of the Coordination Office’s experts on electronic invoicing tasked with maintaining the technical components of the XRechnung and co-responsible for developing the standard’s testing and validation environment. As a main research objective, implicit expert knowledge on the KoSIT’s testing and validation approach, especially on its so called Testsuite, was investigated in this interview. The results aid in addressing research question four and a detailed discussion is hence placed in section 5.4. Table 7 illustrates the second interview questionnaire.

Table 7: Interview questionnaire on testing and validation

Lead in Question
1. Wie würdest du die Testsuite der XRechnung insgesamt bewerten? Eher als erfolgreich oder eher als verbesserungswürdig?
Qualifying Questions
1. Seit wann gibt es die Testsuite der XRechnung ungefähr? 2. Wann und wie bist du mit der XRechnungs-Testsuite das erste Mal in Kontakt gekommen? 3. Was war bzw. ist deine Aufgabe im Zusammenhang mit der Testsuite der XRechnung?
Warm-up Questions
1. Was ist das Ziel der Testsuite der XRechnung? 2. Wie funktioniert die Testsuite allgemein? 2.1.Aus welchen wesentlichen Bestandteilen besteht sie?
Specific Questions
1. Wie wird eine solche Testsuite (wie die XRechnungs-Testsuite) entwickelt? 1.1. Wie werden die einzelnen Bestandteile entwickelt? 1.2. In welcher Reihenfolge werden die Bestandteile entwickelt? 2. Wie lange dauert die Entwicklung einer solchen Testsuite ungefähr? 3. Wie wird die Testsuite der XRechnung momentan eingesetzt? 3.1.Wie wird die XRechnungs-Testsuite aktuell gepflegt? 3.2.Welche Aufgaben umfasst die Pflege der Testsuite? 4. Welchen konkreten Mehrwert bzw. Vorteile schafft eine solche Testsuite bei der Spezifikation/Profilierung und produktiven Nutzung eines Standards? 5. Gibt es wesentliche Herausforderungen in Bezug auf die Entwicklung/Anwendung der Testsuite? 6. Gibt es weitere Punkte, die für die Arbeit an und mit einer solchen Testsuite zu bedenken sind? 7. Möchtest du sonst noch etwas ergänzen?
Demographic Questions
1. Seit wann arbeitest du bei der Koordinierungsstelle für IT-Standards? 2. Wie würdest du deine aktuelle Position bei der KoSIT beschreiben? Für was bist du zuständig? 3. Wie lautet deine aktuelle Jobbezeichnung? 4. Wie alt bist du? 5. Was ist dein Geschlecht?

2.3.4 Requirement Engineering

In line with Pandey et al. [35], requirement engineering is a complex process that aims to incorporate demands from a vast number of stakeholders, viewpoints, responsibilities, and objectives into the software and system development process. As such, it is a critical operation that requires a systematic approach for requirement elicitation, documentation and verification [35]. Klier et al. [36] further highlight the complexity of information system requirement engineering in the public sector. They point out that in the case of the German public sector, requirements often emerge dynamically at any given point because of the complex and everchanging environment the system must operate in, both during the initial design process as well as during all design-loops. Therefore, the scholars propose a more holistic view on requirement engineering for the public sector that incorporates a robust IT-governance and prioritizes iterative and extensive communication between all stakeholders for each design loop [36]. As described in Table 5 in section 2.3.2, in the case of the XKatalog, these findings hold true as the initial solution objectives were subject to changes during the whole specification process. Even after the conceptualization phase, requirements had to be constantly re-checked and adjusted due to the everchanging and complex environment that the standard must operate in. Therefore, in this thesis, the proposed method of [35] is utilized for the initial requirement elicitation process, whereas the holistic requirement engineering process of [36] for digitalization in the public sector is applied onto the requirement engineering process as a whole to guarantee a robust requirement management and governance.

Following the proposed method of Klier et al. [36], Figure 3 illustrates the holistic requirement engineering process for the XKatalog. The model consists of a central IT-Governance steering group and the core requirement engineering process. The central IT-Governance steering group encompasses four different levels of organizations. It includes the European Committee for Standardization TC 440 for Electronic Public Procurement on a European level, the Coordination Office for IT-Standards on a national level (Germany), the Federal Enterprise for Mobility in Rhineland-Palatinate on a Federal level (RLP) and the University of Koblenz on a scientific level. This IT-steering group is tasked with constantly monitoring and coordinating the core requirement process for electronic catalogues on a European, national, federal and scientific level. Most notably, it serves to bring together different perspectives and requirements from all levels to ensure that all standardization efforts, whether national (XKatalog) or international (EN17015), are well informed about and strategically aligned with each other.

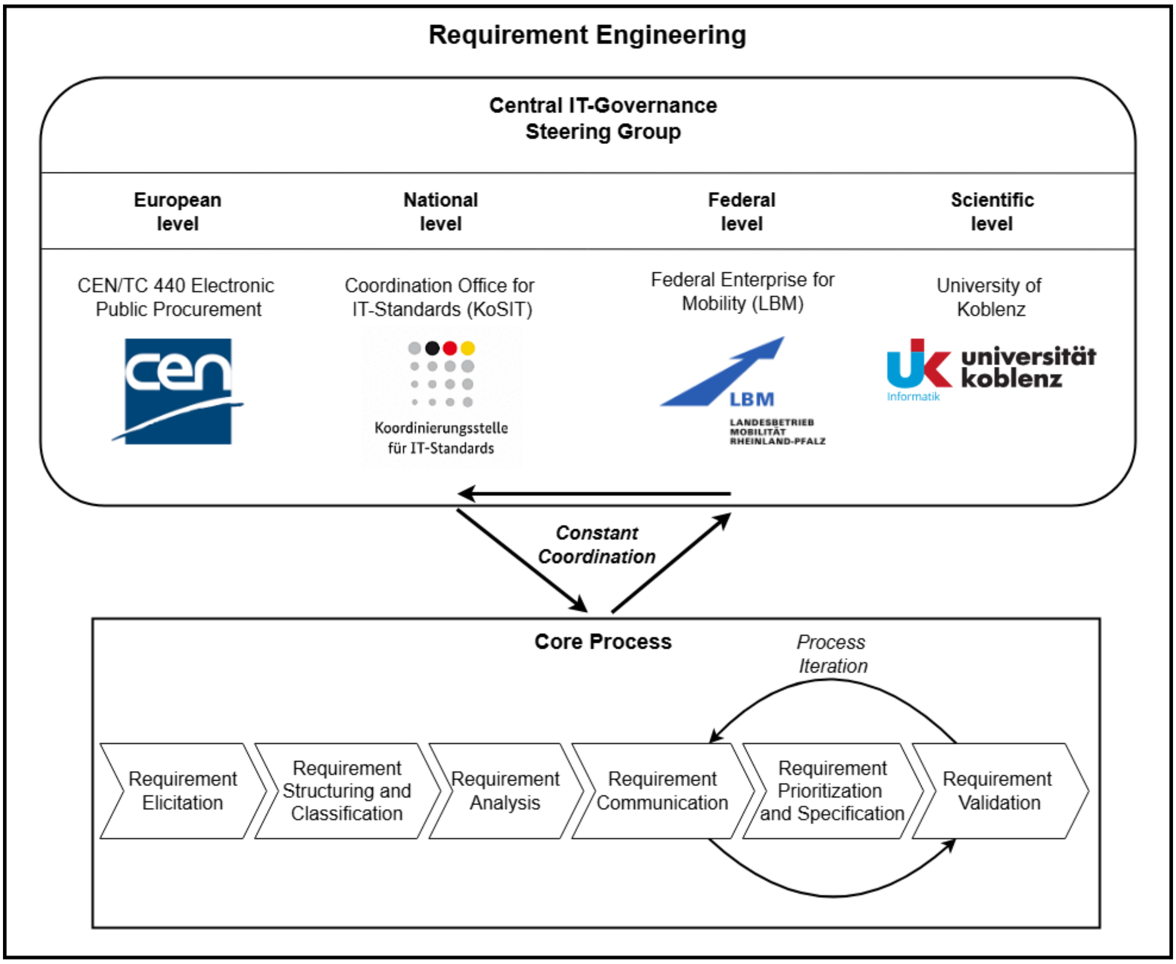

Figure 3: Requirement engineering process based on the proposed model of [36], own depiction

The core Requirement Engineering process begins with the requirement elicitation as specified by [35] and is depicted in Figure 4. The elicitation must carefully consider input from the customer/user, the environment and the technicality of the system. In the case of the XKatalog, customer/user requirements are collected from the LBM during workshop W4 and from the Coordination Office for IT-Standards (KoSIT) during workshop W5 (see Table 5). Environment constraints are defined iteratively in cooperation with various stakeholders during workshops W4, W7, W8, W9, W15, and W17, especially in relation to existing E-Catalogue standards (see 3.5.4) and the legal landscape in Germany and the EU (see 3.5.2). Technical feedback is discussed during the remaining design review workshops. Lastly, in addition to the workshops, requirements are matched and harmonized with the results of the DSR's rigor cycle (see chapter 1 and section 4.1).

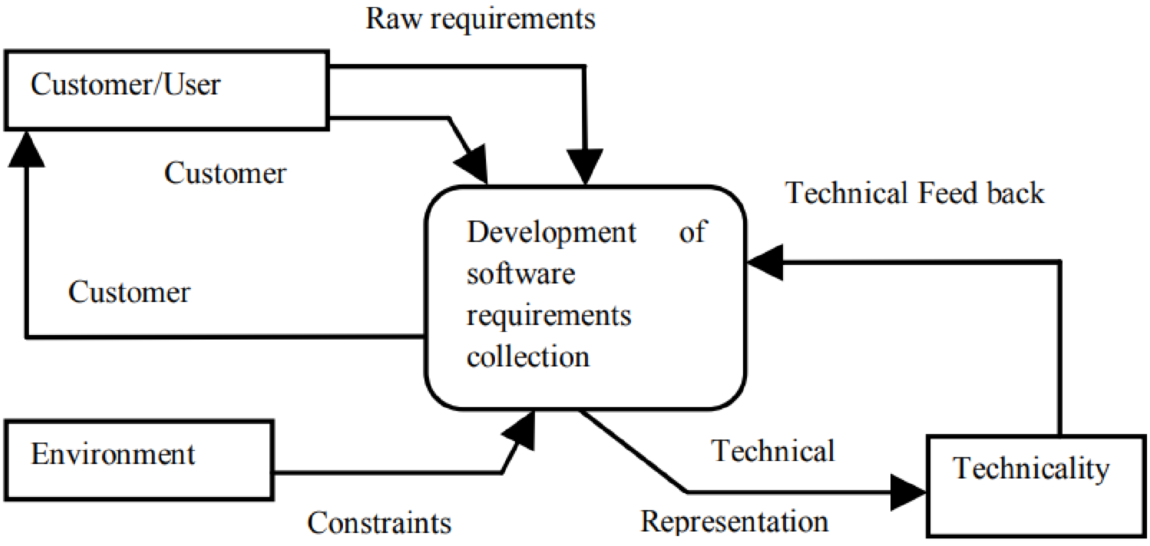

Figure 4: Initial requirement elicitation process, extracted from [35]

In line with [36], the core process continues by structuring and classifying the requirements in-line with the architectural perspectives of the FISAD. Afterwards, requirements are analysed and consolidated to prepare for the upcoming requirement iterations. Subsequently, requirements are constantly demonstrated, validated, and redesigned as well re-prioritized during the workshops in line with design related developments of artifacts. Lastly, it is important to note that this incremental approach to Requirement Engineering is very much in-line with the iterative design approaches of the FISAD [31], the DSRM [25] and the three-cycle-view on DSR [26].

2.3.5 Business Process Model and Notation (BPMN)

The Business Process Model and Notation (BPMN)[11], developed and maintained by the Object Management Group (OMG)[12], is an ISO-certified industry standard for the visual representation of business processes (ISO/IEC 19510:2013[13]). The most recent version, BPMN 2.0.2, allows for the modelling of two distinct diagram types, collaboration and choreography diagrams [37]. In line with Corradini et al. [38], a BPMN collaboration diagram illustrates the participation of several actors, each with their own sub-processes, in a common overall process that also documents the resulting interactions between them. These actors are represented by pools, which may be divided into several swimlanes if

[11] https://www.bpmn.org/ last access: 06.11.2024

[12] https://omg.org/ last access: 06.11.2024

[13] https://www.iso.org/standard/62652.html

the representation of various internal structures or departments is needed. The business process of the corresponding actor is represented by an internal sequence flow within a pool that may contain a start and end point, several process steps, gateways and events. The interaction between different actors, and, as such, different pools, is based on message and data flows. While collaboration diagrams tend to focus on the representation of the sequence flow, choreography diagrams tend to focus on the representation of the message and data flow. Instead of pools, special choreography process steps are used; these steps always consist of a sending and a receiving actor as well as the actual process [37], [38].

In the context of this work, the focus lies on using BPMN collaboration diagrams to illustrate the sequential, collaborative process flow alongside its emerging data elements during the E-Procurement procedure as depicted in section 4.2. The BPMN diagrams are modelled using the online modelling tool “draw.io”[14].

2.3.6 Unified Modeling Language (UML)

The Unified Modeling Language (UML)[15] is a family of notations that aims to conceptualize the design of different software components through different views and capabilities. Alongside the aforementioned BPMN, UML is also maintained by the Object Management Group (OMG)[16]. In the context of this thesis, out of UML’s many sub-notations, only UML Use-Case diagrams and UML Class Diagrams are utilized.

Use-Case diagrams capture specific cases of process applications for a given number of actors within a given application context [39]. They are used within the XKatalog’s business perspective to model both baseline and target use-cases that relevant actors may conduct (see section 4.2). Class diagrams serve to model information about a selected application area in the form of data objects that are represented as so-called classes. A class can be defined as a group of objects with common characteristics, comprising a class name, attributes, and operations associated with the objects of the class; classes may have relationships with each other [39]. In this thesis, class diagrams are utilized to model the XKatalog’s data structure 5.2.4. The UML Use-Case and the UML Class Diagrams are modelled using the online tool “draw.io”[17].

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[14] https://www.draw.io/ last access: 19.01.2025

[15] https://www.uml.org/ last access: 06.11.2024

[16] https://www.omg.org/spec/UML/2.5.1/About-UML last access: 06.11.2024

[17] IBID Footnote 14

2.3.7 Simple Semantic Data Modeling in XML (SeMoX)

“Simple Semantic Data Modeling in XML” (SeMoX) [23] is a technology-neutral modelling approach with additional tooling for capturing the semantics of data within knowledge domains. In SeMoX, domain knowledge is captured in a shareable semantic model that can be read and validated based on its specification by business and legal experts. Its technical implementation of validation artifacts and related tools is kept independently from these artifacts to allow for full freedom of the model’s technical implementation. SeMoX can therefore bridge the gap between individuals with varying degrees of business, legal and technical expertise within a certain knowledge domain through the separation of domain knowledge and technical implementations. As such, SeMoX acts as a semantic framework that aims to standardize interoperable data exchange between heterogenous systems by defining a simple, domain-specific language in XML that structures domain-specific semantics of data [23]. In practice, it is used to develop and maintain several German XEinkauf standards such as the XRechnung [22], XBestellung [21] and the electronic publication of public contract notices known as “eForms”[18].

SeMoX utilizes five basic concepts in its modelling approach to address and bridge the gap between domain experts and technical experts: Terms, Semantic Datatypes, Structures, Syntax-Bindings and Rules [23]. The decisive building blocks for capturing domain knowledge are Terms, Structures and Rules. First, the concept of a Term, also known as a Business Term (BT), aims to capture the semantics of a word or phrase used to describe a particular concept within a given knowledge domain. As such, a Term’s semantics are defined through its name and description by domain experts and encoded in the XML. In line with the needs of domain experts, several Terms can subsequently be aggregated into groups to form a Semantic Structure that defines each Term’s affiliation and cardinality. Lastly, the concept of Rules establishes constraints, restrictions and assertions on the use of Terms and Structures. Rules are to be developed from a business perspective by the domain experts and set the expectation levels that the technical implementation must be measured against. On the other hand, Semantic Datatypes and Syntax-Bindings capture the knowledge of technical experts as crucial components for the technical implementation. The concept of Semantic Datatypes comprises the semantic intents of relevant datatypes, for instance, date, string or

[18] https://projekte.kosit.org/api/v4/projects/356/packages/maven/de/xeinkauf/eforms-de/2.1.0/eforms-de-2.1.0.zip last access: 31.12.2024

identifier, that must be declared for each Term in SeMoX. Syntax-Binding is utilized to allow technical experts for the binding of a Semantic Structure to a concrete XML instance for data parsing. Furthermore, supporting technical components such as validation and transformation files alongside test cases are to be specified [23].

2.3.8 Archimate

ArchiMate[19], developed and maintained by The Open Group[20], is a modelling language across architecture layers for enterprise architecture development (see also section 2.2.2). As such, the specification defines common rules for describing an enterprise's business processes, organizational structures, information flows, IT systems and technical infrastructure [40]. In the context of this thesis, ArchiMate is utilized to develop the XKatalog's Application (see section 4.4) and Technical Architecture (see section 4.5). The models themselves are created via Archi[21], an open-source modelling toolkit for creating ArchiMate models.

2.4 Methodological Synthesis

A synthesis of all research questions, applied methodology and methods, and expected results is presented in Figure 5. To answer the first research question, a Structured Literature Analysis is conducted alongside workshops to gain insights into the current status of standardized E-Catalogues in Public E-Procurement. The SLA is conducted via Parsifal, evaluates literature based on preliminary in- and exclusion criteria as well as a quality assessment checklist, and contributes towards a scientific understanding of the status-quo in line with the DSR's rigor cycle. The workshops are conducted with experts on E-Catalogues, standardization and Public E-Procurement and supplement the SLA's scientific foundation with relevant insights from practice in line with the DSR's relevance cycle. Furthermore, applying these methods contributes towards the first step of both the DSRM and FISAD as the general problem scope and motivation of E-Catalogues are identified. Expected results include an overview of status-quo on standardized E-Catalogues in both literature and practice (see section 3.5), a concept matrix (see Table 8) and a literature spreadsheet (see Table 18).

In addressing the second research question, another SLA and further workshops are conducted in accordance with the DSR's rigor and relevance cycles to analyse how

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[19] https://www.opengroup.org/archimate-forum/archimate-overview last access: 13.11.2024

[20] https://www.opengroup.org/ last access: 13.11.2024

[21] https://www.archimatetool.com/ last access: 13.11.2024

standardized E-Catalogues can overcome current barriers in Public E-Procurement. Moreover, during an expert interview with Renzo Kottmann of the KoSIT in the context of RQ3, a brief and spontaneous discussion on E-Catalogues confirms the potential of E-Catalogues as a solution component, thereby further contributing to the DSR's relevance cycle in the context of RQ2. Consequently, the results of the employed methods add to the FISAD's foundation perspective as well as the DSRM's steps one and two for the identification of the problem scope, motivation, solution objectives. As a result, further contributions are made to the literature concept matrix and spreadsheet, current challenges in Public E-Procurement are identified (see section 3.2.3), and the role of standardized E-Catalogues as a solution component for these problems is synthesized (see section 4.1).

In order to develop the optimal specification of an E-Catalogue standard for Public E-Procurement in Germany in context of the third research question, FISAD is applied. The results of research questions one and two provide foundational input for producing further architectural considerations and requirements (see chapter 4) towards the XKatalog's specification in SeMoX as a data standard (see section 5.2). The requirements themselves are iteratively validated by a central IT-governance steering group in several workshops in accordance with the proposed method of Klier et al. [36]. Furthermore, to gain a better understanding of the KoSIT's standardization approach in practice, an expert interview with Renzo Kottmann is conducted to supplement the DSR's relevance cycle (see section 5.1). Both FISAD and SeMoX related artifacts are iteratively designed, demonstrated and evaluated in workshops in line with the DSRM's iterative design loop and the DSR's design cycle. As a result, the XKatalog's specification implements and strategically enables the requirements as deduced from FISAD (see section 5.5).

Finally, to answer research question four on the XKatalog's validation, an additional expert interview with Barbara Dewein of the KoSIT is held, thereby contributing to the DSR's relevance cycle by offering valuable insights into the KoSIT's validation environment. In light of the interview results and the requirements as derived from FISAD, both the XKatalog-Validator (see section 5.4.1) and Testsuite (see section 5.4.2) are designed, demonstrated and evaluated iteratively in accordance with the DSRM and the DSR's design cycle.

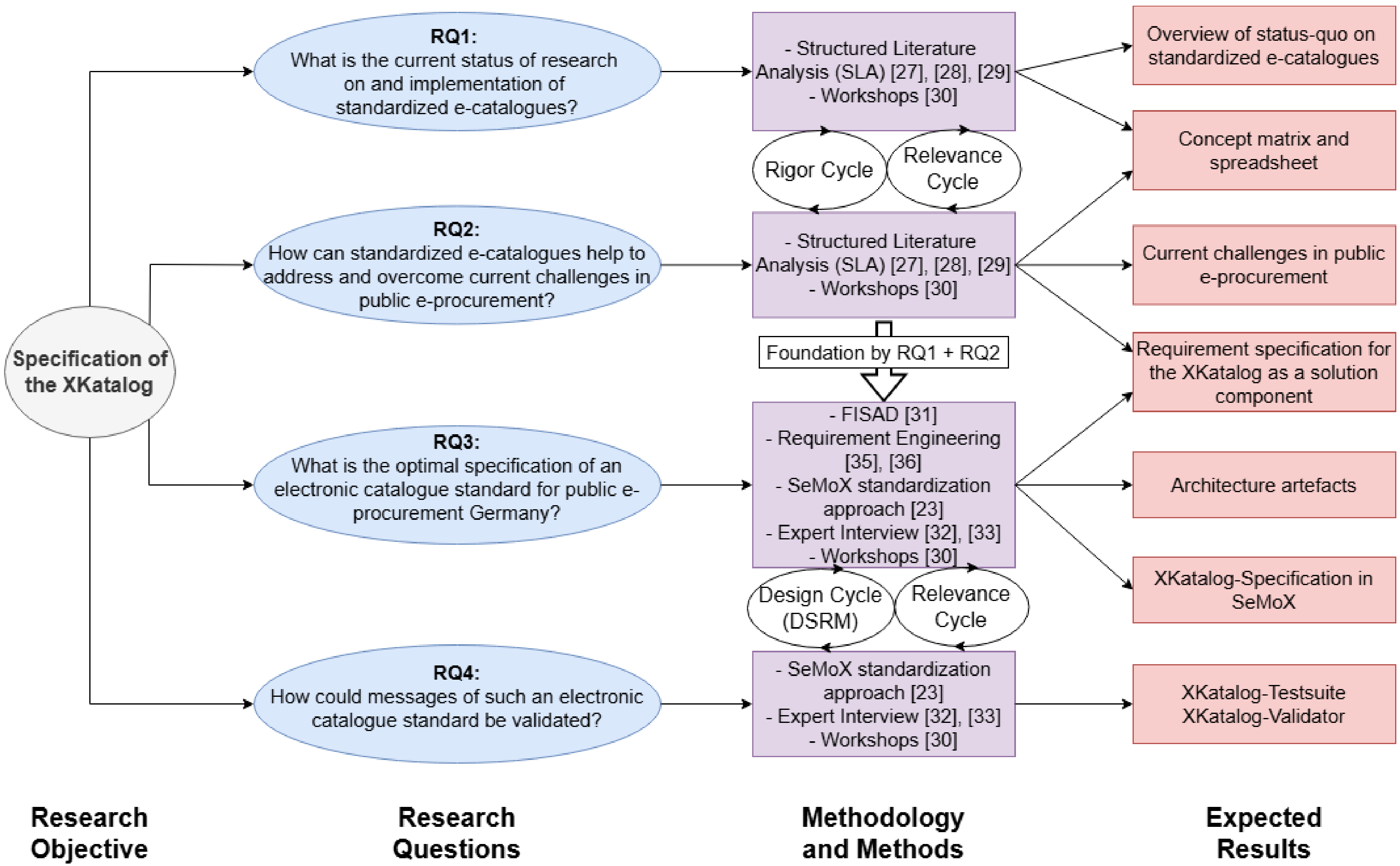

Figure 5: Overview of research questions, applied methods, and expected results

3 Theoretical Background

In this chapter, the theoretical background of the thesis is provided. First, the digital transformation of the public sector is discussed alongside the concept of E-Government in section 3.1. Subsequently, Public E-Procurement can be discussed in section 3.2, analysing and synthesising the German and European procedures (see section 3.2.1), elaborating on Dynamic Purchasing Systems (DPS, see section 3.2.2), and, as a result of the SLA, debating its problem environment as derived from literature to lay the foundation for answering research question two (see section 3.2.3). Afterwards, interoperability (see section 3.3) and standardization (see section 3.4) are examined before results of a further SLA on electronic catalogues, supplemented by relevant insights from grey literature and workshops, are illustrated in section 3.5. Electronic catalogues are scientifically grounded in section 3.5.1, legally grounded in section 3.5.2, relevant actors and systems for their usage explained in section 3.5.3 and relevant standards explained in section 3.5.4. Finally, a theoretical synthesis is conducted in section 3.6, analysing all theoretical concepts and their interrelation in a concept matrix and concept map, thereby providing a holistic scientific grounding of the thesis and answering research question one on the status quo of standardized E-Catalogues in Public E-Procurement.

3.1 Digital Transformation of the Public Sector

A Taxonomy by Kutzner et al. [41] discusses the research characteristics, topics and clusters for digital transformation in any given research domain. The paper highlights, compared to other research domains, the popularity of research on digital transformation in the public sector that most commonly investigates the adoption of innovation and technology as well as changes in the public sector work culture. The findings demonstrate that the public sector is particularly affected by the effects of digital transformation and thus faces a high necessity for extensive research in this domain, especially design science research as utilized in this thesis (see 2.2.1) [41]. In line with Wimmer et al. [1], the digital transformation of the public sector aims to modernize government and public service provisioning through the integration of information and communication technologies (ICT) [1]. To achieve this, Brunetti et al. [42] argue that standalone interventions are insufficient for digital transformation endeavours as they require a holistic view from a systemic perspective. The authors further suggest high cooperation among stakeholders through frequent and extensive communication and the need for developing digital skills within public organizations [42]. These insights are incorporated into this thesis by establishing that the XKatalog’s design cycles require constant and iterative communication and validation between various stakeholders (see sections 2.2.1, 2.3.2 and 2.3.4); additionally, the XKatalog is considered as a solution component for the holistic E-Procurement solution model instead of a singular intervention [11]. As pointed out by multiple scholars, the public sector also has a particularly high need for standardization (see also 3.4) and continuously faces interoperability issues (see also 3.3) that can severely hamper public service adoption and performance [9], [43]. The XKatalog aims to contribute towards the standard based solution of this gap.

Moreover, the digital transformation of the public sector is central to the domain of electronic government (E-Government). While E-Government may also be referred to as digital government [1], in line with discussions in literature [1], [44], the terms electronic government and digital government are used synonymously in this thesis. Although there are a variety of different definitions of E-Government that all cover different nuances of the concept [45], for the purpose of this thesis, Fang [2] provides a general definition of E-Government:

"E-Government is defined as a way for governments to use the most innovative information and communication technologies, particularly web-based Internet applications, to provide citizens and businesses with more convenient access to government information and services, to improve the quality of the services and to provide greater opportunities to participate in democratic institutions and processes." [2, p. 2]

As such, E-Government offers many potential benefits such as increased government accountability to citizens, greater public access to information and a more cost-effective government. To realize these benefits and achieve a high citizen adoption of E-Government solutions, governments should focus on ease of use, compatibility and trustworthiness of the solutions [46].

3.2 Public E-Procurement

Simply put, Public Procurement refers to the acquisition of goods, works and services by public sector organizations from all types of other organizations, including private, public and semi-public bodies [3]. It can be defined as *"the designated legal authority to advise, plan, obtain, deliver, and evaluate a government's expenditures on goods and services that are used to fulfill stated objectives, obligations, and activities in pursuant of desired policy outcomes"* [7, p. 329]. Public E-Procurement generally aims to conduct the Public Procurement process via the use of electronic means, particularly Web based applications

[4]. A comprehensive definition of the Public E-Procurement process is provided by Abu Bakar et al. [47, p. 84]: *"E-Procurement can be defined as the use of electronic tools and technologies, and Web-based applications, to support the procurement process conducted by the strategic procurement management. The procurement process includes sourcing, negotiating and collaborating with trading partners in order to undertake operational procurement procedures"*. In the EU, Public E-Procurement accounts for about 14% of the gross domestic product[22] and around 29% of its member states' national government expenditures[23]. Consequently, saving costs and increasing process efficiency is imperative [7], most notably through an increase in interoperability [8], [31] (see section 3.3) and standardization (see section 3.4) [48].

3.2.1 Procedure

In the context of this thesis, it is important to highlight that the Public E-Procurement procedure differs in the EU and Germany. Therefore, in the following, the European and German procedures will be discussed and subsequently harmonized to illustrate their differences and similarities alongside other notable findings of the synthesis. While the German process is of direct relevance for the XKatalog as a German data standard, it is important to also understand relevant considerations that stem from the European procedure as an internationally applicable procedure.

3.2.1.1 European Procedure

In the European Union, the Public E-Procurement process is generally divided into the pre-award and post-award phases, where the first denotes the part of tendering where economic operators submit their offers, whereas the second part starts after an EO is awarded with a contract by the contracting authority (CA) [5], [6]. In-line with [5], [6] and the Peppol BIS open procedure guide [49], the pre-award phase consists of e-Sourcing, e-Notification, and e-Tendering, whereas the post-award comprises e-Contracting, e-Ordering and e-Payment. The e-Awarding marks the transition between both phases.

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22 https://single-market-scoreboard.ec.europa.eu/business-framework-conditions/public-procurement_en#:~:text=Public%20procurement%20is%20the%20process,gross%20domestic%20product%20(GDP). Last access: 19.06.2024

23 https://data-explorer.oecd.org/vis?tm=public%20procurement&pg=0&snb=33&vw=tb&df[ds]=dsDisseminateFinalDMZ&df[id]=DSD_GOV%40DF_GOV_PPROC_2023&df[ag]=OECD.GOV.GIP&df[vs]=1.0 last access: 19.06.2024

E-Sourcing marks the start of the procurement procedure where a CA must specify its needs and requirements that serve as the base for further procurement documents. The e-Notification comprises the notification process, during which a CA releases notification documents about the procedure on relevant publication boards, as well as the call for tenders process, where interested EOs receive the necessary procurement documents such as a pre-award catalogue request from the contracting authority during the subsequent e-Tendering process to participate in the procedure. After gaining access to the relevant procurement documents such as the call for tenders, during the e-Submission sub-process of the e-Tendering, an EO may submit a tender alongside a pre-award catalogue and an ESPD response. Subsequently, in the e-Awarding, all received Tenders are opened and evaluated by the CA in-line with legal regulations and predetermined awarding criteria such as price, time and other economic or environmental factors. The EO whose tender is accepted subsequently receives a contract award notice (CAN) [5], [6], [49].

This marks the beginning of the post-award procurement phase, which starts with the e-Contract. The CA and EO may establish a contract or framework agreement based on the award-winning tender and, if desired, agree upon the implementation of key performance indicators to monitor the contract or framework agreement. Notably, in its current state, the European e-Contract process does not explicitly foresee the implementation of electronic post-award catalogues, although an international standard for post-award catalogues, the Peppol Catalogue, already exists (see section 3.5.4). However, since the implementation and use of electronic catalogues, especially in the post-award, is advised by the EU, the European Committee for Standardization is currently working on addressing this gap via the EN17015 for electronic catalogues (see W15). During the subsequent e-Order, the CA issues an electronic order from the EO that is based on the contract or framework agreement. In the future, in-line with the current drafts of the EN17015-1 and EN17015-2[24], the e-Ordering may allow for the direct generation of an electronic order out of an electronic catalogue. Upon accepting the order and shipping the items, the EO prepares an electronic invoice during the e-Invoicing that is issued and processed electronically. The procurement procedure ends with the e-Payment process, during which the CA electronically pays for the goods, works or services as specified in electronic invoice [5], [6].

[24] Internal and unreleased draft documents from December of 2024

3.2.1.2 German Procedure

The German architecture and solution concept for the standard-based digitalization of Public E-Procurement, based on European E-Procurement specifications and extended with national requirements, legal grounds and other peculiarities, provides insights into the Public E-Procurement process in Germany [12]. The process is depicted in Figure 6 and consists of three main parts, the identification of needs and requirements (Bedarfserhebung), the tendering procedure (Vergabeverfahren) and the contract execution alongside the purchase (Vertragsdurchführung und Einkauf). Additionally, a distinction between the pre-award and post-award is made, although the aforementioned process fragmentation is preferred in the document.

Figure 6: Public E-Procurement Process in Germany, retrieved from [12, p. 23]

During the identification of needs and requirements, the need for a service or product is determined by collecting both domain and technical requirements in a so-called service description (Leistungsbeschreibung) that specifies the need itself as well as its scope and time. Afterwards, two optional processes in the form of the Notification (Bekanntmachung) and Prequalification (Präqualifizierung) may start depending on the scope, estimated cost and other factors of the procedure as defined in the service description; although optional, the Notification process commonly occurs in practice in Germany. Next, the tendering procedure, consisting of three interlinked sub-processes, starts with the call for tenders (Aufruf zur Angebotsabgabe). The call for tenders allows Economic Operators to subscribe to the procedure and thus receive the necessary procurement documents such as a pre-award catalogue request from the contracting authority to participate in the following tendering process. During the tendering, the EO may create and submit a tender alongside a filled-out pre-award catalogue response to specify offered goods, works and services as well as a European Single Procurement Document (ESPD) response to prove that they fit the CA's requirements to participate in the procedure. Subsequently, the CA evaluates all received tenders and awards the winning tender based on predefined awarding criteria.

This marks the end of the German pre-award phase that consists of two main process components and the start of the post-award that contains the contract execution and purchase process component. Subordinate to this component, the post-award phase starts with the catalogue management, the most important process step for the XKatalog in the context of this thesis. As such, the process is discussed in much more detail in chapter 4, especially section 0. The catalogue management comprises the creation and maintenance of post-award E-Catalogues and notably contributes towards the establishment, maintenance and execution of framework contracts between the CA and the EO. An agreed upon post-award catalogue may then be used by the CA in a catalogue-based ordering system to generate an e-order in-line with the XBestellung-Standard [21] for the EO. Afterwards, the EO delivers the goods or performs the works or services as specified in the order. Upon positive evaluation of the goods, works or services by the CA, and e-invoice in-line with the XRechnung-Standard [22] is created by the EO and paid by the CA, marking the end of the German E-Procurement procedure [12, pp. 23–43].

3.2.1.3 Synthesis

When synthesizing the European and German E-Procurement procedures, several strengths and weaknesses of both approaches become apparent. In Germany, the procurement procedure is sectioned into three main phases. While the German architecture concept for procurement also differentiates between pre- and post-award, this distinction is much less emphasised than in the EU. This is problematic because international standards have evolved to adapt to the clear distinction of pre-[25] and post-award[26] and designated communities for the research and work on both phases have formed themselves accordingly (PoAC and PrAC)[27]. As such, the distinction between pre- and post-award is much more in-line with the current state-of-the-art of electronic procurement and is advised to be considered as the main distinction for Public Procurement phases in Germany as well.

Moreover, there are vast differences in the availability of established E-Procurement standards during all phases. The EU utilizes many different procurement standards during all electronic sub-processes of the E-Procurement procedure via Peppol[28] and the CEN/TC 440[29], whereas Germany mostly aims to incorporate these standards into its

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[25] https://docs.peppol.eu/pracc/ last access: 21.11.2024

[26] https://docs.peppol.eu/poacc/upgrade-3/2024-Q2/ last access: 21.11.2024

[27] https://peppol.org/learn-more/communities-and-work-groups/ last access: 21.11.2024

[28] https://peppol.org/documentation/technical-documentation/ last access: 21.11.2024

[29] https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/public-procurement/cen-tc-440-electronic-public-procurement/ last access: 21.11.2024

processes in the future. This becomes apparent when looking at Germany's currently established E-Procurement standards, released and maintained by the Coordination Office for IT-Standards: eForms as a standard for electronic notification forms in the pre-award, the XBestellung as a standard for electronic orders and the XRechnung as a standard for electronic invoices[30].

Lastly, in contrast to Germany, the EU fails to specify the electronic catalogue management process in a thorough and detailed manner. While the process is recognized and standardization attempts are made[31], findings from the Workshops W15 REF point towards no practical relevance of existing EU solutions and reaffirm the need for the EN17015 which is closely considered during the XKatalog's development as a superordinate, legally binding standard norm in the foreseeable future. The catalogue management process is of utmost importance for this thesis and analysed in the XKatalog's business perspective in section 4.2. A much more detailed discussion of existing E-Catalogue standards in general can be found in section 3.5.4.

3.2.2 Dynamic Purchasing Systems (DPS)

In literature, Dynamic Purchasing Systems (DPS) have only been covered vaguely. Querying the keyword "Dynamic Purchasing System" on Scopus leads to a total of just eleven results, of which only three are used in this work. Despite this, DPS are discussed in the following. According to Eyo [50], The first relevant mention of DPS is in Articles 1(5) of EU Directive 2004/17/EC [51] and 1(6) of EU Directive 2004/18/EC [52]. When discussing the concept of DPS, scholars commonly refer to these directives via a direct citation to define the term [50], [53], [54]. As such, in-line with [50], [53], [54], the definition of DPS within Article 1(6) of 2004/18/EC is used in this thesis and reads as follows [52, p. 127]:

"A dynamic purchasing system is a completely electronic process for making commonly used purchases, the characteristics of which, as generally available on the market, meet the requirements of the contracting authority, which is limited in duration and open throughout its validity to any economic operator which satisfies the selection criteria and has submitted an indicative tender that complies with the specification."

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[30] https://xeinkauf.de/dokumente/ last access: 21.11.2024

[31] https://docs.peppol.eu/poacc/upgrade-3/2024-Q2/profiles/1-catalogueonly/ last access: 21.11.2024

As Gözbilgin et al. [54] point out, the term DPS simply refers to an electronic process, usually within a restricted procedure, and is not limited to a singular system. This process starts with a public authority specifying auction rules in-line with procurement requirements such as the duration and qualification criteria as well as national or international law. Afterwards, given that they possess a suitable qualification, eligible suppliers are notified and can take part in the dynamic purchasing process. The Contracting Authority may manage the pool of suppliers and framework agreements to add qualified suppliers to the DPS at any given point in time [54]. Giosa [53] thus argues that DPS are most useful when used for the execution of existing framework agreements where a contracting authority establishes contracts for continual purchasing of goods from Economic Operators for a given period of time. A CA may then perform dynamic purchases from its suppliers whenever the need arises and forego most of the complex procurement procedure as described in section 3.2.1 [53].

The EU argues that the main benefit of DPS is their ability increase competition and lead to notable savings in time and money through streamlining the Public Procurement process [52]. These benefits are further cemented in the more recent EU Directive 2014/24/EU, which supersedes the 2004/18/EC, and is still relevant 20 years after the first Directive's initial publishing [55]. Several scholars add upon this by stating that DPS can contribute towards transformative change in the procurement process [50], improve time efficiency, accountability and benchmarking [54], and elevate the effectiveness of framework agreement execution [53].

In this thesis, the concept of Dynamic Purchasing Systems is of central importance due to the XKatalog's potential role in practice. Since DPS require Contracting Authorities to electronically view, browse and order products, works or services from Economic Operators [50], [54], electronic catalogues are identified as a potential solution component. Specifically, using the XKatalog as a catalogue standard within a DPS may enable a holistic catalogue management process that can bridge the gap between pre- and post-award and carry data over to the order and invoice.

3.2.3 Problem environment

This section contributes towards answering RQ2 by illustrating the scientific problem context of Public E-Procurement in line with the DSR's rigor cycle. A synthesis of all challenges that are directly relevant to the answer to research question two in the scope of this thesis can be found in section 4.1.1.

In literature, several scholars argue extensively about the challenges that must be overcome to realise the full potential of Public E-Procurement. First, regulatory issues require political commitment to ensure an enabling business environment and a standardized infrastructure [56], [57]. In this context, national policymakers are expected to challenge, discuss and evaluate the quality of E-Procurement systems to develop more suitable laws on Public E-Procurement as a whole [58]. While Wirtz et al. [59] point out that the regulatory framework for Public E-Procurement implementations must be eased because of its complexity, Platis et al. [60] discuss that, in the case of Greece, the adoption of E-Procurement often boils down to simply complying with the law without further considerations that would go beyond that regulatory compliance. Raya and González-Sánchez [61] add on this by identifying gaps for regulations that do not explicitly cover electronic tender procedures. As such, regulations on Public E-Procurement must carefully balance between sophisticated regulations that cover enough ground to ensure a standardized infrastructure without notable gaps while simultaneously facilitating ease of implementation for all stakeholders of the procurement process [61].

This is especially important in the context of small and medium-sized enterprises (SMEs), because they often struggle to participate in Public E-Procurement processes at all [62]. This is mainly due to a lack of available information for SMEs [62], a contract awarding that is often based on just the price instead of a comprehensive tender award criteria model [63], a lack of knowledge on or access to a suitable ICT infrastructure [57], [64] and a general resistance to change [64]. Saastamoinen et al. [65] further find that SMEs are mostly burdened by too complex e-services and too high administrative costs. Their findings also suggest that improvements to information exchange are equally important, although SMEs themselves prioritize them as less important compared to easing e-services and reducing administrative costs [65]. Fernandes and Vieira [66] add to this discussion, concluding that factors such as a lack of technologically suitable solutions, digital signatures and language related issues are significant barriers towards SME participation. Most notably, while SMEs represent 99% of all EU-businesses[32] and generate 51,8% of all business-added-value within the EU[33], they struggle to participate in Public E-Procurement procedures at all, leading to less competition and unrealized potential. This is also emphasized by the European Commission itself [15]. As such, in the

[32] https://single-market-economy.ec.europa.eu/smes_en Last access: 29.12.2024

[33] https://single-market-economy.ec.europa.eu/document/download/b7d8f71f-4784-4537-8ecf-7f4b53d5fe24_en?filename=Annual%20Report%20on%20European%20SMEs%202023_FINAL.pdf see p.3, Last access: 29.12.2024

scope of this thesis, it is important to consider how the XKatalog may contribute towards addressing these SME related problems.

Furthermore, scholars agree that cybersecurity and data privacy issues must be addressed to overcome issues such as the increasing vulnerability of information systems to cyber-attacks [62], [67], [68]. Common concerns include the prevention of document tampering, the protection of private data and ensuring information confidentiality [67], [68], [69]. Ferreria and Amaral [70] further discuss the potential of digital signatures and certificates in this context, highlighting that, while these solutions contribute towards fixing cybersecurity issues, they may also create constraints on public purchase management and force adaptions in the tendering process. Additionally, in Portugal, currently employed technologies and systems mostly act as standalone island solutions, thus failing to achieve meaningful synergies among themselves [70]. In general, Public E-Procurement requires solutions that harmonize data exchanges between heterogenous systems [71]. Babica et al. [63] identify that functional tender descriptions and system dialogue transactions between suppliers and procurers are needed to address interoperability issues in the procurement process. Khorana et al. [57] further argue that electronic catalogue and electronic invoicing standards are necessary to both build trust in the reliability of Public E-Procurement procedures and ensure a smoother process and data flow. This is further supported by insights from various other scholars that discuss the usage of such standards to overcome overarching issues of Public E-Procurement [11], [13], [16], [23]. One of the main issues addressable by interoperable data exchange standards is the gap between the pre- and post-award phases of Public E-Procurement [11], [16]. Currently, due to a lack of reusable data along the procurement process, data cannot be transferred seamlessly from the pre- to the post-award procurement documents [16], thereby necessitating further productive standards [11]. Through their implementation, the gap between pre- and post-award can be bridged and thus overarching issues such as media disruptions, information inconsistencies and disproportionate administrative burden overcome [13], [16]. As pointed out by Soylu et al. [72], once standardized sufficiently, the availability of open and high-quality procurement data can furthermore increase efficiency in delivering services, ensure transparency, prevent fraud and corruption and contribute towards a healthier economy with more competition. As interoperability is very much in the scope of this thesis, the XKatalog must directly address these issues and contribute towards harmonizing the data exchanges in Public E-Procurement.

Stakeholders are another key area of concern in Public E-Procurement. Scholars argue that both a lack of skilled personnel and a lack of leadership and stakeholder engagement significantly hinder the progress of Public E-Procurement [62]. Wirtz et al. [59] highlight the need to continuously convince employees to interact with new technology as this leads to a lower resistance against E-Procurement technologies and, as such, improves the realizable benefits of these tools. Spacek and Spackova [58] provide insights into the user experience for using E-Procurement systems, discussing that performance, ease of use and stability are the most important factors to consider. In general, change resistance of relevant stakeholders is a reoccurring issue in the literature as it hinders the effective usage of E-Procurement implementations and causes the process to become more complex than intended [59], [62], [64], [69]. Most notably, repetitive operations that stem from change resistance and lack of understanding are discussed as a common process-related issue in the literature [62], [67]. Mavidis et al. [62] argue that business process reengineering is a pressing matter because of a plethora of inefficient and non-value-adding Public E-Procurement processes. In this context, Platis et al. [60] provide valuable insights as they identify public administrations in Greece to simply comply with the law without reengineering their internal procedures and practices. This leads to an absence of systematic procedures and assessments necessary to realize the actual benefits of Public E-Procurement [60]. To conclude this discussion, Eadie et al. [69] highlight that solving these issues is difficult due to the public sector being extremely cautious when it comes to changing processes. Whereas the private sector must often adapt to change quickly because of economic pressure, public authorities commonly require several layers of safeguards and systematic procedures to ensure that all laws are abided with, and tax money can be spent without consequences [69]. As such, processes and structures often depend on laws and regulations to change, which once again emphasizes the close connection between regulatory and process-related barriers that both legislative bodies and leading implementation stakeholders must carefully consider. In context of this thesis, it is thus necessary to consider that simply designing an optimal electronic catalogue standard and illustrating its integration into existing processes, even when highlighting its substantial benefits, will not directly lead to a change in Public E-Procurement processes or structures.

Other process-related issues include a lack of thorough needs assessment, subjective selection criteria and inconsistent information access for stakeholders during the process. This leads to untransparent procurement procedures that require further addressing in the field of Public E-Procurement [73]. Finally, Raya and González-Sánchez [61] point out that the ratio of unsuccessful tender procedures to total procurement procedures unfortunately remains to be quite high and thus also requires further research.

3.3 Interoperability

In-line with the European Interoperability Framework (EIF), in the context of this thesis, Interoperability can be defined as *"the ability of organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems"* [10, p. 5]. Subsequently, Interoperability is an important concept within the domain of E-Government, as it enables public administrations, economic operators and citizens to share and exchange data with each other [10]. Margariti et al. [74] argue that interoperability is crucial for the successful digital transformation of public administrations and governments. It is a key enabler for effective and transparent government services and a prerequisite for open data policies and services [74]. Pardo et al. [75] add upon this by discussing interoperability as the chief facilitator for seamless services between public and non-public bodies and, subsequently, cross boundary collaboration of traditionally often rigid public structures. A high level of interoperability is fundamental for governments to achieve a high E-Government maturity and, as such, combat common E-Government related problems [75]. Based on these discussions from literature, DeNardis [71] assesses the importance of Interoperability for Public E-Procurement. In the field of Public E-Procurement, interoperability is identified as a main success factor to combat a variety of structural and technical issues (see section 4.1). Therefore, governments should seek to develop policies and solutions in-line with E-Government interoperability frameworks to promote open standards. Government interoperability frameworks may exist on national or international levels and specify interoperability on different layers between organizations from a sociotechnical point of view [71]. Notably, the positive effect of such interoperability frameworks has recently been empirically validated for the interaction between governments and citizens [43].

3.3.1 European Interoperability Framework (EIF)

As described in 3.3, efforts that seek to increase interoperability in the public sector are advised to follow guiding interoperability frameworks [71]. In this thesis, the European Interoperability Framework (EIF) [10] is utilized as one such framework for ensuring the XKatalog's interoperability as a national data exchange standard between heterogeneous systems during the Public E-Procurement process. While several guiding interoperability frameworks exist on both national and international levels as well as in literature [43], [76], the EIF is chosen in this thesis for two specific reasons. First, the Coordination Office for

IT-Standards base their standardization philosophy, and thus, their standardization efforts, on the EIF (see section 5.1). Second, Public E-Procurement standards that apply on an EU level are also developed in-line with the EIF (Peppol, see section 3.5.4). Since both the relevant national and international approaches for standardization in Public E-Procurement are rooted within the EIF and serve as a paradigm for the XKatalog specification, it is chosen as a guiding interoperability framework for this thesis.

3.3.1.1 Layers

The European Interoperability Framework defines four core interoperability layers, a cross-cutting component across these layers and a background layer. These elements are depicted in Figure 7. An analysis of the EIF's layers and their relevance for this thesis is conducted in the following.

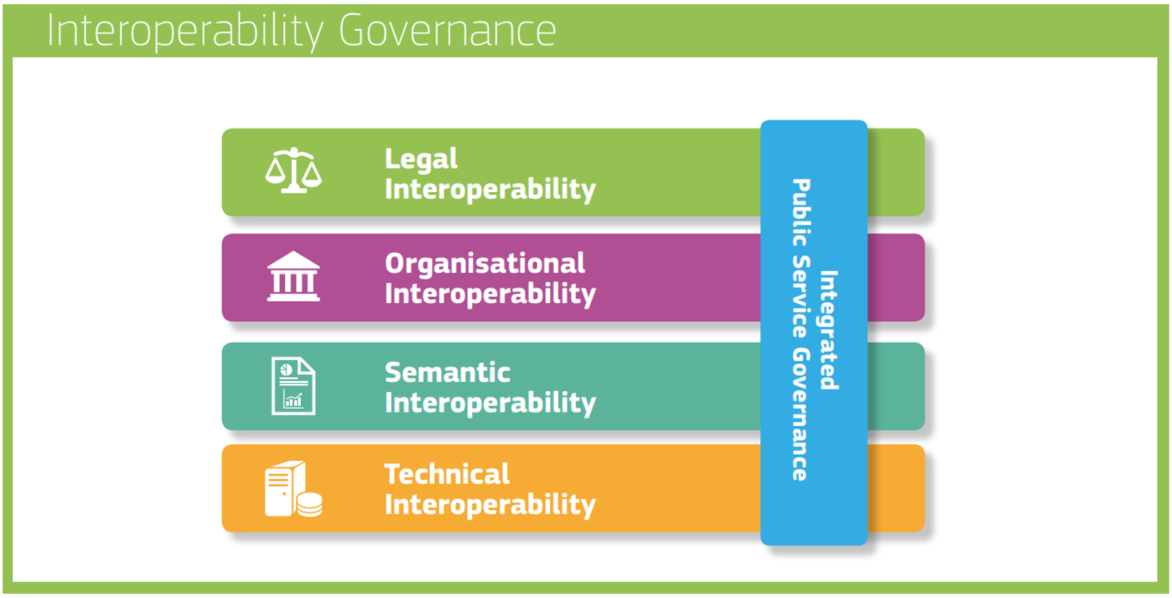

Figure 7: Layers of the European Interoperability Framework, retrieved from [10]

Legal Interoperability

The EIF's first core layer, legal interoperability, aims to ensure that organisations operating under separate legal frameworks, policies and strategies - for example organisations from different countries - are able to collaborate and co-create together effectively and without legal barriers. Therefore, it is recommended to perform thorough legal interoperability checks by screening existing legislation for such barriers [10, pp. 27–28]. In the case of this thesis, as proposed by the EIF, an interoperability check for the legal background of Public E-Procurement and, more specifically, E-Catalogues, is conducted in section 3.5.2.

Organisational Interoperability

Organisational Interoperability serves to align business processes and information exchanges between different organizations while simultaneously emphasizing user-focused services. Therefore, the requirements of all involved organizations and users must be met when integrating systems and services [10, pp. 28–29]. As such, the requirements of all stakeholders are analysed (see sections 2.3.4 and 4.1) and both the relevant business processes (see section 4.2) as well as the required information exchange perspective (see section 4.2.4) are conceptualized in this thesis.

Semantic Interoperability

The semantic layer aims to ensure both semantic and syntactic interoperability for exchanged information. The EIF proposes that exchanged data and information requires standardization that preserves the data’s structure (syntax) and meaning (semantic) throughout all exchanges between different parties. In line with this proposal, it is recommended to coordinate information management at the highest possible strategic level and utilize existing, agreed upon data standards as a base for such efforts [10, pp. 29–30]. In the context of this thesis, the information management coordination at the highest strategic level is ensured by the central XKatalog steering group with members of the Coordination Office for IT-Standards, the University of Koblenz and the CEN/TC 440 working group for Public E-Procurement (see also Figure 3). Furthermore, several agreed upon data standards and current standardization efforts are evaluated to serve as the basis for the XKatalog, especially its semantics (see chapter 5).

Technical Interoperability

The fourth and final layer, technical interoperability, encompasses all applications and infrastructures required to link systems and services. The EIF points out that, in public administrations, applications and information systems are historically developed to focus on solving domain-specific problems, resulting in fragmented islands of technologies and services that are not interoperable with each other. Consequently, the use of open specifications and standards is recommended [10, pp. 30–31]. Based on this recommendation, several open standards and specifications for Public E-Procurement serve as the basis for the XKatalog’s specification, which – in itself – is developed as an open standard for electronic catalogues as well (see section 5.2).

Integrated Public Service Governance

Across these layers, integrated public service governance aims to provide guidance on how organizations can plan, coordinate, implement and operate public services. It requires central governance steering groups to overlook and plan efforts by defining requirements, structures, roles, responsibilities and more across all four of the interoperability layers [10, pp. 25–26]. While the full contents of the EIF's integrated public service governance are beyond the scope of this thesis, the aforementioned central strategic steering group of KoSIT, Uni Koblenz and CEN/TC 440 is established to cover critical efforts such as strategic coordination, requirement engineering and interoperability evaluation across all interoperability layers for the XKatalog (see also Figure 3).

Interoperability Governance

As an all-encompassing background layer, interoperability governance includes all governing decisions on interoperability frameworks, legal policies, organizational structures, (open) standards, et cetera. Although some governing decisions are beyond the limits of this thesis, the EIF notably defines a sequential approach for the integration of standards and specifications [10, pp. 22–25] that is utilized within this work and functions as follows:

As a prerequisite, the foundation for standardized E-Catalogues is analysed (see sections 2.3.2 and 3.5). Afterwards, candidate standards for the XKatalog's base are identified and assessed (see section 3.5.4) to determine which standards should be incorporated into the XKatalog's design (see sections 4.1 and 4.3). Afterwards, compliance with the standards are constantly monitored in line with the DSR's relevance cycle (see section 2.2.1) via the iterative requirement engineering approach (see section 2.3.4) and workshops (see section 2.3.2). Subsequently, change management is conducted via several design iterations in line with the DSRM (see section 2.2.1) and documented in section 2.3.2 as well as chapter 4. Additionally, the final XKatalog standard itself is documented thoroughly in this thesis (especially chapter 4), in SeMoX and in its PDF-specification (see Appendix C: German PDF-Specification of the XKatalo).

3.3.1.2 Principles

In addition to its layers, the EIF additionally lists twelve interoperability principles that are grouped into four categories. Since not all twelve interoperability principles are of direct relevance in the scope of this thesis, only applicable principles for the XKatalog's specification are discussed below.

Core Interoperability Principles

The EIF's core interoperability principles of openness, transparency, reusability and technological neutrality are central to the XKatalog. The EIF emphasizes that the degree of a standard's openness is crucial for the reuse of software components that implement the specification. Subsequently, the specification should enable the contribution of all relevant stakeholders and be available for everyone to read and study. Transparency is another core interoperability principle that aims to ensure the visibility and availability of technical interfaces, especially within the vast landscape of heterogeneous systems in public administrations. Third, the reusability of IT-solutions, information and data is expected when developing standards such as the XKatalog to improve quality and save time and money. The last core principle, technological neutrality, establishes the importance of technology neutral implementations and data portability [10, pp. 11–15].

In-line with these core interoperability principles, the XKatalog specification receives input from many different stakeholders (see section 2.3.2) during all stages of development and will be open and available for everyone to use. Additionally, many productive standards are incorporated into the XKatalog's design to reuse existing specifications, concepts and solutions (see section 5.2). Finally, the XKatalog's interfaces, specifications and validation artifacts enable a technology neutral implementation and are going to be provided as publicly available information in the future to guarantee openness, transparency and technological neutrality.

Foundation principles for cooperation among public administrations

The EIF defines three foundational principles for the cooperation among public administrations. First, administrative simplification includes all efforts to simplify administrative processes of public administrations by improving business architecture and utilizing digital channels whenever possible. The preservation of information, although not of central importance for this thesis, relates to the way in which public administrations formulate and follow long-term preservation policies for information related to public services. Lastly, an assessment of effectiveness and efficiency for interoperability solutions should be conducted by considering user needs, costs and benefits [10, pp. 18–20].

The XKatalog incorporates these principles by improving the catalogue management process, addressing the gap between pre- and post-award, achieving high interoperability with the subsequent order and invoice standards, and, as a consequence of these improvements, leads to a significant reduction in administrative costs and burden (see section 5.5). Lastly, the assessment of the XKatalog's effectiveness in practice is identified as future research need and discussed in chapter 7.

Multilingualism

This thesis considers multilingualism as another key principle for the specification of the XKatalog. The EIF recommends that information systems and technical architectures should consider multiple languages based on the application context and expected end-users [10, p. 18]. During development, the topic of multilingualism has also been discussed in several workshops (see Table 5). Both the EIF and the findings of the workshops indicate that the XKatalog should fully support bilingualism instead of just the German language for two specific reasons. First, pre-existing standards and solutions that serve as the basis for the XKatalog (see section 3.5.4) especially the Peppol Catalogue, are English based standards that operate on a European level. While the XKatalog mainly functions as a national E-Procurement standard in Germany, open and accessible XML, PDF and Schematron based specification artifacts in English help to keep clear and close connections to the European standardization landscape. Supporting the English language enables the simple integration and reuse of pre-existing artifacts such as the UBL Catalogue 2.4 XML-Schema, Peppol and EN based Schematron rules (see section 5.4.1) as well as Peppol's specification (see section 5.2). Simultaneously, it empowers the international standardization community to read, study and improve or learn from the standard. In practice, this has already led to the XKatalog's specification contributing towards the currently unreleased EN17015-2 (see Table 5). As such, multilingualism even contributes directly towards the EIF's other interoperability principles, for instance, openness, transparency and reusability. Another example for the implementation of multilingualism as a best practice is Norway's national EHF standard family for Public E-Procurement[34] (see section 3.5.4) that also invites both Norwegian and English-speaking stakeholders to study the standard.

3.4 Standardization

The concept of standardization can generally be defined as *"the activity of establishing and recording, a limited set of solutions, to actual or potential matching problems, directed at benefits for the party or parties involved, balancing their needs, and intending and expecting that these solutions will be repeatedly or continuously used, during a certain period, by a substantial number of the parties for whom they are meant"* [77]. More specifically, Gal and Rubinfeld [78] argue that the standardization of data occurs through setting standards that relate to the data value chain. It requires a common consensus of all involved parties that regulate aspects such as attributes, terminology, structure or use

[34] See also https://ec.europa.eu/digital-building-blocks/sites/display/DIGITAL/eInvoicing+in+Norway last access: 28.11.2024

of data in a specific context, which hereby sets a standard for that data [78]. Two important concepts arise within the domain of data standardization: semantic and syntax. In literature, the discussion on the nature of semantic data has historically been quite philosophical and complex [79], [80], [81]. In contrast to this, Wood proposes to simply view semantics as "*the meaning and the use of data" [82].* As Sheth [83] points out, this definition is simple and understandable but not flawless as the terms "meaning" and "use" in itself are flexible and interpretable. Therefore, in the context of information systems and in line with [83], the semantics of data can be viewed as "the mapping between a real-world object and the way in which the object is modelled, represented and stored in an information system". This mapping can be viewed as semantics because it inherently represents the meaning and use of the real-world object [83]. The concept of data syntax, on the other hand, has led to less complex discussions in the standardization world. In its taxonomy, the European Commission proposes the definition via ISO 21849:2006[35] as the "set of rules defining the way in which data is put together with appropriate identifiers, delimiters, separator character(s), and other non-data characters to form messages"[36]. Simply put, syntax is necessary to standardize the format of messages, whereas semantics are needed to standardize its content. When both syntax and semantics are standardized, data becomes easily machine readable and interpretable [84], especially across heterogeneous systems [23]. Furthermore, it builds the foundation for further processing, validation and transformation of data (see section 5.4.1) [23]. In the public sector, standardization is a central success factor for digital transformation [9], [71]. The degree to which technical standards are open and accessible influences the ability of governments to perform electronic services both efficiently and cost effectively [71]. As such, open standards aid Governments in ensuring efficiency, transparency, and accountability as well as maintaining competitive markets and healthy economies [72].

The concept of standardization is of central importance for this thesis as the XKatalog represents a thorough standardization effort that aims to capture and define both semantics and syntax of E-Catalogue data in Public E-Procurement. Since the focus of this thesis is on capturing semantics, SeMoX is utilized as the superordinate standardization method to create semantic models that standardize mostly semantics, but

[35] https://www.iso.org/obp/ui/#iso:std:iso:14817:-1:ed-1:v1:en:term:4.59 last access: 29.11.2024

[36] https://interoperable-europe.ec.europa.eu/taxonomy/term/10270#:~:text=DEFINITION%3A,%3Aen%3Aterm%3A4.59 last access: 29.11.2024

also the syntax of data (see section 2.3.7). As such, in line with Gal et al. [78], the XKatalog's SeMoX-Model regulates and standardizes semantic aspects such as terminology, structures and rules, but also datatypes and syntax-binding (see also section 5.1). This serves as the basis for further validation (see section 5.4.1).

3.4.1 Extensible Markup Language (XML) and supporting languages

The Extensible Markup Language (XML) acts as an application profile of the Standard Generalised Markup Language (SGML)[37] and is intended for the exchange of human- and machine-readable information, historically via HMTL[38] in the World Wide Web [85]. In its most recent version 1.1, XML documents consist of different storage units called entities that contain either parsed or unparsed data. Parsed data consists of character-related data and markup. Markup encodes the description of the storage layout and defines the logical structure of the document, while character-related data contains the specific content of the document. Additionally, attributes may be used to further describe the specific content within each node. As such, parsed data is preferred over unparsed data and central to the concept of machine-to-machine communication [86]. To parse data, unparsed data must be converted into its hierarchical format (markup)[39].

XML is used throughout this thesis to specify the XKatalog-Specification in SeMoX (see section 5.2), develop the XKatalog-Test-Suite (see section 5.4.2) and implement the XKatalog-Validator (see section 5.4.1). All of the code written in XML and its supporting languages is coded and validated via IntelliJ IDEA Ultimate[40] and Oxygen[41] IDEs.

Universal Business Language (UBL)

XML can capture semantic data on its own already, however, several supporting languages have emerged over the years to support XML's semantic capabilities. In the context of this thesis, the most noteworthy of these is the Universal Business Language (UBL)[42] from OASIS[43]. UBL provides standard electronic business documents and

[37] https://www.iso.org/standard/16387.html last access: 29.11.2024

[38] https://www.w3schools.com/html/ last access: 29.11.2024

[39] https://www.ibm.com/docs/en/db2/10.5?topic=data-xml-parsing last access: 29.11.2024

[40] https://www.jetbrains.com/idea/ last access: 18.12.2024

[41] https://www.oxygenxml.com/ last access: 18.12.2024

[42] https://oasis.connectedcommunity.org/communities/tc-community-home2?CommunityKey=556949c8-dac8-40e6-bb16-018dc7ce54d6 last access: 29.11.2024

[43] https://www.oasis-open.org/ last access: 29.11.2024

information models that aid in standardizing semantics of data in specific domains. Specifically, UBL defines relevant business documents and information models that are utilized by various public E-Catalogue standards (see sections 3.5.4, 4.1 and 4.3) as syntactical and semantical foundations [87]. Among these is the UBL Catalogue[44], which is highly relevant for this thesis due to the Peppol Catalogue, which the XKatalog is based on, using UBL as the foundation for its syntax and semantics (see section 5.2).

XML-Schema

In general, data schemas are used to turn semi-structured data into fully structured, machine-readable information, e.g., through semantic enrichment [88]. There are a variety of languages that enable the definition of schema in XML, most notably XML-Document Type Definition (DTD)[45] and XML-Schema Definition (XSD)[46]. A study from 2004 by Bex et al. [89] highlights that, initially, both schema languages were mostly used in an equivalent manner in practice, although XSD has always incorporated more features and possibilities into its design. Both notations aim to define and enforce schema on XML-files; DTD is simpler in terms of features and application and stems from the aforementioned DGML that XML is based on, while XML-Schema has been the preferred Schema of the World Wide Web Consortium (W3C)[47] since its release as a (predetermined) successor to DTD [89]. Today, XSD has proven itself (partly through the improved feature capabilities pointed out in [89]) as one of the most important XML-Schema standards and is widely used throughout different application context in research and practice [90], [91], [92].
XSD in its current version 1.1[48][49] is utilized within this thesis to check whether the schema of the XKatalog's specification is in line with the SeMoX XSD and whether an XKatalog

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[44] https://docs.oasis-open.org/ubl/os-UBL-2.4/UBL-2.4.html#S-CATALOGUE last access: 29.11.2024

[45] https://www.w3schools.com/xml/xml_dtd.asp last access: 29.11.2024

[46] https://www.w3schools.com/xml/xml_schema.asp#:~:text=An%20XML%20Schema%20describes%20the,Formed%22%20and%20%22Valid%22 last access: 29.11.2024

[47] https://www.w3.org/ last access: 29.11.2024

[48] https://www.w3.org/TR/xmlschema11-1/ last access: 29.11.2024

[49] https://www.w3.org/TR/xmlschema11-2/ last access: 29.11.2024

XML-file from the test-suite is schema valid in line with the UBL Catalogue 2.4 XSD[50] (see section 5.4).

Schematron

Schematron[51] is a rule-based schema language for XML that can be used to validate business rules and, if needed, can also enforce Schema in a similar fashion as the aforementioned DTD and XSD. In contrast to DTD and XSD, however, Schematron does not construct grammatical infrastructures, but instead utilizes rule-based statements, commonly in the style of “if-then-else”, and XPath[52] as an underlying query language to navigate through elements and attributes in an XML document [93], [94]. Currently, the ISO Schematron ISO/IEC 19757-3 from 2020 is the newest version of the open-source standard[53]. To fully understand the role of Schematron for validation purposes, Erik Siegel’s simplified model on the XML validation workflow [95, Fig. 3.1] is shown in Figure 8 below. Full Validation of XML requires chronologically checking the syntax, the schema and the Schematron schema. Once the syntax is validated, the XML is well-formed, once the schema is validated, the document is schema-valid and once the Schematron schema is validated, the XML file is then considered Schematron valid. It is important to understand that, in order to achieve holistic XML validation, all three steps have to be done consecutively and without fail [95, p. 25].

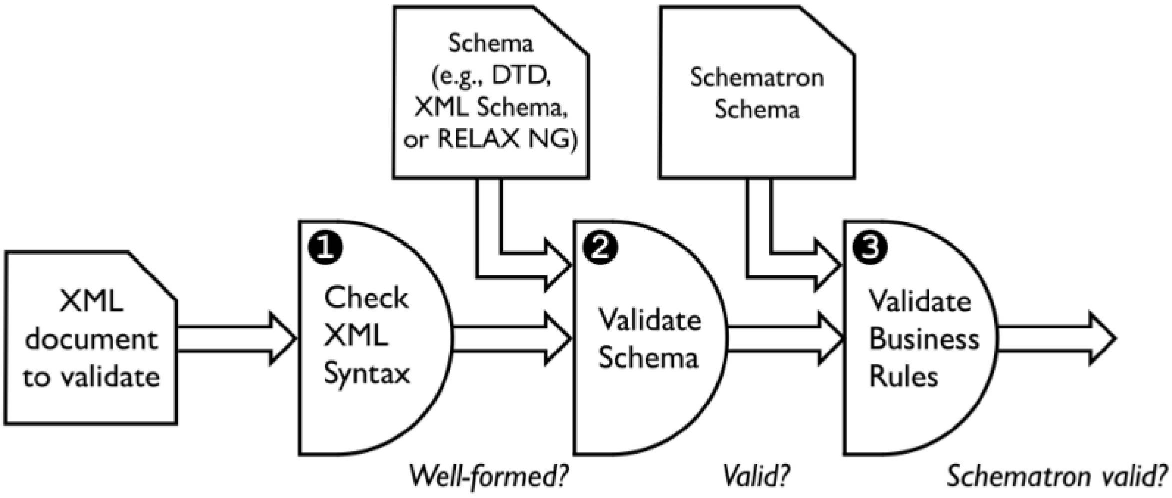

Figure 8: XML validation workflow with Schematron, retrieved from [95, Fig. 3.1]

[50] https://docs.oasis-open.org/ubl/csd01-UBL-2.4/xsd/maindoc/UBL-Catalogue-2.4.xsd last access: 29.11.2024

[51] https://schematron.com/ last access: 18.12.2024

[52] https://www.w3schools.com/xml/xpath_intro.asp last access: 18.12.2024

[53] https://www.iso.org/obp/ui/#iso:std:iso-iec:19757:-3:ed-3:v1:en last access: 18.12.2024

In this thesis, Schematron is used to validate all business rules and national extension schema for the XKatalog instances in the XKatalog-Validator. In line with Figure 8, XML Syntax is validated first for each XKatalog instance via a simple check on well-formedness by the Oxygen IDE. After testing whether an instance is schema-valid via the UBL-Catalogue 2.4 XSD, Schematron is then used to validate all relevant business rules, codelists and the national extension schema (see section 5.4.1)

3.5 Electronic Catalogues

In the following, the results of the first SLA on the status of research on and implementation of E-Catalogues in Public E-Procurement, supplemented by grey literature and insights from workshops, are discussed. Scientific status-quo (see section 3.5.1), legal frameworks (see section 3.5.2), relevant actors and systems (see section 3.5.3), as well as current E-Catalogue standards (see section 3.5.4) are discussed in the following. Consequently, this section serves as the foundation towards answering research questions one and additionally contributes towards research question two on how E-Catalogues can overcome current challenges in Public E-Procurement. The answer to RQ1 is synthesized in section 3.6, whereas the answer to RQ2 is discussed in section 4.1.

3.5.1 Scientific Grounding

One of the earliest discussions of electronic catalogues in the scientific community is conducted by Schmitz and Leukel in 2003 [96]. In their conference paper on CEN business interoperability workshops for developing electronic product catalogues, they analyse several E-Catalogue standardization efforts - such as the BMEcat (see section 3.5.4) in its beginning stages - and describe several relevant building blocks for designing an E-Catalogue standard. Based on this, the paper presents a model of e-business standardization with six levels of standardization that are as follows: data types, vocabulary, documents, processes, framework and meta model. Additionally, the authors highlight the importance of establishing multilingualism within E-Catalogues to foster cross-border trade and understanding in Europe [96]. This paper is highly relevant to this thesis because it represents the historic foundation for E-Catalogue standardization in Europe, including basic standardization levels, principles and recommendations. All presented levels of standardization in the paper are addressed within this thesis; the SeMoX specification (see section 5.2) includes data types, vocabulary and documents, whereas the application of FISAD (see chapter 4) leads to the conceptualization of architecture artefacts and models. Lastly, in line with section 3.3.1 and as presented in

[96], multilingualism is considered as a central principle for the XKatalog in both its specification and instances via the bilingualism of German and English.

Since then, most research on E-Catalogues has focused on analysing the perceived benefits and challenges of E-Catalogue usage in practice. Pekolj et al. [97] state that E-Catalogues can be used during both pre- and post-award phases in the Public E-Procurement procedure and are particularly effective when used within Dynamic Purchasing Systems and to execute framework agreements. Furthermore, the authors discuss that the implementation of E-Catalogues leads to a significant reduction in administrative burdens for both CAs and EOs because their use leads to a more effective tender preparation, comparison and evaluation that may even be automatable in the future [97]. Adding to this discussion, several other scholars note that E-Catalogues can help to make E-Procurement more transparent, effective and efficient by reducing administrative costs, increasing tender competition and bridging the gap between the pre- and post-award phases [13], [16], [98], [99]. Vaidya and Campbell point out that, in the case of Australia, E-Catalogues were able to achieve a significant, positive impact on the procurement process efficiency, especially when utilized in electronic marketplaces [17]. These findings are in-line with independent findings of [18] in Australia. A recent study in Chile from 2024 discovered that standardized electronic product catalogues for framework agreements have led to a considerable increase in supplier competition and a decrease in transaction costs by 8%, which, based on the latest statistics from 2022, equals roughly 74 million US Dollars in savings for the Chilean government [19]. Multiple articles additionally highlight that electronic catalogues can aid small and medium sized enterprises to participate in the procurement process by simplifying both the creation of a tender as well as participating in several similar procedures with little additional effort [13], [20]. In a recent study, Nurprismawan et al. further argue that an increase of SME participation in Public E-Procurement procedures with E-Catalogues will lead to a direct growth of SMEs and, as such, a significant growth of the market and the economy as a whole over time [20].

However, to realize these benefits, several barriers for E-Catalogues must be overcome. An overlying issue for E-Catalogue adoption is the absence of a coherent supporting framework for the interoperability of existing E-Catalogue solutions. While general frameworks such as the EIF (see 3.3.1) and the EIRA[54] exist in the EU, there is no interoperability framework that directly addresses how existing E-Catalogue standards and solutions can be harmonized in practice [99]. In practice, when specifying an E-Catalogue standard, the challenge is to determine both their format and content [97]. Hence, it is important to understand for which type of procedures E-Catalogues are suitable. As pointed out by [100], the public sector often also needs customized technological solutions to deliver their services, rather than 'off-thE-Catalogue' products, for which E-Catalogue solutions may not be suitable. A detailed analysis of suitable procurement procedures for the XKatalog can be found in section 4.2.1. Furthermore, when not designed and executed properly, E-Catalogues face poor adoption rates and are unable to generate any added value for the procurement process [101]. Crucially, E-Catalogues must always contain up-to-date information on the stock of available items to avoid process mistakes. Hence, E-Catalogue standards must be able to be continuously managed and updated throughout their relevant information lifecycle [98], [99]. Li and Georghiou argue that, in the case of China, E-Catalogues also require a centralized, well-regulated procurement system to be implemented to realize their full benefits. As such, E-Catalogue standards dependent on their integration into a well-functioning procurement architecture to achieve positive results [100].

In practice, the degree of E-Catalogue implementation varies between different nations in both the EU [99] and worldwide [8]. While some countries like Chile[55], Norway[56], Germany[57] and Indonesia [102] have started to actively encourage and promote the use of structured electronic catalogues, a lot of countries are lacking behind as E-Catalogue usage only happens on an ad-hoc basis or does not take place at all [8], [99]. A more detailed analysis of productive E-Catalogue standards and solutions can be found in section 3.5.4. Electronic catalogues may also be used as the basis to implement an accurate and user-friendly search function for electronic marketplaces [101]. In short, a matching algorithm can be utilized to compare a supplier's E-Catalogue against existing call for tenders, hence enabling suppliers to discover business opportunities by simply creating and maintaining electronic catalogues [103]. Lastly, Lee et al. also discusses a

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[54] https://interoperable-europe.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/interoperability-architecture-solutions last access: 27.12.2024

[55] https://www.mercadopublico.cl/Home last access: 27.12.2024

[56] https://anskaffelser.dev/postaward/g3/spec/current/catalogue-3.0/guide/ last access: 27.12.2024

[57] https://www.bme.de/services/bmecat/info/ last access: 27.12.2024

potential e-commerce content ontology for E-Catalogues that functions as a standard reference system for E-Catalogue construction and management [104]. While noteworthy to mention, it does not find application within this thesis because of its limited adoption in practice.

3.5.2 Legal Grounding

In the context of this thesis, both EU law and German law provide relevant legislative input that must be considered for the XKatalog's specification. Although the XKatalog is a national standard and would not necessarily require deep insights into European law if it just operated on a strictly German level, its harmonized specification takes the European Peppol standard as its core data model and simply extends upon it via several national extensions (see section 4.2.4). In practice, this means that an XKatalog instance without national extension is fully compatible with all syntax and schema rules set by Peppol and can be used in European tendering procedures. As such, and because of its reliance on the European Peppol core, both EU and German law is discussed hereafter.

First, it is important to note that EU law possesses the "right of primacy" over national law. In short, the right of primacy states that EU laws must take precedence over any provision of national law, especially when national and European law are conflicted, and including constitutions[58]. The right of primacy has evolved through jurisprudence of the Court of Justice of the EU, mainly seen in cases 26/62[59], 6/64[60] and C-106/89[61]. In practice, this means that European law is superordinate to German law, which is important for the legal context of Public E-Procurement.

There are two main EU directives on Public E-Procurement, 2014/24/EU [55] and 2014/25/EU [105]. Since directive 2014/25/EU is only concerned with outlier procurement procedures of entities operating in the water, energy, transport and postal services sector [105], only the directive 2014/24/EU is relevant for the XKatalog in the context of this thesis. In general, the 2014/24/EU establishes rules on Public Procurement procedures

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[58] https://eur-lex.europa.eu/EN/legal-content/glossary/primacy-of-eu-law-precedence-supremacy.html last access: 28.12.2024

[59] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:61964CJ0006 last access: 28.12.2024

[60] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A61962CJ0026 last access: 28.12.2024

[61] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A61989CJ0106 last access: 28.12.2024

with respect to all public contracts whose value is estimated to not be below certain thresholds as per article 4: 5.186.000€ for public works (a), 134.000€ for public supply and service contracts awarded by central government authorities (b) and 207.000€ for public supply and service contracts awarded by sub-central contracting authorities (c). If the estimated value of a public contract is below these thresholds, national law applies [55].
There are several mentions of electronic catalogues within the 2014/24/EU. As stated in recital 55, concerned with the landscape of several E-Catalogue island solutions, the directive states that *“Standardising the catalogue formats would thus improve the level of interoperability, enhance efficiency and would also reduce the effort required of economic operators”* [55]. Furthermore, in line with recital 68, the directive states that the use of standardized electronic catalogues, especially during framework agreements and within dynamic purchasing systems (see also 3.2.2), increases competition and leads to savings in time and money [55]. Most notably, article 36 describes rights, obligations and usage scenarios for electronic catalogues in European procurement procedures. In summary, contracting authorities may require E-Catalogues to be submitted as part of the tendering process (1) or during framework agreements (4) in accordance with the technical specifications and format that is established by the contracting authority (2). Notably, catalogues can be managed, updated and reused within the same (4) or similar (recital 68) procedures [55].

In Germany, the regulation on the award of public contracts (Vergabeverordnung - VgV) is the main legislative work that regulates the organization of competitions and the awarding of public contracts by the contracting authority that fall below the aforementioned thresholds of the 2014/24/EU directive [106]. In the VgV, article 27 defines the role of electronic catalogues in the German procurement process from a legal perspective. Similar to the EU directive, the VgV states that E-Catalogues can be included as part of the tendering process (1) and during framework agreements (3) and must be declared as necessary for the procedure during the notification phase (2). E-Catalogues can also be constantly updated during framework agreements in line with the requirements set in (3) for procurement procedures for individual contracts [106].

While both the German and European legal frameworks regulate the general context and scope for electronic catalogues, they leave freedom to the individual E-Catalogue standard specifications themselves. As of now, there are no legal obligations that force the adherence to specific E-Catalogue solutions, standards or formats in both the EU and Germany. In the future, this is likely to change due to internal, ongoing work on the

European Norm 17015[62] on electronic catalogues by the European Committee for Standardization technical working group 440 on Public E-Procurement. In its current draft, EN17015-1 specifies choreographies and EN17015-2 specifies transactions for electronic catalogues; EN17015 generally attempts to standardize electronic catalogues in a similar way to EN16931 that has already standardized electronic invoices[63]. More specifically, EN 17015-2 contains superordinate data models for the E-Catalogue transactions that will operate as top-down standards for all member states upon its release, requiring the implementation of national E-Catalogue standards that incorporate the EN's core E-Catalogue specifications with the possibility of additional national extensions in line with national requirements. As such, the internal work on the EN17015-2 is highly relevant for the XKatalog specification and several interoperability conformance checks were conducted in the workshops (see W15, W16, W18). As described in Figure 3 in section 2.3.4, this thesis aims to harmonize both European and German standardization efforts on electronic catalogues within a central IT-Governance steering group that frequently checks the XKatalog's conformance with the ongoing efforts on the EN17015 to ensure perfect interoperability once the norm releases. Based on internal documents and workshops W15, W16 and W18, the internal timetable roughly schedules the Norm's completion for Q3 of 2025, voting on the Norm in Q4 of 2025 and, should the vote be positive, the legally binding release of the EN17015 in quick succession after the ballot results are evaluated.

3.5.3 Actors and Systems

Based on sections 3.5.1 and 3.5.2 as well as the results of multiple workshops (see Table 5), several relevant actors and systems can be identified in the context of the XKatalog. In terms of relevant actors, both economic operators and contracting authorities are the two main parties that interact with each other through the XKatalog. Among other use-cases (see 4.2.3.1), the economic operator (EO) is tasked with creating and managing catalogues and sending them to the contracting authority (CA), whereas the contracting authority may browse a received catalogue to prepare an order for a required need. Furthermore, especially during framework agreements, there may be up to two additional parties involved. In addition to the EO that provides the catalogue and a CA that receives the catalogue, an additional EO may be responsible for the delivery of products or

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[62] Unpublished draft of December 2024, internal documents of CEN/TC 440

[63] https://ec.europa.eu/digital-building-blocks/sites/display/DIGITAL/EN+16931+compliance last access: 28.12.2024

services and an additional CA might pay for the products or services for the authority that receives them. Separate from these parties, a fifth actor in the form of a service provider commonly implements standards such as the XKatalog in IT-tools and systems that are possibly provided to both CAs and EOs in exchange for financial goods. As such, it is important to consider all five main actors, including their many sub-variants such as small- and medium sized enterprises (SME) as a possible EO or local public authorities as a possible CA, for the requirements and the specification of the XKatalog.

In terms of relevant systems, some island solutions already exist to cover partial use-cases of electronic catalogues. The Kaufhaus des Bundes (KDB)[64] is an electronic purchasing platform for public authorities and federal authorities and institutions, which enables public administrations to order goods and services via its online platform. To do this, economic operators must secure a framework agreement with at least one of four KDB contracting authorities and subsequently submit their electronic catalog data in either a standardized XML format (e.g. as BMEcat) or alternatively as XLS files by using an Excel template (see also 3.5.4 and 4.2.2.2). Afterwards, any CA with access to the KDB can browse the catalogues of all suppliers and order relevant products. Notably, the department stores enable suppliers to display products in a fully configurable way. This allows suppliers to offer configurable products such as computers where various components, colours and other attributes can be customized by CAs.
In addition to the KDB, there are two other standalone solutions that attempt to incorporate electronic catalogues into their workflow. First, the pre-Award Catalogue Tool (pACT)[65] from the University of Koblenz is a catalogue management tool that allows both EOs and COs to create, read, update and delete electronic catalogues that adhere to the Peppol standard (see 4.2.1.4). While mostly focused on pre-award catalogues, possible extensions for post-award catalogues, including transformation and validation components, are identified as possible additions to the catalogue management tool. Second, the Lieferantencockpit (LC)[66] is a central platform for all suppliers that have a framework agreement with the federal government, federal states or local authorities that allows EOs to upload electronic catalogues in a standardized format via a central access point for CAs. The LC also enables electronic consultation between a CA and an EO in case of questions or uncertainties and aims to implement the generation of valid Orders

[64] https://www.kdb.bund.de/KdB/DE/Startseite/home_node.html last access: 28.12.2024

[65] http://141.26.157.226/menu last access: 28.12.2024

[66] https://www.lieferantencockpit.de/ last access: 28.12.2024

out of a catalogue in the future (see also 4.2.3.2). Both the pACT and the LC are identified as possible solution components for the XKatalog's target architecture (see 4.2.3 and 4.4.2).

3.5.4 Standards

As defined in recital 68 of directive 2014/24/EU, electronic catalogue standards simply refer to *"a format for the presentation and organisation of information in a manner that is common to all the participating bidders and which lends itself to electronic treatment"* [55]. In line with this definition, from a European perspective, an electronic catalogue does not need to contain structured or machine-readable data to be considered as such; it simply requires data to be harmonized in the same format for all participating bidders, focusing on pre-award catalogues and making no distinction between a makeshift Excel sheet and a highly structured, machine-readable XML file [55]. However, in light with the rigorous foundation of this work (see sections 3.3 and 3.4), when analysing relevant electronic catalogue standards, not all electronic clustering of information into an interpretable catalogue can be considered as a relevant E-Catalogue standard in the context of this work. The degree to which information is seamlessly transferable throughout the Public E-Procurement process, especially in the post-award, depends on E-Catalogues being well-structured in a machine readable format that is interoperable with both relevant pre- and post-award procurement standards (see 4.1.1). As such, the following section discusses catalogue standards of the EU and Germany that are relevant for the XKatalog's specification.

From a European perspective, as identified in both literature [31] and practice (see W4 in Table 5), Peppol is the single most important family of Public E-Procurement standards. In general, Peppol (Pan European Public Procurement OnLine)[67] is an initiative that provides business interoperability specifications (BIS)[68] alongside an open and secure network[69] for exchanging common procurement documents such as electronic catalogues, invoices and orders. Most notably, the KoSIT uses Peppol standards as a base when developing German E-Procurement "XEinkauf"[70] standards such as the XBestellung and XRechnung by both narrowing down the Peppol standards and extending upon them based on

[67] https://peppol.org/about/ last access: 29.12.2024

[68] https://docs.peppol.eu/poacc/upgrade-3/ last access: 29.12.2024

[69] https://peppol.org/about/for-service-providers/ last access: 29.12.2024

[70] https://xeinkauf.de/ last access: 29.12.2024

national requirements (see also section 5.1). Peppol specifies both pre-[71] and post-award[72] catalogue standards for the Public E-Procurement process; in line with the KoSIT's standardization philosophy, the Peppol post-award Catalogue serves as the base for the XKatalog's specification (see W4).

Although unreleased as of now, CEN/TC 440 specifies transaction models for electronic catalogues in the current EN17015 draft of December 2024[73]. As explained in section 4.2.1.2, the EN will require all member states to adhere to its transaction specifications with the possibility of national changes upon its release. Therefore, the in-progress transaction model for the EN17015-2 post-award catalogue is also used as input for the XKatalog specification as interoperability with the EN will become crucial in the future. Since the EN17015-2 E-Catalogue transaction models consider Peppol as the main input alongside additions from the E-Procurement ontology[74], ensuring high interoperability with Peppol automatically leads to high interoperability with the EN17015 (see W15, W16, W18).

In Germany, the main E-Catalogue standard for Public E-Procurement is the BMEcat[75]. As mentioned in section 4.2.1.3, the BMEcat is already in productive use for maintaining framework agreements within the Kaufhaus des Bundes. As such, the XKatalog's specification must consider the BMEcat as a relevant E-Catalogue standard; by specifying the XKatalog based on the Peppol catalogue, existing island solutions such as the KDB are tasked with adapting to a new standard whose structure is different to the BMEcat. A step towards addressing this challenge is defining national extensions in line with national requirements to the Peppol catalogue that are based on the BMEcat's structure and semantic (see 4.1.3). In general, it is also important to note that the XKatalog is going to be part of the aforementioned XEinkauf family of standards and must therefore also consider interoperability to other XEinkauf standards such as the XBestellung outside of their common Peppol base. There are also several other, less relevant E-Catalogue standards in Germany that were analysed during the workshops. The joint committee on

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[71] https://test-docs.peppol.eu/pracc/Pre-Award_Catalogue/syntax/catalogue/tree/ last access: 29.12.2024

[72] https://docs.peppol.eu/poacc/upgrade-3/syntax/Catalogue/tree/ last access: 29.12.2024

[73] Internal documents

[74] https://docs.ted.europa.eu/EPO/latest/index.html last access: 29.12.2024

[75] https://www.bme.de/services/bmecat/info/ last access: 29.12.2024

electronics in the construction industry (GAEB)[76] catalogue is an electronic catalogue for the field of construction that is used productively in Germany. There are also different Excel templates for the KDB, the Rhineland-Palatinate Kaufhaus des Landes (KDL)[77] and the award management system (VMS)[78]. Furthermore, the BreKat[79] is another small island solution that enables contracted EOs from the furniture industry to present their goods in an electronic format to authorized CAs from Bremen[80]. While used in practice, these E-Catalogues mostly contain either generic information or aim to cover a certain niche. Hence, while interoperability is considered to be beneficial, these catalogue standards should not serve as direct input for the XKatalog (see W4).

Internationally, even more notable E-Catalogue standards exist. While considering all of these standards for the XKatalog would push beyond the scope of this thesis, some relevant standards can be described briefly in line with Pauken et al. [13]. Italy utilizes the MePa catalogue within its electronic marketplace for public authorities[81] that, according to an OECD report from 2019, has led to a significant increase in competition and considerable savings in money and time [107]. In Norway, the "Elektronisk handelsformat" (EHF)[82], standardizes both pre-[83] and post-award[84] catalogues. Similar to the German standardization philosophy of the KoSIT, EHF also bases its catalogue standards on Peppol with slight deviations for national extensions in line with national requirements. The implementation and use of the EHF catalogues has resulted in more efficient management of procedures, increased competition and a significantly higher participation of small and medium sized enterprises [13]. Both E-Catalogues are examples of European standards that are already implemented in practice to address and overcome challenges in Public E-Procurement. A more detailed analysis of both the problem scope and E-Catalogues as a solution component can be found in section 4.1.

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[76] https://www.gaeb-online.de/gaeb-phasen.html last access: 29.12.2024

[77] https://kdl.rlp.de/Ordering/Login/ last access: 29.12.2024

[78] https://www.cosinex.de/produkte/vergabemanagementsystem/ last access: 29.12.2024

[79] https://www.einkaufskatalog.bremen.de/ last access: 03.01.2024

[80] https://www.immobilien.bremen.de/einkauf-vergabe/elektronische-beschaffung/einkaufskatalog-brekat-14925 last access: 03.01.2025

[81] https://www.mepa.it/ last access: 29.12.2024

[82] https://www.digdir.no/standarder/ehf-elektronisk-handelsformat/1678 last access: 29.12.2024

[83] https://anskaffelser.dev/preaward/g2/spec/draft/pacr-1.0/ last access: 29.12.2024

[84] https://anskaffelser.dev/postaward/g3/spec/current/catalogue-3.0/ last access: 29.12.2024

3.6 Theoretical Synthesis

By synthesizing the theoretical concepts that are presented within this chapter, the rigorous foundation for the XKatalog's specification in the context of the DSR's rigor cycle can be laid. Table 8 illustrates a literature concept matrix that maps all relevant concepts and literature used to discuss these concepts. A more detailed overview of all used literature artifacts, including their relevant key findings for the scope of this thesis and their QA rating, can be found in Table 18 in the appendix.

Table 8: Literature Concept Matrix

Concept	Segment	Literature ID
Digital Transformation of the Public Sector		[1], [9], [11], [41], [42], [43]
E-Government		[1], [2], [44], [45], [46]
Public Procurement		[3], [7]
Public E-Procurement	Definition	[47]
	Fundamental aspects	[4], [7], [8], [31], [48]
	Procedure	[5], [6], [12], [21], [22], [49]
	Dynamic Purchasing Systems	[50], [51], [52], [53], [54], [55]
	SLA RQ2: Regulatory issues	[56], [57], [58], [59], [60], [61]
	SLA RQ2: SME related issues	[15], [57], [62], [63], [64], [65], [66]
	SLA RQ2: Cyber- and data security Issues	[62], [63], [67], [70], [73]
	SLA RQ2: Interoperability and Standardization Issues	[11], [13], [16], [23], [57], [63], [70], [72]
	SLA RQ2: Stakeholder related issues	[58], [59], [62], [64], [69]
	SLA RQ2: Change resistance	[60], [61], [62], [67], [69], [73]
Interoperability	Fundamental aspects	[10], [43], [71], [74],

		[75], [76]
	Principles and Layers	[10]
Standardization	Definition	[77], [78]
	Data Semantics	[23], [79], [80], [81], [82], [83], [84]
	Open Standards	[71], [72]
	Extensible Markup Language and supporting languages	[85], [88], [89], [90], [91], [92], [93], [94], [95]
Electronic Catalogues	Overview	[13], [17], [96], [97]
	Benefits	[13], [16], [17], [18], [19], [20], [98], [99]
	Challenges	[97], [98], [99], [100], [101]
	Implementation	[8], [99], [101], [102], [103], [104]

Furthermore, Figure 9 visualizes the relationships between the different concepts of this thesis. Most main concepts are directly interrelated with each other, especially through interoperability and standardization. The digital transformation of the public sector requires holistic standardization efforts to overcome interoperability issues that manifest themselves in common principles and layers. It directly relates to the domain of E-Government and influences the digitalization of Public Procurement in the form of Public E-Procurement. As such, E-Government, too, aims to achieve a high adoption of electronic government systems and services, thereby also requiring these solutions to be compatible with existing technologies through interoperability and standardization. Hence, Public E-Procurement is heavily influenced by the concepts of Public Procurement, E-Government and digital transformation. Digitalizing Public Procurement has led to electronic solutions such as dynamic purchasing systems, electronic procedures that are based on such electronic tools and systems, and a new, distinct problem environment. For instance, Public E-Procurement solutions are tasked with addressing interoperability issues that arise repeatedly due to the everlasting influx of newly implemented technologies used to reduce administrative costs and increase the efficiency of procurement procedures. Without standardization, especially through open standards, these solutions in the form of tools and systems are unable to communicate and exchange data effectively with each other. Public E-Procurement standards such as electronic catalogues therefore require the definition of appropriate, interoperable data syntax and semantics. Consequently, common barriers can be overcome and a reduction in administrative costs and burdens for both Economic Operators and Contracting Authorities achieved.

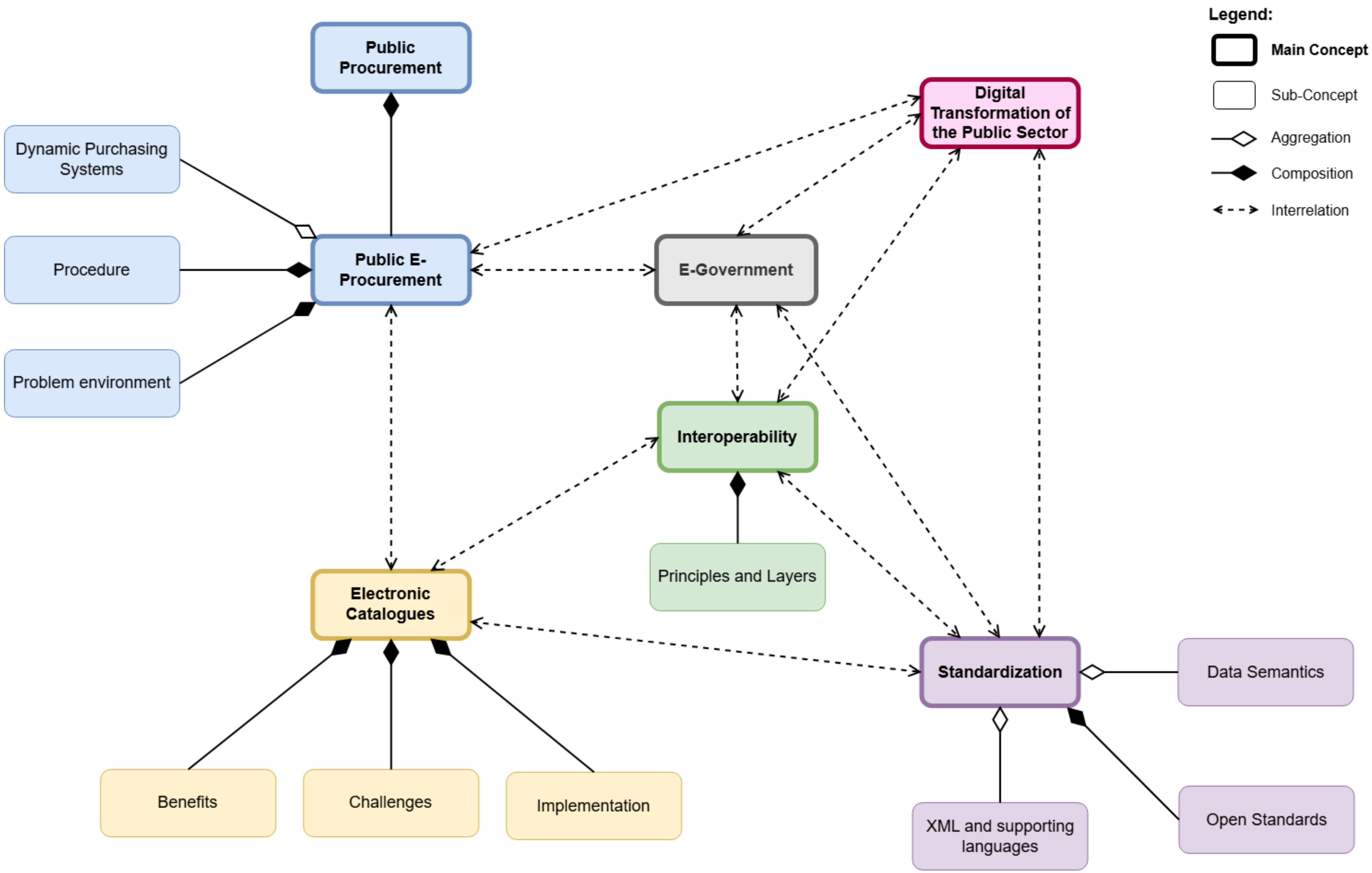

Figure 9: Concept map of key research themes, own depiction

Lastly, as a results of this synthesis, particularly through the structured literature analysis of the current status of research on and implementation of electronic catalogues in Public E-Procurement, research question one can be answered. While this chapter has also examined the scientific problem environment for Public E-Procurement in the context of RQ2 (see section 3.2.3), the synthetic discussion towards answering the second research question is placed in section 4.1.

The concept of electronic catalogues has existed in Public E-Procurement for roughly 20 years in both literature and law. The findings of the CEN/BII workshop on electronic catalogues, communicated through scientific publications such as that of Schmitz and Leukel [96], represents the historical foundation for electronic catalogues in literature. The first relevant legislative mention of E-Catalogues appears in article 12 of directive 2004/18/EC [52], which has since been superseded by directive 2014/24/EU [55]. In contrast to the paper of Schmitz and Leukel, today's research places less emphasis on how to optimally design E-Catalogue standards and instead highlights the direct benefits that can be achieved through their implementation. While several scholars continue to discuss the necessity of specifying E-Catalogue standards that harmonize the current Public E-Procurement landscape to achieve significant impact [97], [99], [100], [101], current research also analyses both the direct potential and benefits of E-Catalogues in practice [19], [20], [97] as well as innovative solutions that build upon E-Catalogue implementation [103]. While the results of both the Structured Literature Analysis and the workshops confirm that E-Catalogue adoption and implementation is not optimal, some countries like Chile, Norway, Italy and Germany (see sections 2.3.2, 3.5.1 and 3.5.4) have started to utilize E-Catalogues to realize significant benefits. Most notably, Olivares et al. [19] have researched that the usage of E-Catalogues in framework agreements has led to 8% savings in total spendings for framework agreements. When applied to all framework agreement procedures, this would amount to 74 million US Dollars in savings from a total of 924.4 million US Dollars spent [19]. While there is no data on the current expenditures for framework agreements in Germany, extrapolations by the OECD suggests that Germany has generated total government procurement spendings of over 900 billion US Dollars[85] in 2022. Although no concrete estimations can be made because of the lack of

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[85] https://data-explorer.oecd.org/vis?tm=public%20procurement&pg=0&snb=33&vw=tb&df[ds]=dsDisseminateFin

data on German framework agreement expenditures and the limited comparability between Germany and Chile, achieving a similar percentage of transaction cost savings would lead to highly significant reduction of procurement costs for Germany as well.
In terms of productively used E-Catalogue standards, two are highly significant in the scope of this thesis: the Peppol Catalogue and the BMEcat. Although still limited in its utilization in the scope of Public E-Procurement as a whole, the BMEcat is used in Germany to cover some framework agreements via the KDB. However, since the Coordination Office for IT-Standards roots its Public E-Procurement standards in the national adaption of Peppol standards, and other productive post-award standards such as the XBestellung und XRechnung also follow this principle, the XKatalog must consider the Peppol Catalogue as the foundation for its specification. This is further cemented by the upcoming EN17015's basis on Peppol with additions from the Public E-Procurement ontology. Nevertheless, national extensions to the Peppol Catalogue should follow the syntax and semantics of the BMEcat. Finally, continuous reviews of whether the XKatalog's specification is in line with the upcoming EN17015's E-Catalogue transaction models are needed. A more comprehensive discussion for foundational requirements, extrapolated from literature, law and practice in the context of research questions one and two, can be found in section 4.1.

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alDMZ&df[id]=DSD_GOV%40DF_GOV_PPROC_2023&df[ag]=OECD.GOV.GIP&df[vs]=1.0&dq=A.DEU.GPROC....&pd=%2C&to[TIME_PERIOD]=false last access: 30.12.2024

4 Architectural considerations and requirements

In this chapter, the application of FISAD onto the XKatalog leads to comprehensive architectural considerations and requirements. Although the XKatalog simply represents the specification of a data standard, thereby mostly concerned with its baseline and target data perspective, employing FISAD contributes towards a more holistic understanding of its interoperability as a whole. Considering all architectural layers is imperative to synthesize what the XKatalog must, should or could do to achieve utmost interoperability within a given architectural perspective. Consequently, compatibility to legacy processes and systems must be carefully balanced with target visions and requires iterative design and requirement review and consolidation (see sections 2.3.2 and 2.3.4). Since the scope of this thesis is not on providing a technologically neutral target architecture but rather consider how the XKatalog as a technology neutral data standard can be integrated into productive use with existing solution components, the target architecture builds upon relevant target systems as identified during workshop W17 (see also section 3.5.3), namely the pre Award Catalogue Tool and Lieferantencockpit. However, all requirements are formulated to be technology neutral to illustrate that no dependence on existing technologies is desired, and specific technologies of the target architecture simply serve to consider the XKatalog's feasibility in practice.

In the following, the XKatalog's foundation synthesizes results of the DSR's rigor and relevance cycles in section 4.1 to discuss and answer research question two on how standardized E-Catalogues can overcome certain barriers in Public E-Procurement. This synthesizes, alongside requirements that stem from it (see section 4.1.3), is fundamental to all further FISAD perspectives. As such, subsequently, the baseline and target architectures are discussed for the business (see section 4.2), data (see section 4.3), application (see section 4.4), and technical (see section 4.5) perspectives and requirements deduced. A synthesis of all FISAD perspectives and requirements is placed in section 4.6.

4.1 Foundation

In this section, architectural foundations are discussed. Section 4.1.1 synthesizes the XKatalog's problem scope, whereas section 4.1.2 illustrates how the XKatalog can be utilized to overcome these challenges. Furthermore, requirements are derived from these considerations and illustrated in section 4.1.3. Consequently, this section directly addresses and answers research question two.

4.1.1 Problem Scope

When synthesizing the scientific findings of the rigor cycle (see chapter 3, particularly sections 3.2.3 and 3.5) with the results of the relevance cycle (see section 2.3.2), a vast landscape of current issues in Public E-Procurement can be identified. Upfront, it is important to note that the XKatalog is a data centred standard for electronic catalogues. As such, it cannot address all challenges of Public E-Procurement. For the sake of interoperability, however, being informed about the general problem environment of Public E-Procurement from a scientific, legal and relevant perspective helps the standard to identify which problems it can directly address, which ones it must be aware of, and which ones are of no direct concern for its existence. Interoperability must be analysed through a holistic lens, by considering all of its layers (see section 3.3.1.1) and considering all of its core principles (see section 3.3.1.2) [10]. Hence, to contribute towards answering research question two, how current challenges in Public E-Procurement can be overcome through standardized E-Catalogues, an evaluation of Public E-Procurement's applicable problem environment in the scope of standardized E-Catalogues is conducted within this section. Subsequently, section 4.1.2 elaborates on the role of the XKatalog as a solution component to the herewith presented context.

When narrowed down to the scope of this thesis, only a portion of the presented challenges are directly addressable by an electronic catalogue standard. For instance, the XKatalog is aware of the regulatory issues that present a significant barrier towards the adoption of Public E-Procurement solutions. Studies such as [60] illustrate that in some cases, adoption can only be achieved through explicit legislation and not simply through the specification of perfectly interoperable standards with open-source components. While this issue is significant, no legislation can be deduced from this thesis; the XKatalog depends on legislation from other actors, outside of the scope of this thesis. Fortunately, due to the EN17015's current development by CEN/TC 440, a significant regulation for electronic catalogues, is likely set to come during 2025 (see also section 3.5.2). Closely related, scholarly discussions on change resistance [59], [62], [64], [69] add onto these assumptions, indicating that, even after further refinement through the KoSIT, the XKatalog will not face significant adoption rates immediately. Furthermore, the specification of a data standard cannot solve problems in the domains of cyber- and data security issues such as preventing data tampering and ensuring information confidentiality on its own [67], [68], [69]. However, architectural considerations such as secure protocols for transferring messages and files between systems (see section 4.4.2) within a robust technical infrastructure (see section 4.5.2) help to overcome such barriers.

Whereas the XKatalog cannot contribute towards overcoming these barriers on its own, other challenges can be addressed directly through its specification and future integration into practice. Figure 10 illustrates an overview of all issues that are directly within the scope of the XKatalog as an E-Catalogue standard. While some interoperable standards are used in practice already (see section 3.2.1.2) and the overall process flow is harmonized to a satisfying degree [12], [49], the data transformation flow is not fully standardized yet. As highlighted by multiple scholars [11], [13], [16], there is a gap between the pre- and post-award phases of Public E-Procurement that leads to a series of further issues. Common problems include media disruptions, information inconsistencies and the subsequent disproportionate administrative burden are significant problems that arise during the transition from pre- to post-award. This leads to higher costs, less process efficiency and less interest from EOs to participate in Public Procurement procedures [11], [13], [16]. Notably, accounts from literature [16], [65], [66] and practice [15] highlight that, due to these barriers, SMEs struggle to participate in Public E-Procurement procedures at all; despite making up most of the business-added-value in the EU[86], a significant portion of this value remains unrealized for Public E-Procurement. Furthermore, findings from Workshop W25 suggest that a lack of standardization additionally occurs during the very beginning of the pre-award procedure. Since the specification of needs and requirements is often captured in unstructured Word or PDF documents, the data cannot be reused across later processes and no validation or transformation is possible.

[86] https://single-market-economy.ec.europa.eu/document/download/b7d8f71f-4784-4537-8ecf-7f4b53d5fe24_en?filename=Annual%20Report%20on%20European%20SMEs%202023_FINAL.pdf see p.3, Last access: 29.12.2024

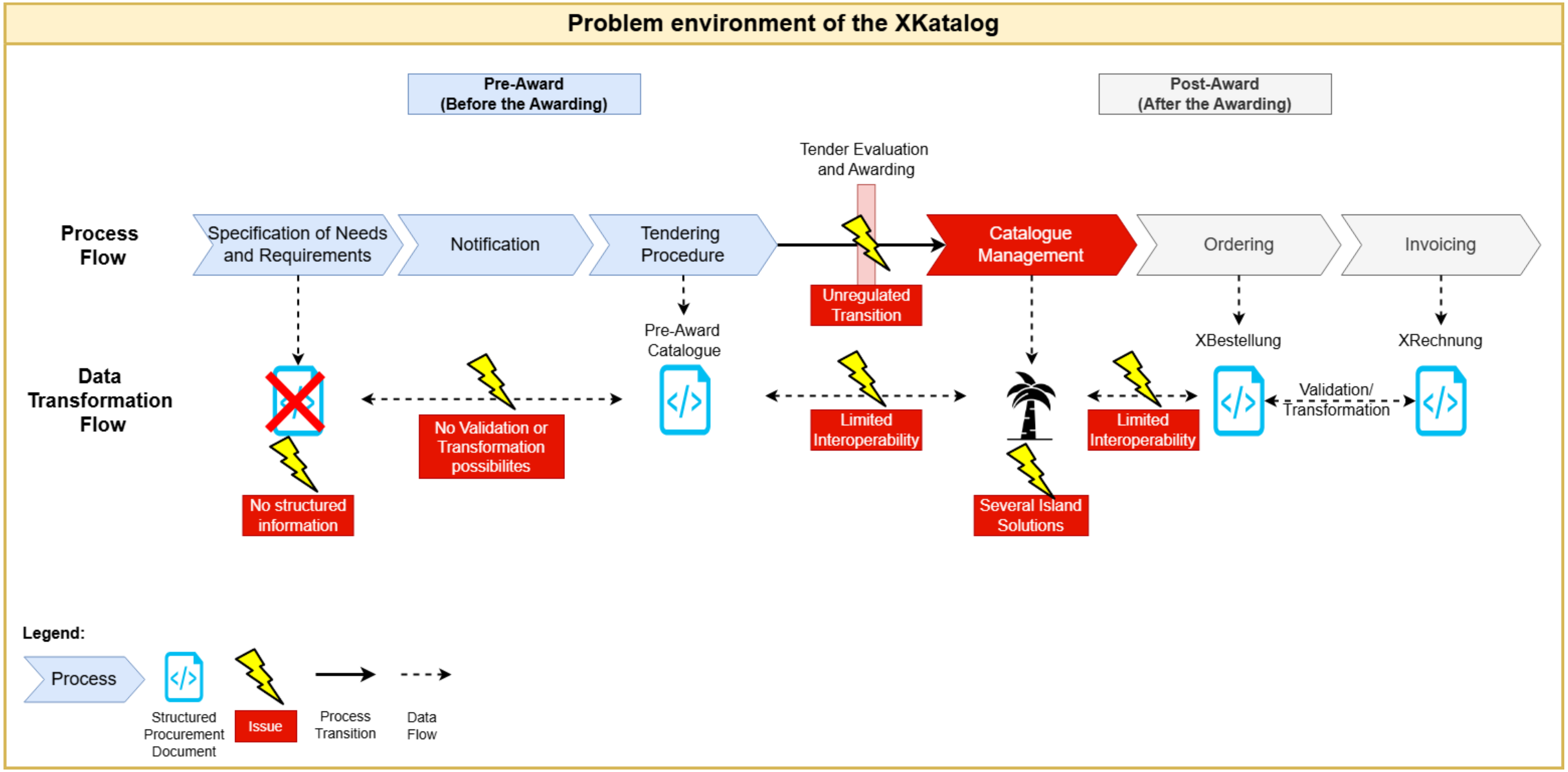

Figure 10: Synthesized problem environment of the XKatalog, own depiction

4.1.2 Solution Objectives

Considering the SLA's findings on E-Catalogues within the DSR's rigor cycle (see section 3.5), the workshops' and interview's results on the XKatalog's role in practice within the DSR's relevance cycle (see sections 2.3.2 and 2.3.3), and the synthesis of the standard's problem environment, an evaluation of how the XKatalog can overcome relevant issues in Public E-Procurement can be conducted. Hence, the answer to research question two is discussed in the following.

As argued by Renzo Kottmann of the Coordination Office for IT-Standards in Germany during interview one, standardized E-Catalogues can serve as the main interface between the pre- and post-award phases and thus significantly contribute towards harmonizing the whole procedure (see Appendix B: Interview Transcripts).

"Diese Kette fest als Gesamtheit zu denken, das ist genau der Katalog in diesen zwei Formen, <u>die Schnittstelle</u>, um diese Gesamtheit hinzukriegen. Konkret heißt es eben, dass dann viel effizienter […] für die öffentliche Verwaltung bestell[t] [werden] kann."

Recent scientific discussions in literature confirm this potential [13], [16] and highlight electronic catalogues as a crucial solution component for increasing process efficiency and competition while simultaneously reducing administrative costs [13], [98], [99]. This is further cemented in European legislation within recitals 55 and 68 of directive 2014/24/EU [55], the currently unreleased EN17015 and article 27 of the German VgV [106]. Most notably, as presented in Figure 11, the specification of the XKatalog as a standardized E-Catalogue contributes significantly towards improving the Public E-Procurement procedure's data transformation flow. Through its integration, data can be transferred seamlessly from the pre-award Catalogue to the XKatalog, which can then be carried over towards the XBestellung and XRechnung, thus harmonizing the procedure's most crucial data transformation flow and bridging the gap between the pre- and post-award. While the standard cannot entirely solve the pre-award specific problems that arise from a lack of structured documents at the very beginning of the Public E-Procurement procedure, in accordance with relevant findings from Workshop W25, it can contribute towards reusing structured catalogue data during subsequent procedures with similar procurement needs. Furthermore, overcoming these challenges via the XKatalog has direct implications for the currently low participation of SMEs. The integration of standardized E-Catalogues into the procedure can reduce transaction costs [17], [18], [19], ease the participation of SMEs across several similar procedures [20], and thus lead to a higher competition as well as a growing market [13], [16], [20]. Additionally, although not of central importance for Germany itself, as noted by Schmitz and Leukel [96], establishing multilingualism within the E-Catalogue standard may help to further promote understanding across member states in Europe in the future. This is further cemented through the EIF as one of its central interoperability principles [10, principle 9]. Since Norway's EHF catalogue standards are readable in English, they have contributed towards gaining a better understanding for the national specification of the XKatalog based on Peppol; hence, the XKatalog should also be available in both English and German. Finally, the availability of open, structured and high-quality E-Catalogue procurement data may prospectively lead to an increase in transparency, a reduction in dubious procurement activities and an overall healthier economy [72].

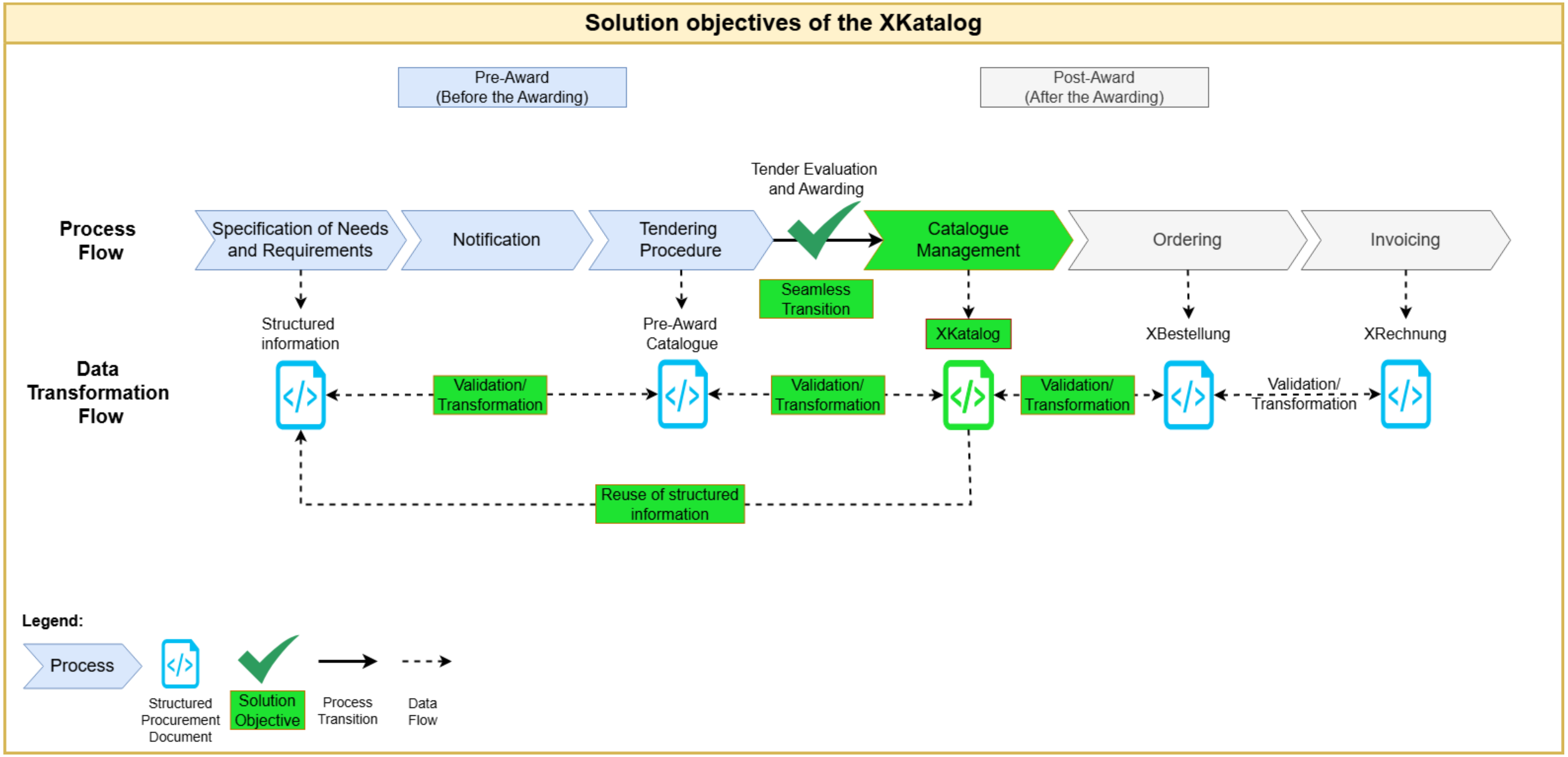

Figure 11: Synthesized solution objectives of the XKatalog, own depiction

4.1.3 Resulting Requirements

In accordance with the DSR's rigorous and relevant findings that are synthesized in sections 4.1.1 and 4.1.2, fundamental requirements for the XKatalog's specification can be derived from both scientific literature and the relevant application context. Hence, these requirements aim to describe general needs that arise from the analysis of the XKatalog's architectural foundation and are illustrated in Table 9. Most notably, the XKatalog must fix the data transformation and validation flow by bridging the gap between pre- and post-award phases, which requires interoperability with existing Public E-Procurement standards. As a result, a seamless process transition must be achieved, transaction costs reduced, and competition increased.

Table 9: XKatalog requirements derived from the foundation

ID	Title	Description	Priority			Origin (References)
			Must-Have	Should-Have	Nice-to-Have	
F-REQ-1	Reduce transaction costs	The XKatalog must contribute towards reducing transaction costs for Public E-Procurement procedures.	X			[17], [18], [19]
F-REQ-2	Fix the data validation/transformation flow	The XKatalog must bridge the gaps in Public E-Procurement's data validation and transformation flow, most crucially between the pre- and post-award phases.	X			[13], [16]; Interview 1
F-REQ-3	Achieve a seamless process transition	The XKatalog must contribute towards a seamless process transition from pre- to post-award.	X			[13], [16]; Interview T1
F-REQ-4	Ensure compatibility with existing standards	Compatibility with existing Public E-Procurement standards must be ensured. This includes the Peppol pre-award Catalogue, the XBestellung/XRechnung and	X			W4; Figure 11

		other productively used E-Catalogue standards in Germany such as the BMEcat.				
F-REQ-5	Increase competition	The XKatalog should contribute towards an increase in competition during Public E-Procurement procedures.		X		[13], [16], [20]
F-REQ-6	Increase SME participation	The XKatalog should contribute towards increasing the participation of SMEs in Public E-Procurement procedures.		X		[20]
F-REQ-7	Improve data quality for the specification of needs and requirements	The XKatalog's contribution towards reusing structured information for the specification of needs and requirements in across similar procedures is desirable.			X	W25
F-REQ-8	Enable multilingualism	The XKatalog should enable multilingualism to foster cross-border understanding of E-Catalogues in Europe.		X		[10, principle 9], [96]

4.2 Business Perspective

In the following, architectural considerations on the XKatalog's business perspective are analysed. First, an overview of the suitability of E-Catalogues for different kinds of Public E-Procurement procedures is provided (see section 4.2.1). Afterwards, the baseline (see section 4.2.2) and target architecture (see section 4.2.3) discuss use-cases and processes for electronic catalogues, from which requirements are synthesized in section 4.2.4.

4.2.1 Overview

Upfront, as illustrated in Figure 12, it is important to note that standardized electronic catalogues are not suitable for every type of procedure. As highlighted in section 3.2.1, contracting authorities may choose to procure either products, works or services, each having their own legislative rules and peculiarities. In line with internal findings project findings[87], in Germany, E-Catalogues are suitable for all kinds of product procurements, most kinds of work procurements and no kinds of service procurements. When procuring products, if the procedure is a one-time only procurement, the use of E-Catalogues within an open procedure is advised; otherwise, the use of E-Catalogues within DPS is recommended. When procuring works, the procedure can be classified as either simple or complex based on its scope and environmental factors. During a complex procedure, if a catalogue cannot capture the contents of the procured works, its usage is not advised; otherwise, its usage is advised in a DPS. During a simple procedure, if qualification is needed, its usage is once again recommended within a DPS, and if no qualification is required, its usage is advised during an open procedure. In terms of service procurements, both internal project findings and scientific discussions in literature [100] point towards electronic catalogues not being suitable for service procurement due to their current scope, state and format. The main scope of the XKatalog is to act as a product catalogue within both open procedures and DPS.

[87] Internal documentation of „Kooperationsprojekt zur Digitalisierung der Beschaffung"

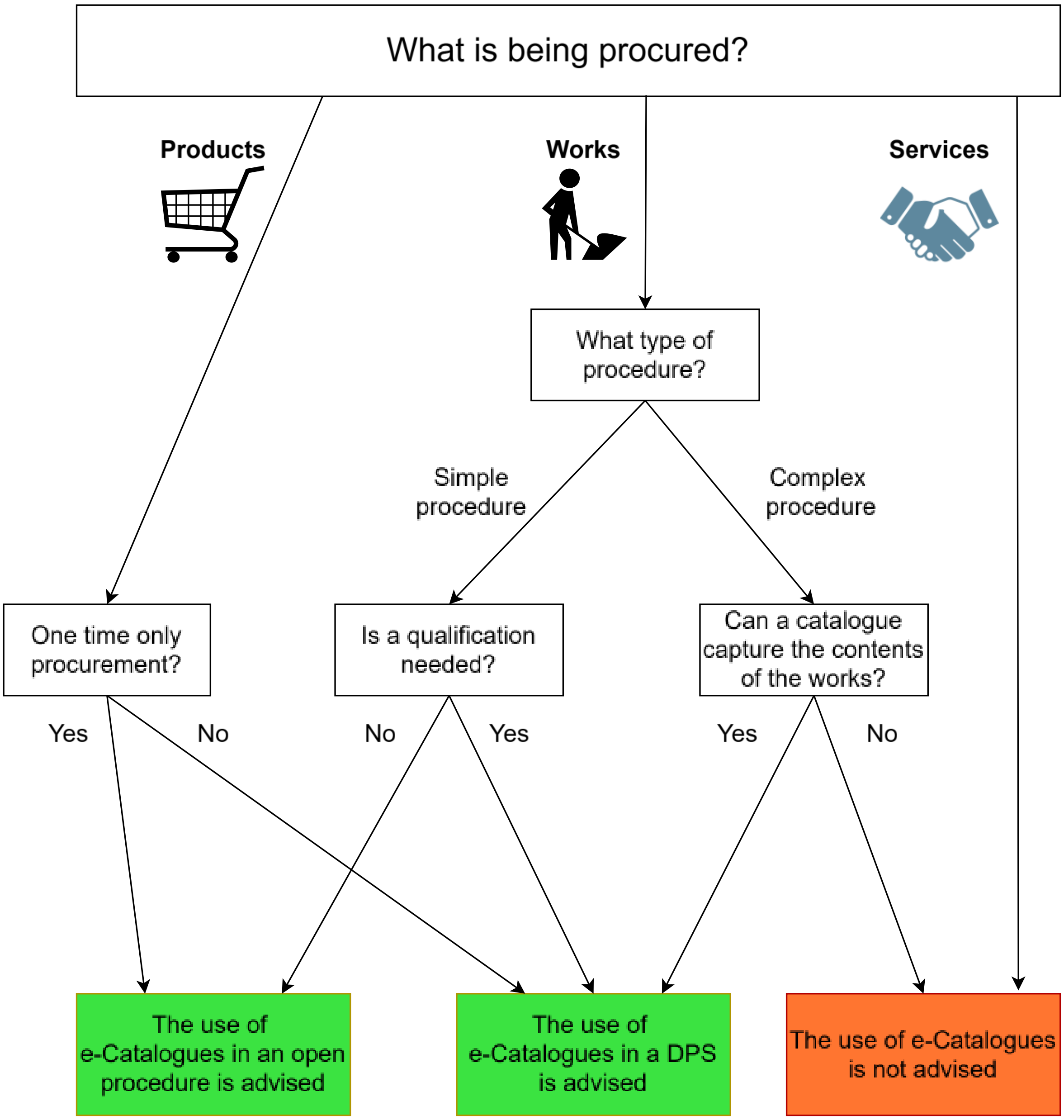

Figure 12: Relevant Procedures for E-Catalogues, own depiction based on internal project documents

4.2.2 Baseline Architecture

In this section, the XKatalog's baseline business architecture is discussed. Currently, the BMEcat is used by some EOs to execute framework agreements with one of four CAs in Germany to offer their products within the KDB. In the following, an in-depth analysis of this baseline is conducted.

4.2.2.1 Use-Cases

Based on Workshops W6 and W25, Figure 13 depicts the baseline use-cases of standardized E-Catalogues in Germany. There are two limitations that must be discussed upfront. First, EOs must establish a framework agreement with a representative CA of the KDB as post-award E-Catalogues are only used productively when executing such framework agreements within the KDB. Second, only product procurements are conducted in practice; the procurement of works or services is currently not in scope of the KDB. Once a framework agreement for products is established, an authorized EO must manually create an E-Catalogue in the format of a BMEcat, manually validate the result and manually upload it to the KDB. Afterwards, a CA with access to the KDB can browse the available catalogues of all EOs and choose suitable products. Subsequently, an electronic order is created and sent to the relevant EOs via the KDB.

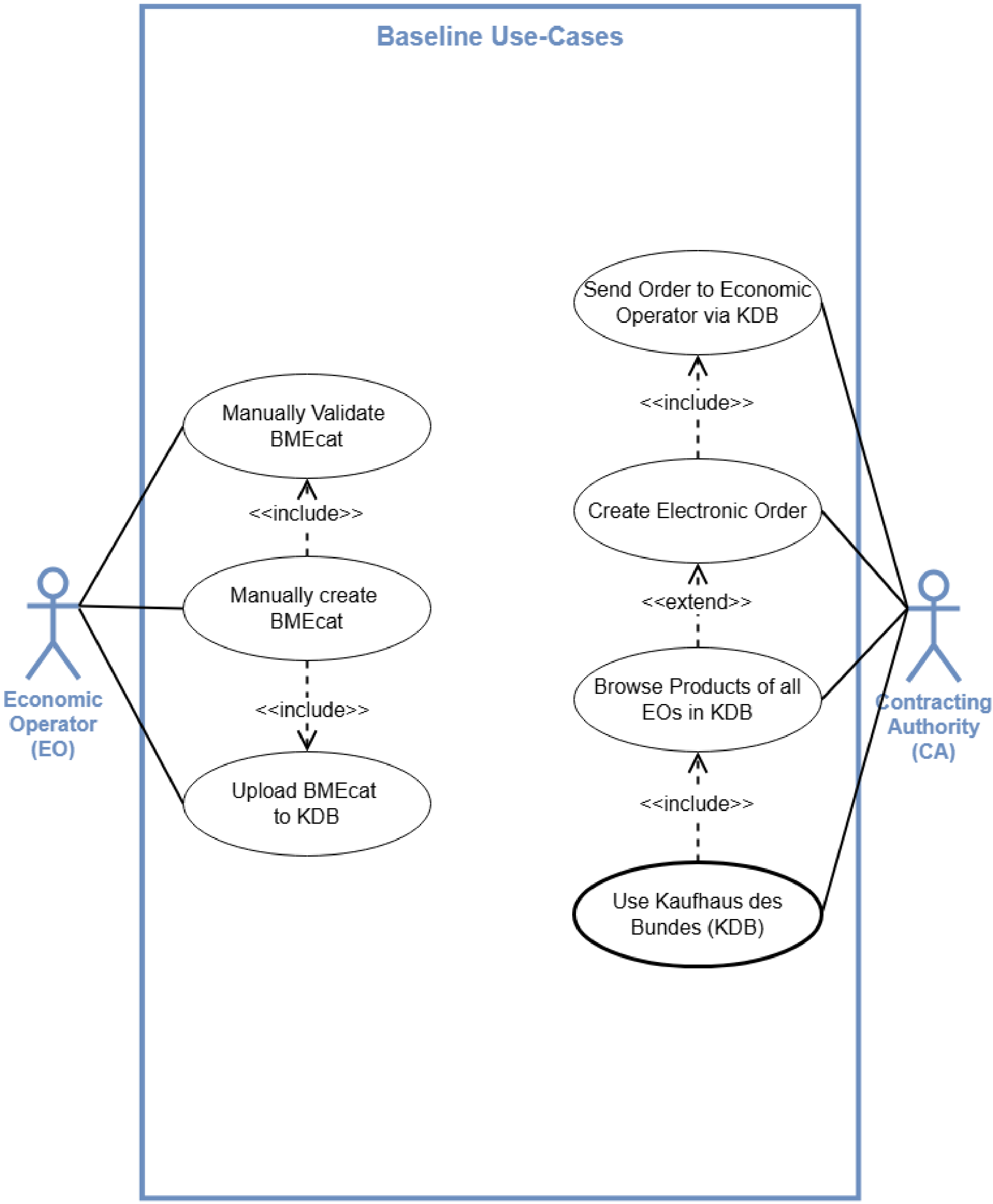

Figure 13: Baseline Use-Cases, own depiction based on workshops W6 and W25

4.2.2.2 Business Process

Based on findings of workshops W4 and W25 as well as the KDB's short specification[88], the baseline business process for E-Catalogues in Germany is described in Figure 14 and Figure 15. First, EOs must establish a framework agreement with one of four CAs of the KDB, the "Beschaffungsamt des Bundesministeriums des Inneren (BMI)", the "Bundesanstalt für Materialforschung und –prüfung (BAM)", the "Bundesfinanzdirektion Südwest" or the "Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr (BAAINBw)". Once the framework agreement is established, the EO must manually create and validate a BMEcat based on the products he wants to sell in the KDB. Subsequently, the EO can request and receive access to the KDB based on the framework agreement to upload the BMEcat. All CAs with intend to procure may request access to the KDB to browse the products of all EOs with framework agreements to prepare and conduct orders. As a result, the KDB automatically creates an electronic order and sends it to the EO, thereby ending the process.

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88 https://www.verwaltung-innovativ.de/SharedDocs/Publikationen/Artikel/broschuere_kaufhaus_des_bundes.pdf?__blob=publicationFile&v=3 last access: 03.01.2025

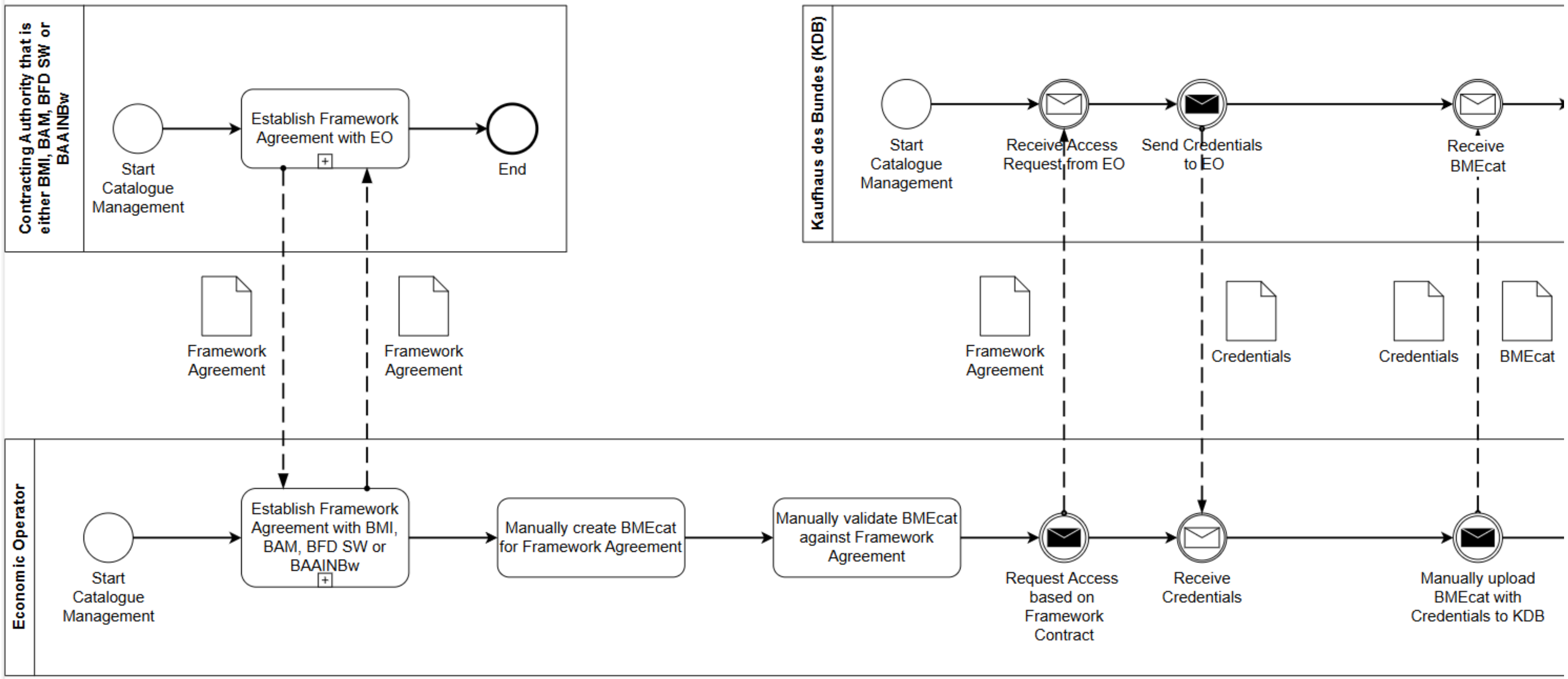

Figure 14: Baseline Catalogue Management Process 1/2, own depiction based on workshops W6 and W25

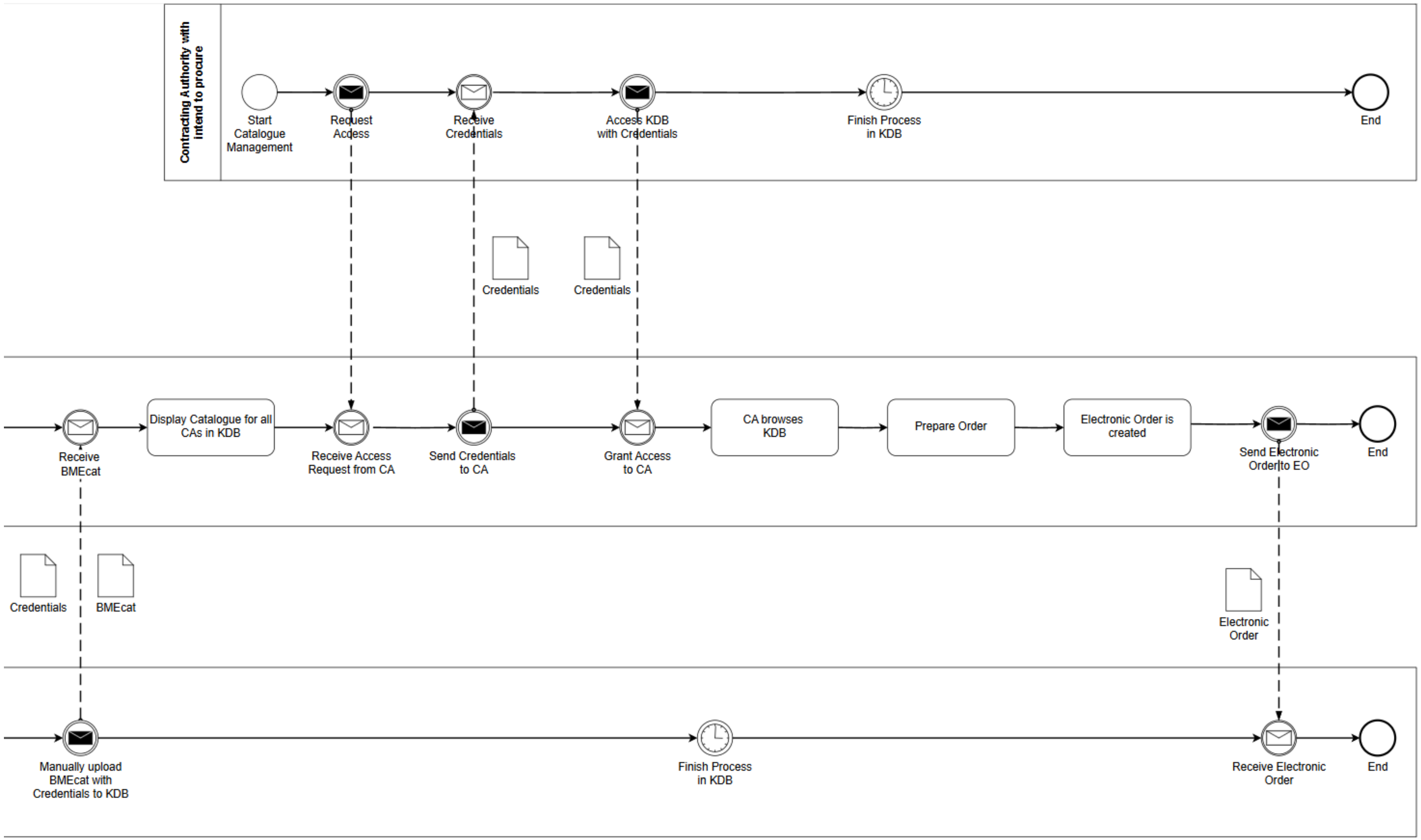

Figure 15: Baseline Catalogue Management Process 2/2, own depiction based on workshops W6 and W25

4.2.3 Target Architecture

The business perspective's target architecture is analysed in the following. Relevant actors and systems include EOs and CAs that may use the XKatalog for a streamlined Public E-Procurement via the pre-Award Catalogue Tool and Lieferantencockpit. Currently, both the pACT and LC do not yet have the required capabilities to realize the target architecture. However, results of workshop W23 demonstrate that, with just a few technological additions to these systems, it will become feasible in practice. Lastly, it is imperative to highlight that the baseline business architecture is limited, and while legacy compatibility to the KDB should be maintained, utilization of the XKatalog must improve the Public E-Procurement process as a whole, and not just the execution of framework agreements within the KDB.

4.2.3.1 Use-Cases

In line with workshops W6 and W25, Figure 16 illustrates all target use-cases for the XKatalog. In contrast to the baseline, the scenarios should not be restricted to framework agreement procurements within the KDB but apply to all types of procedure by utilizing other, less limiting technological solutions. In the scope of this thesis, both the pACT and LC are identified as possible solution components for executing the XKatalog's target use-cases in practice. An EO may use the pACT to continuously manage all of their E-Catalogues over time. This includes CRUD operations (create, read, update, delete) for all catalogues as well as the possibility to automatically transform a pre-award Catalogue such as the Peppol pre-award Catalogue into an XKatalog. Furthermore, all XKatalog instances can be validated and sent automatically to corresponding CAs with intent to purchase via an interface with the LC. A CA may subsequently use the LC to browse the provided catalogue and prepare his order with suitable products or works. Once this is done, the XKatalog can automatically be transformed into the XBestellung, which is automatically validated before being sent to the EO. Additionally, the CA may request and receive consultation from the EO at any given time if needed during the shopping process.

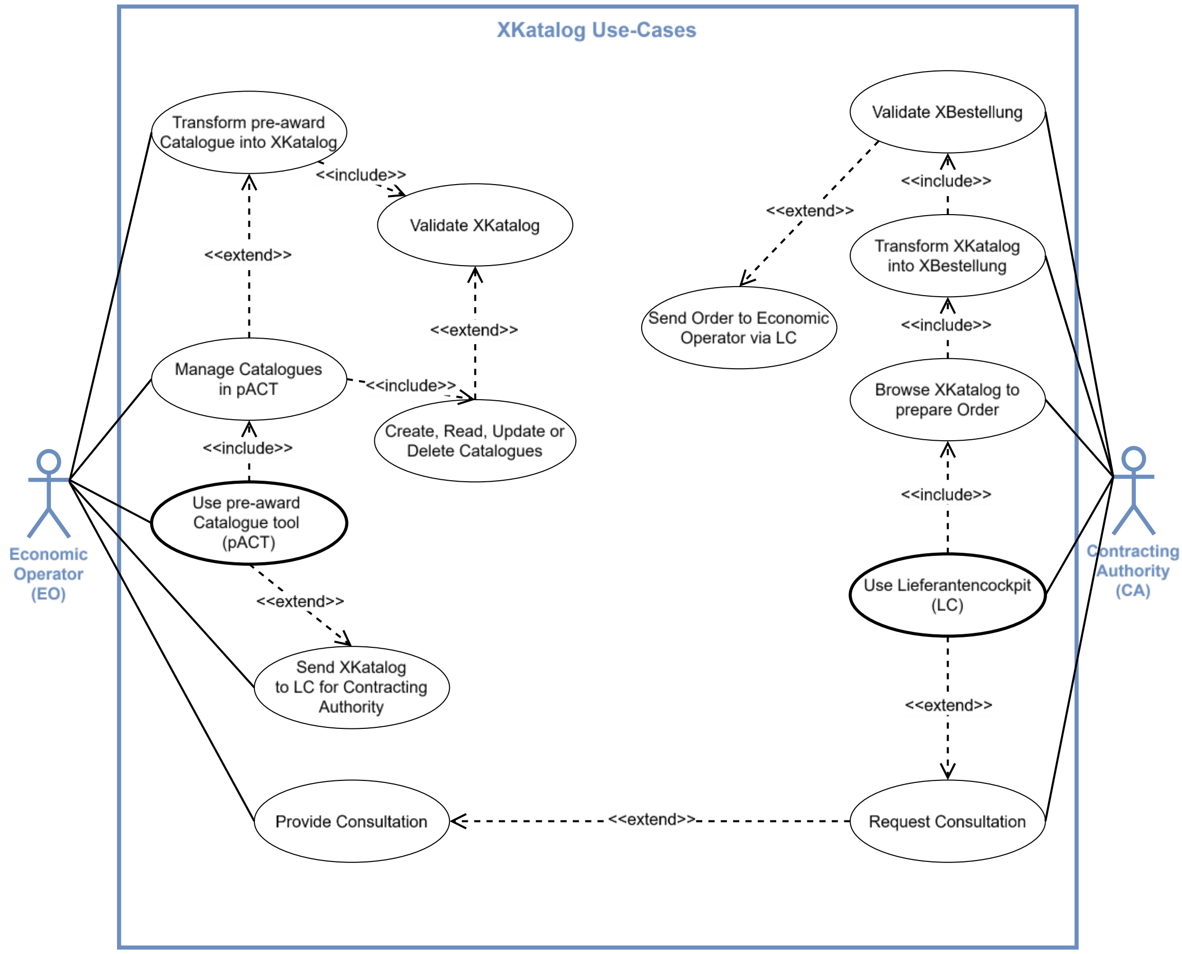

Figure 16: Target Use-Cases, own depiction based on [12, pp. 63–65] and workshops W6 and W25

4.2.3.2 Business Processes

There are two main target business processes for the XKatalog. The first process instance, depicted in Figure 17-19, illustrates how the XKatalog can be utilized to streamline the whole Public E-Procurement procedure in line with the solution objectives as presented in section 4.1.2. The pre-award specific sub-processes of the BPMN are based on the Peppol AISBL for the pre-award [49], whereas the rest of the process is created in line with the results of workshops W6 and W25 as well as the German architecture concept [12, pp. 63–65]. It starts with the sub-processes that take place during the pre-award phase; once the CA awards the EO with a contract award notice based on the EO’s tender with an attached pre-award Catalogue, a contract or framework agreement can be established to start the core XKatalog process. Now, the EO may upload their pre-award Catalogue in the pACT and transform it into an XKatalog. Within the tool, the E-Catalogue can now be enriched with more information such as product group systems, product attribute configurations and allowances or charges. Afterwards, the resulting XKatalog instance can be validated via the XKatalog-Validator and get sent directly to the LC. Upon the XKatalog’s arrival within the LC, the CA is automatically notified and can access the system to browse the EOs products. If consultation about the offered products is required, they can notify the EO through the LC to inquiry about the required information; in response, the EO provides consultation answers. The process continues with the preparation of an order by the CA. Once the order is decided upon, the LC can automatically transform the XKatalog into an XBestellung which is then enriched with more information such as the total order quantity for each of the purchased articles. Afterwards, the XBestellung is validated within the LC and can automatically be sent to the EO, marking the end of the core XKatalog process. During the remaining procurement procedure steps in the post-award, the order is confirmed and executed by the EO, transformed into the XRechnung and sent to the CA. After the CA pays the invoice, the target Public E-Procurement process comes to an end.

Notably, a core part of this process has been validated in practice by neusta under the supervision of the University of Koblenz and the free hanseatic city of Bremen. The final piloting results (see W23) confirm that a catalogue management tool can be used to create and validate XKatalog instances and send the XKatalog directly to the LC endpoint where it can automatically be transformed it into an XBestellung once the order quantity is specified.

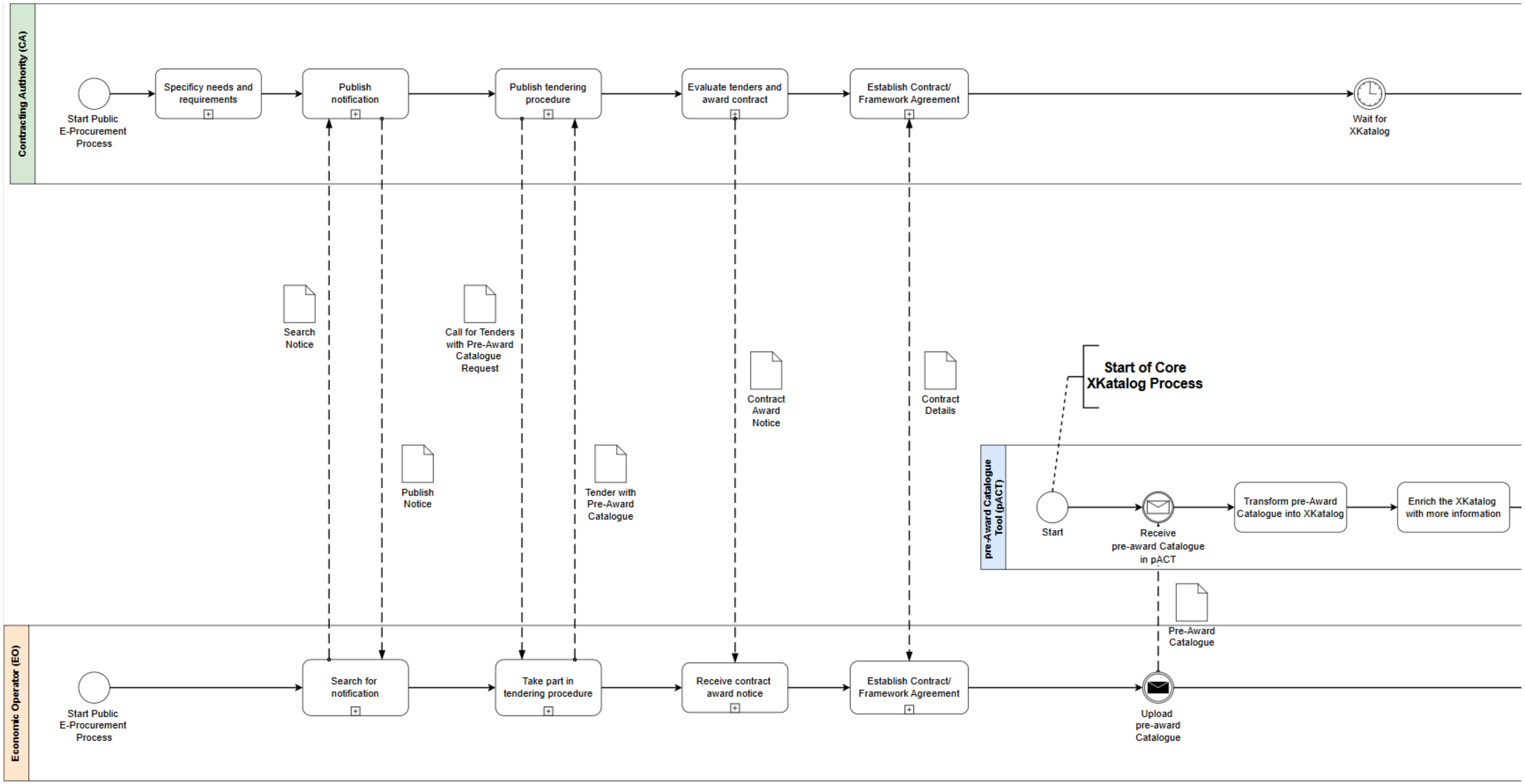

Figure 17: Target E-Procurement Process with the XKatalog 1/3, own depiction based on [12, pp. 63–65], [49] and workshops W6 and W25

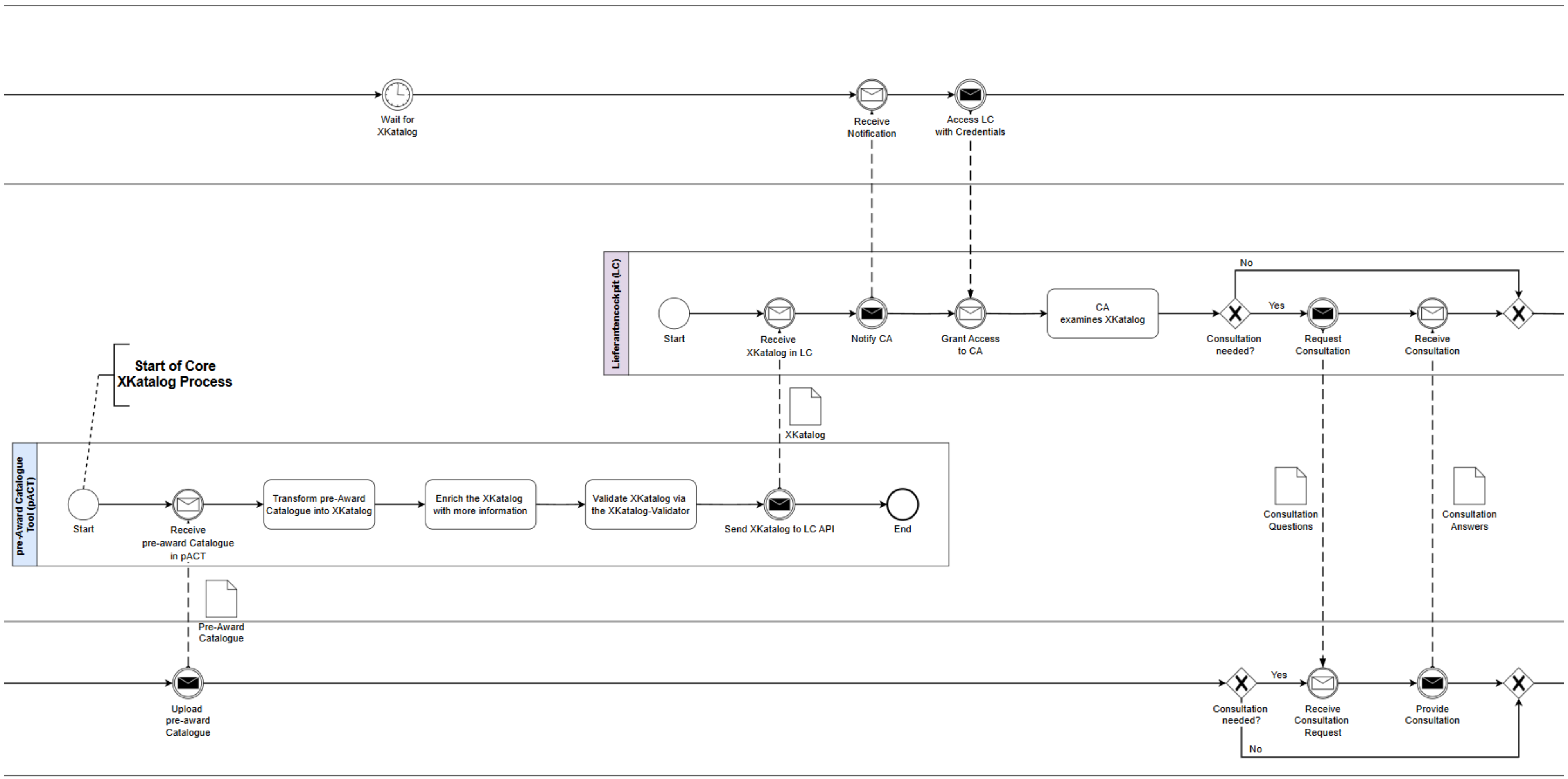

Figure 18: Target E-Procurement Process with the XKatalog 2/3, own depiction based on [12, pp. 63–65], [49] and workshops W6 and W25

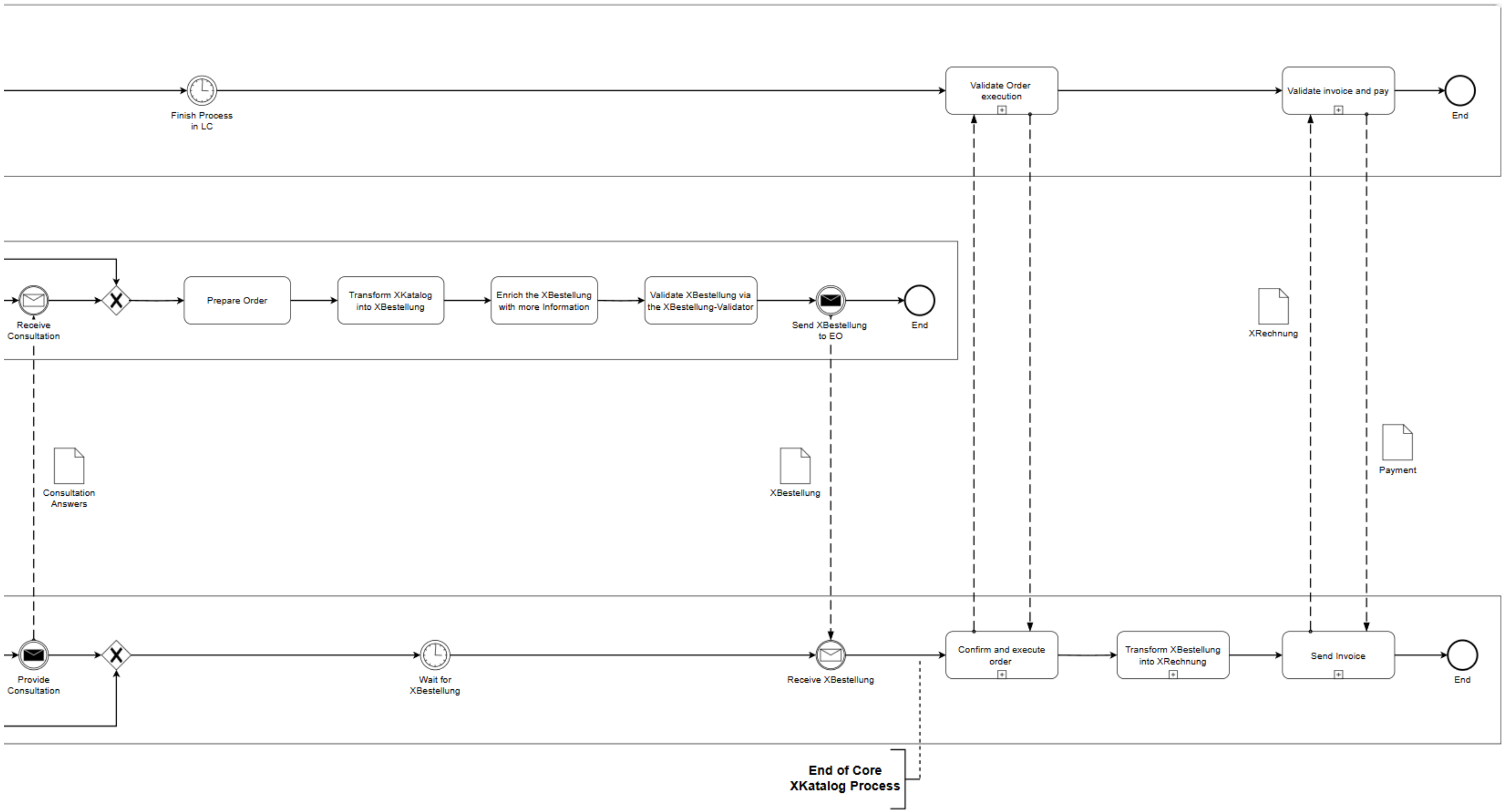

Figure 19: Target E-Procurement Process with the XKatalog 3/3, own depiction based on [12, pp. 63–65], [49] and workshops W6 and W25

The second process instance, depicted in Figure 20 and 21, provides insights into how the XKatalog can contribute towards a continuous catalogue management during the execution of contracts and framework agreements over time. The process is based on workshops W6 and W24 and begins with the EO accessing the pACT to manage all of their E-Catalogues. In the pACT, catalogues may be created, read, updated or deleted based on the EOs intents; when choosing to simply read or delete existing catalogues that are of no direct concern for the CA, the EO may choose to end the process early. However, if the EO decides to create or update an XKatalog instance, the process continues. When creating a new XKatalog, the EO can either transform an existing catalogue into a new file or create an instance from scratch. Afterwards, after the initial creation of an XKatalog or then choosing the update operation, the EO can manually add or change data within the catalogue until a desired level of information is achieved. Subsequently, the XKatalog is validated via the XKatalog validator and the EO chooses whether the changes are supposed to be uploaded to the LC or kept internally for now. If the changes are not uploaded, the EO may once again decide to terminate the process or go back to the CRUD loop. If the changes are determined to be uploaded to the LC, the new/updated XKatalog file is sent directly to the LC, which notifies the CA of its arrival. If there are any questions, the CA will request consultation from the EO; otherwise, the catalogue management process finishes. Since the ordering process is out of scope for the catalogue management process itself, if the CA determines to order from an updated catalogue, the remaining process steps remain completely unchanged to those described in Figure 19.

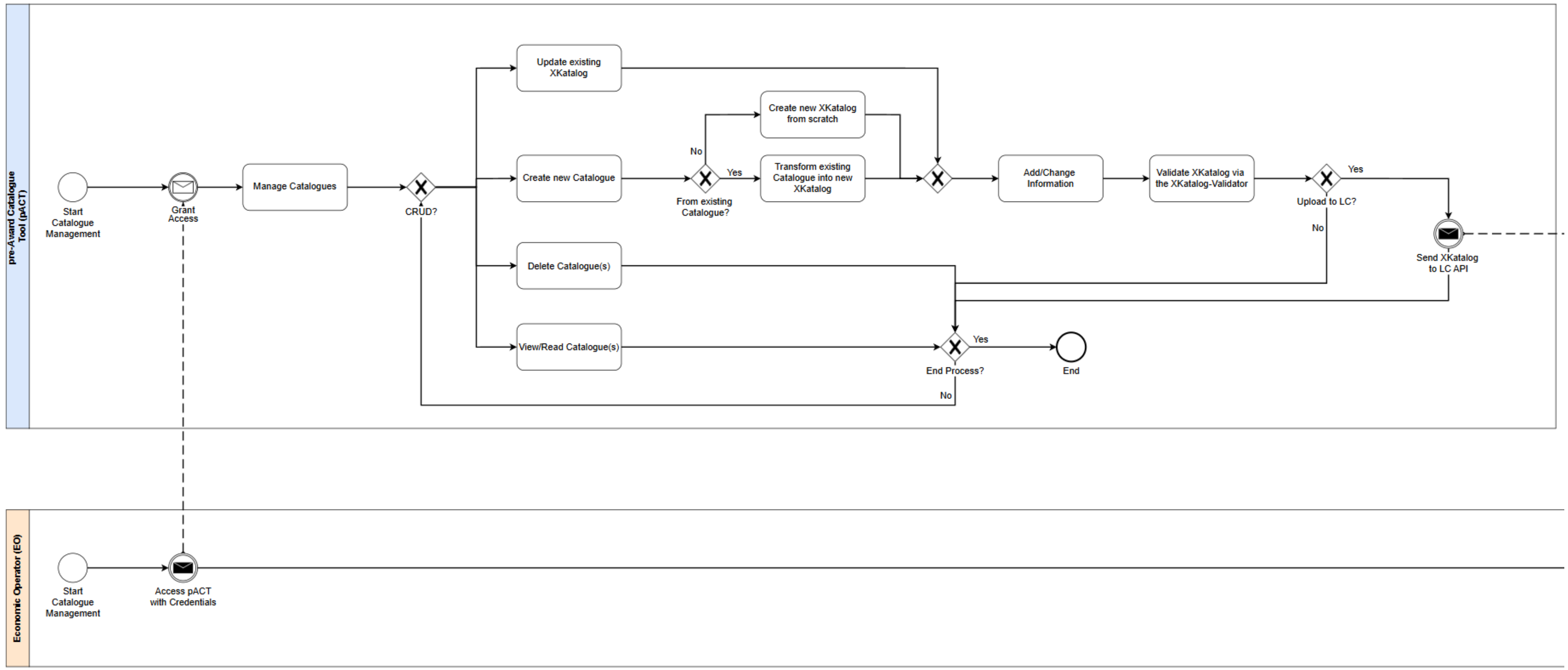

Figure 20: Target Catalogue Management Process with the XKatalog 1/2, own depiction based on Workshops W6 and W24

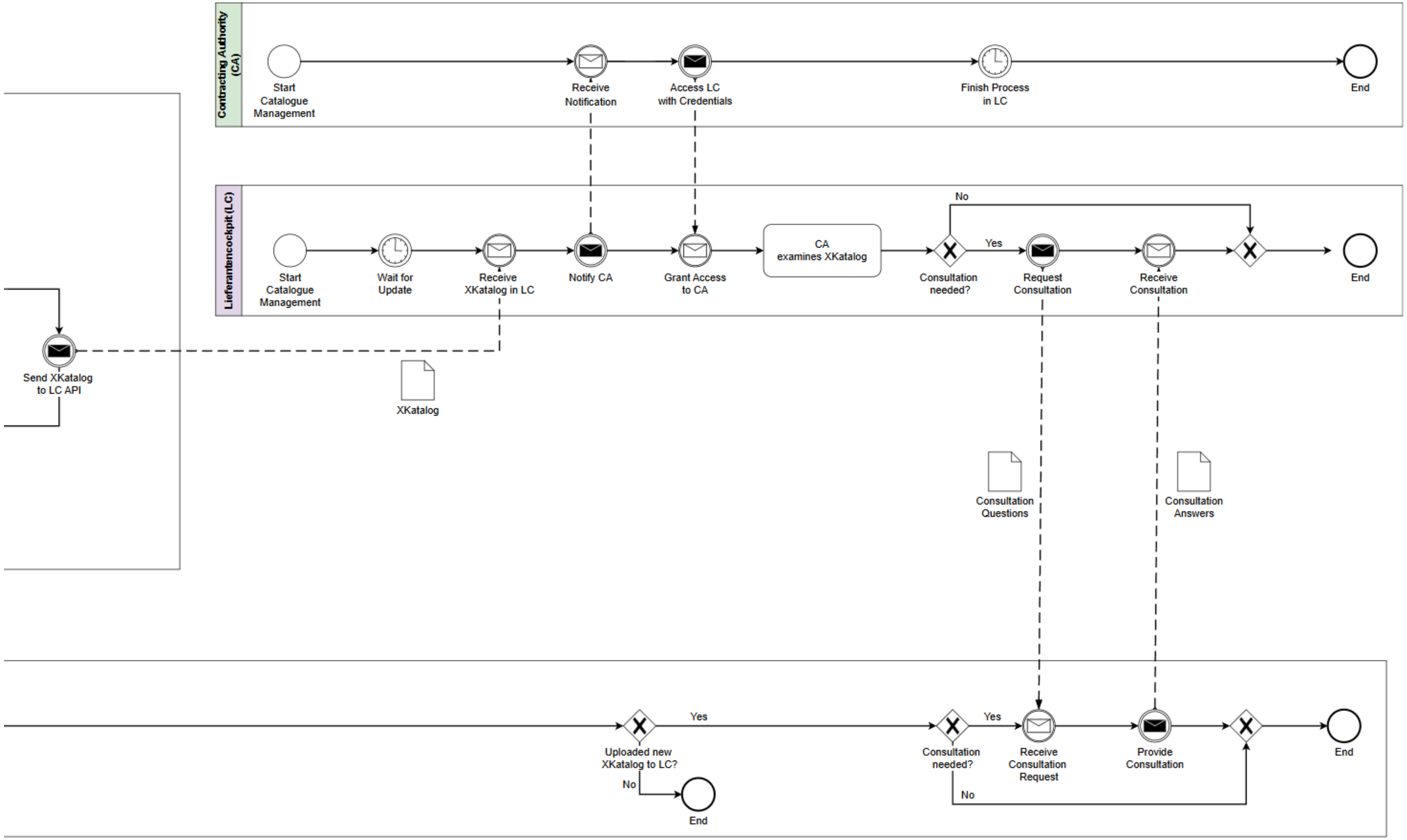

Figure 21: Target Catalogue Management Process with the XKatalog 2/2, own depiction based on Workshops W6 and W24

4.2.4 Resulting Requirements

By synthesizing the architectural considerations of the business perspective in both its baseline and target architecture, relevant requirements for the XKatalog specification can be derived. These requirements are depicted in Table 10. In general, the XKatalog must enable a streamlined Public E-Procurement procedure as well as a continuous catalogue management process while retaining legacy compatibility to the KDB. As such, legacy compatibility and target vision must be carefully balanced in the standard. Most crucially, the XKatalog must be transformable out of a pre-award Catalogue and allow for the migration of data to the XBestellung to enable the target procedure.

Table 10: XKatalog requirements derived from the business perspective

ID	Title	Description	Priority			Origin (References)
			Must-Have	Should-Have	Nice-to-Have	
B-REQ-1	Enable product procurement procedures	The XKatalog must enable Public E-Procurement procedures for products.	X			W21
B-REQ-2	Retain legacy compatibility with the KDB	The XKatalog should ensure legacy compatibility with the baseline KDB process.		X		W4
B-REQ-3	Enable streamlined Public E-Procurement process	The XKatalog must enable a streamlined Public E-Procurement process with a seamless transition from pre- to post-award.	X			[13], [16]; W6
B-REQ-3.1	Enable XKatalog transformation	The XKatalog must be transformable out of a pre-award Catalogue; the dedicated standard for pre-award Catalogues is the Peppol pre-award Catalogue.	X			W4
B-REQ-3.2	Enable	The XKatalog must be validatable.	X			W19;

	XKatalog validation					Interview 2
B-REQ-3.3	Enable e-Order transformation	The XKatalog must be transformable into an electronic order; the dedicated standard for electronic orders in Germany is the XBestellung.		X		W4
B-REQ-4	Enable continuous catalogue management process	The XKatalog must enable a continuous catalogue management process that includes create, read, update and delete operations.	X			W24; [98], [99]
B-REQ-5	Enable catalogue browsing and shopping	The XKatalog must enable the process of browsing and shopping from E-Catalogue instances.	X			W6
B-REQ-6	Enable consultation	The XKatalog should contribute towards enabling the consultation of CAs by EOs.		X		[12, pp. 63–65]

4.3 Data Perspective

In the following, the baseline (see section 4.3.1) and target (see section 4.3.2) data architectures are discussed, and applicable requirements for the XKatalog derived (see section 4.3.3). Notably, this section does not include the XKatalog's specification as a data standard in SeMoX. Although technically part of the target data architecture, it is placed in the separate chapter 5 due to its reliance on requirements from all FISAD perspectives.

4.3.1 Baseline Architecture

As analysed in sections 3.5, 3.6, 4.2.2, in line with the findings of Workshop W4, the baseline data architecture is very limited in Germany. In Terms of productively used E-Catalogue standards in Public E-Procurement, only the BMEcat can be identified as a relevant E-Catalogue. As described beforehand, it is used to execute framework agreements within the KDB, and, with much less relevance, the Rhineland-Palatinate's KDL; the BMEcat can be considered as a very extensive data standard with its current specification[89] requiring over 400 pages just to describe its data elements. Thus, understanding the BMEcat in its entirety may present itself as a substantial challenge to EOs, especially SMEs. Additionally, its whole data model cannot be discussed in this thesis. However, by narrowing down national requirements towards E-Catalogues to their respective syntax and semantics within the BMEcat, a better overview of relevant data elements can be achieved. First, the BMEcat allows for the definition of catalogue and product group systems to build hierarchical product trees via the "CATALOG_GROUP_SYSTEM" and "PRODUCT_TO_CATALOGGROUP_MAP" data elements. Second, product attributes and components can be configured with customizable prices through the "PRODUCT_CONFIG_DETAILS" element; as highlighted during workshop W18, while this feature is seen as essential by CAs (see W4), the product configurability is so complex that many EOs surprisingly resort to using a previous version of the BMEcat to avoid dealing with this feature altogether. A more detailed discussion on the integration of these data elements into the XKatalog is placed in section 5.2.4.

[89] https://a.storyblok.com/f/104752/x/9344382bd6/bmecat_2005-2_deu.pdf last access: 02.01.2025

While there are other, smaller island solutions that can also be classified as E-Catalogue data standardization efforts, they are not deemed to be relevant for the scope of this thesis. As described in section 3.5.4, these E-Catalogues are the GAEB catalogue for procuring construction works, the BreKat for procuring furniture and office materials in Bremen, the Excel-Templates used for both the KDL and KDB, and the Excel template for the VMS. While interoperability with these standards is considered to be noteworthy (see W4), the standards are either very generic or directed towards a specific niche that the XKatalog does not attempt to address in the scope of this thesis.

In any case, in Germany, E-Catalogues are created and validated manually, their transformability out of pre-award standards, while theoretically possible, is currently limited due to their contrasting standardization scopes and contexts [13], and their interoperability with other productive post-award standards such as the XBestellung and XRechnung is also severely restricted (see also W8). Thus, Germany's baseline data architecture exhibits two significant gaps within the data transformation flow of Public E-Procurement: the gap between the pre- and post-award catalogues and the gap between the post-award catalogue and the XBestellung/XRechnung, both resulting out of insufficient interoperability between the standards.
On an international level, however, the Peppol catalogue exists. Peppol standards are used as the foundation for the XBestellung and XRechnung in the post-award (see W4) and other countries such as Norway have successfully adopted the Peppol Catalogue in line with national requirements already (see EHF in section 3.5.4). Therefore, Peppol is considered as a significant standard for the target data architecture.

4.3.2 Target Architecture

For the XKatalog's target architecture, only the Peppol pre-award Catalogue, the Peppol (post-award) Catalogue, the BMEcat and the XBestellung are evaluated to be relevant standards (see W4). Achieving interoperability with all four standards is difficult due to differences in their scope, structure and semantics, requiring the XKatalog to carefully balance between their specifications. As highlighted in the target business architecture (see section 4.2.3), however, the XKatalog must most crucially enable the migration of data from pre-award Catalogues into electronic orders to bridge the gap between procurement phases. Therefore, interoperability with the Peppol pre- and post-award Catalogue and the XBestellung is of utmost importance, whereas legacy compatibility to the BMEcat is assigned a lower priority. As identified during workshop W4, by utilizing the Peppol Catalogue as a foundation, most data from the Peppol pre-award Catalogue can be carried over into the XKatalog due to the inherent interoperability by design of the pre-and post-award catalogues. Furthermore, since the XBestellung's syntax and semantics are based on the Peppol BIS Order only, most of the data can subsequently be migrated to the XBestellung and thus bridge the current data transformation gap. On the other hand, however, the Peppol Catalogue does not support three features that are identified as relevant in Germany and used productively within the KDB through the BMEcat. In line with Workshops W4 and W8, three national extensions to the Peppol Catalogue must be made for Germany. First, it must be possible to specify a catalogue group system to define hierarchical product trees. This allows EOs to categorize all their products in a hierarchical structure and helps CAs to navigate and understand the EO's catalogue. Second, the XKatalog must support the configuration of products to support EOs in presenting complex products and enable CAs to conduct complex product procurements such as configurable computers, furniture or even cars. Lastly, allowances and charges must be able to be specified in the catalogue, thereby allowing EOs to indicate special offers or specific surcharges. An in-depth discussion on how this target architecture is realized in the XKatalog is placed in section 5.2. In particular, the design choices for the XKatalog's structure and semantics can be found in section 5.2.4.

4.3.3 Resulting Requirements

In the following, a synthesis of all data requirements is illustrated in Table 11. The XKatalog requires interoperability with three standards, the Peppol pre-award Catalogue, the XBestellung and the BMEcat. While interoperability with both the Peppol pre-award Catalogue and XBestellung is required to bridge the gap between pre- and post-award phases, interoperability with the BMEcat is essential to ensure the XKatalog's legacy compatibility with nationally used E-Catalogues in the KDB. While interoperability with the remaining standards is considered to be desirable, these standards are not central to any considerations on the XKatalog's baseline or target data architecture and thus deemed to be of secondary importance.

Table 11: XKatalog requirements derived from the data perspective

ID	Title	Description	Priority			Origin (References)
			Must-Have	Should-Have	Nice-to-Have	
D-REQ-1	Ensure interoperability with the Peppol pre-award Catalogue	The XKatalog must be interoperable with the Peppol pre-award Catalogue.	X			W4
D-REQ-2	Ensure interoperability with the XBestellung	The XKatalog must be interoperable with the XBestellung.	X			W4
D-REQ-3	Ensure legacy compatibility with the BMEcat	The XKatalog should ensure legacy compatibility with the BMEcat.		X		W4
D-REQ-4	Ensure legacy compatibility with the GAEB	Legacy compatibility between the XKatalog and GAEB is desirable.			X	W4

D-REQ-5	Ensure legacy compatibility with the BreKat	Legacy compatibility between the XKatalog and BreKat is desirable.			X	W4
D-REQ-6	Ensure legacy compatibility with the VMS	Legacy compatibility between the XKatalog and the VMS Excel catalogue is desirable.			X	W4

4.4 Application Perspective

The application perspective provides insights into the XKatalog's baseline (see section 4.4.1) and target (see section 4.4.2) application architectures. As previously elaborated upon, the pACT and LC are considered as specific systems for the target architecture to evaluate the XKatalog's feasibility in practice. However, technology neutral requirements are derived from all considerations in line with workshop W24 (see Table 12).

4.4.1 Baseline Architecture

Figure 22 depicts the baseline application architecture based on Workshops W17, W23 and W26 as well as the KDB's short specification[90]. Currently, only basic application components and interfaces exist in Germany to execute the KDB use-case based on existing framework agreements. Hence, in the baseline, the EO only uses a generic supplier system, for example in the form of an off-the-shelve Enterprise Resource Planning system, and the CA utilizes the KDB. The EO manages catalogues within their system via a catalogue editor component to create BMEcat instances and must manually validate them. A file transfer component connects the EO's system to the KDB via a secure transfer interface with HTTP/S[91] and SMTP /S MIME[92] protocols and can thus be used to upload a BMEcat to the KDB. The KDB is used by the CA to browse the EO's products until an electronic order is created via an electronic order management component directly in the KDB. Once again, the order can then be transferred to the EO via the secure file transfer component.

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[90] https://www.verwaltung-innovativ.de/SharedDocs/Publikationen/Artikel/broschuere_kaufhaus_des_bundes.pdf?__blob=publicationFile&v=3 last access: 03.01.2025

[91] https://www.rfc-editor.org/rfc/rfc9110.html last access: 03.01.2025

[92] https://datatracker.ietf.org/doc/html/rfc8551 last access: 03.01.2025

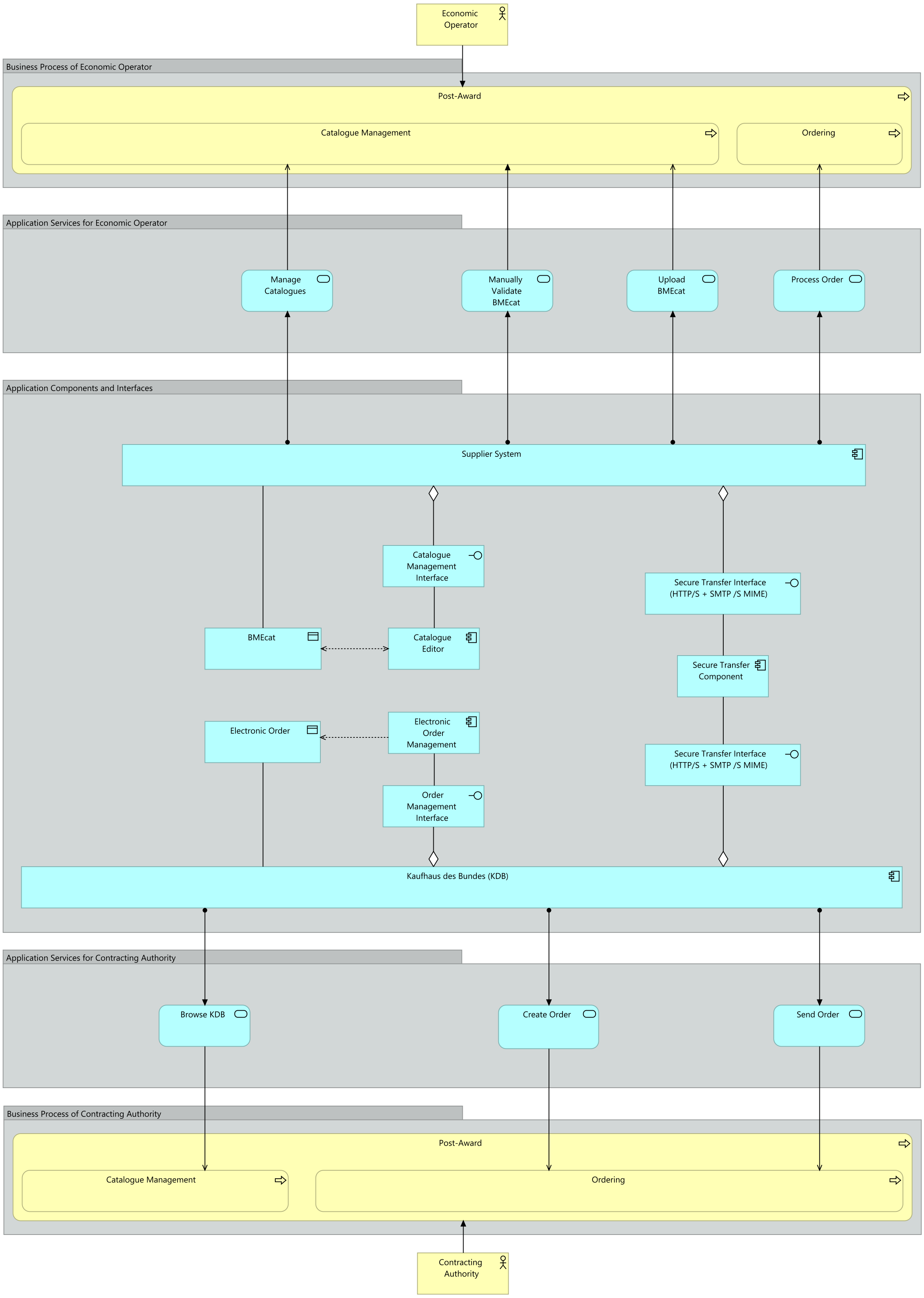

Figure 22: Baseline Application Architecture, own depiction based on workshops W17, W23 and W26

4.4.2 Target Architecture

For the target application architecture (see Figure 23), several solution components have been identified in Workshop W17 and their viability validated in Workshop W23. As explained in the introduction of chapter 4, since the scope of this thesis is not on providing a technologically neutral target architecture but rather illustrate how the XKatalog can be used in practice, specific solution components are utilized in the target application architecture. The EO may use three kinds of systems in the target architecture, a messaging system, the pre-Award Catalogue Tool (pACT) and an ERP-System, whereas the CA only uses the Lieferantencockpit (LC). The messaging system, which may also be part of the EO's ERP-System, is utilized to provide consultation on the XKatalog if needed. To realize this, interfaces with HTTP/S and OAuth2.0[93] are employed between a secure consultation component and the EOs and CAs systems. The EOs target XKatalog processes are conducted in the pACT, which contains the necessary application components for transforming, managing and validating XKatalogs and is connected to the LC via an FTPS[94] application interface for transferring XKatalog messages. On the other hand, the CA uses the LC to receive and browse a catalogue instance and transforms it into a valid XBestellung via the LC's transformation and validation components. Finally, the XBestellung may be sent directly to the EO's ERP-System through a secure interface that also employs FTP-SSL as a secure file transfer protocol.

[93] https://oauth.net/2/ last access: 09.01.2025

[94] https://datatracker.ietf.org/doc/html/rfc4217 last access: 09.01.2025

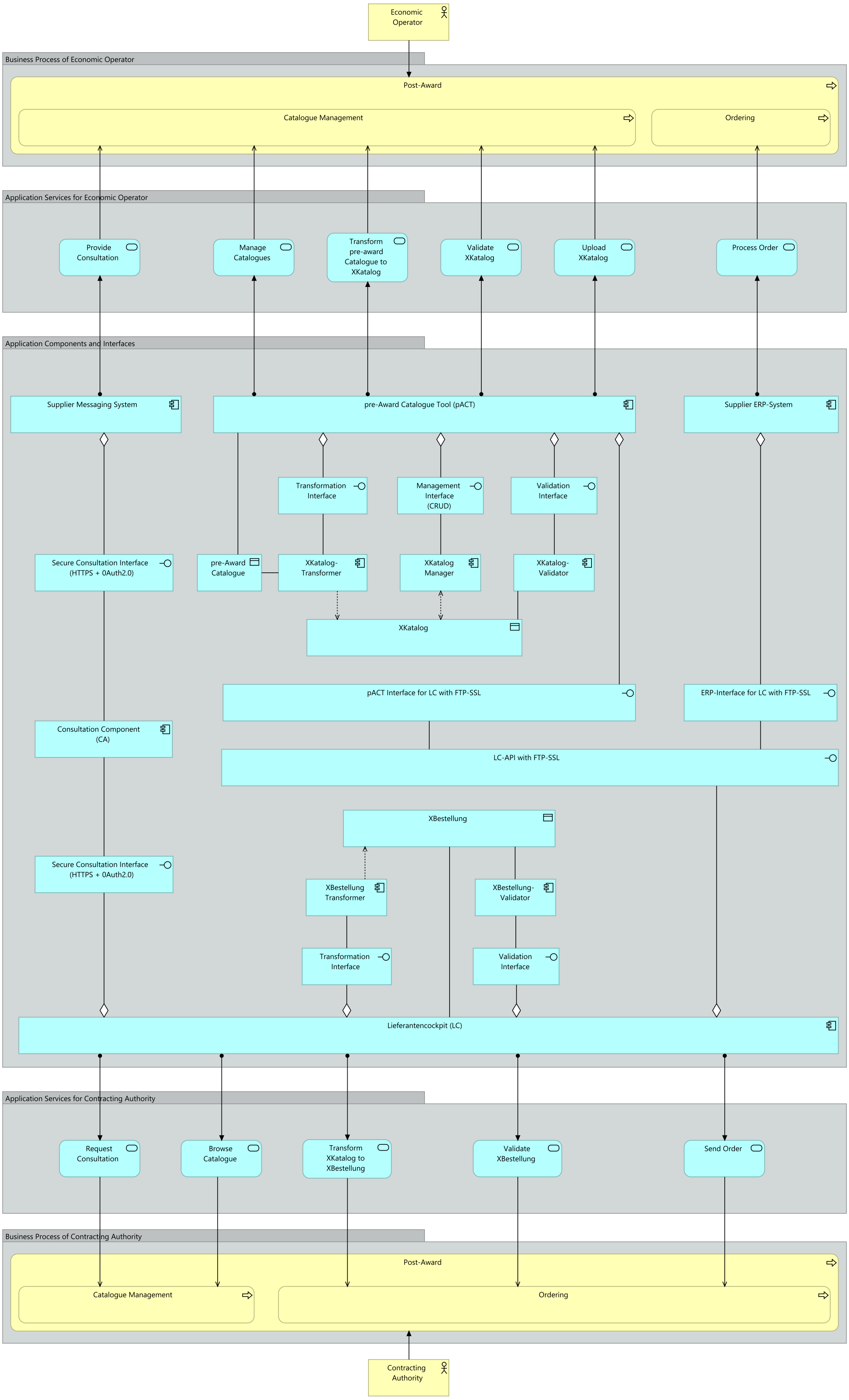

Figure 23: Target Application Architecture, own depiction based on workshops W17 and W23

4.4.3 Resulting Requirements

Based on these considerations and in-line with the KoSIT's productively used technical components for XEinkauf as discussed during several workshops (see 2.3.2) and interview two (see section 5.4), technology neutral application requirements are presented in Table 12. Most notably, several application components are required to transform, manage and validate instances of the XKatalog. Furthermore, all components must be developed technologically neutral and usable within any suitable application system or tool.

Table 12: XKatalog requirements derived from the application perspective

ID	Title	Description	Priority			Origin (References)
			Must-Have	Should-Have	Nice-to-Have	
A-REQ-1	XKatalog-Management Component	The XKatalog must be manageable using a management component by the system.	X			W24
A-REQ-2	XKatalog Transformation Component	The XKatalog must be transformable from a pre-award Catalogue using a transformation component by the system.	X			W4
A-REQ-3	XKatalog Validation Component	The XKatalog must be validatable using a validation component by the system.	X			W19
A-REQ-4	Secure Consultation Component	A consultation component by the system should enable secure consultation of the XKatalog.		X		[12, pp. 63–65]
A-REQ-5	XBestellung Transformation Component	The XKatalog must be transformable into an XBestellung using a transformation component by the system.	X			W4

4.5 Technical Perspective

In this section, the baseline (see section 4.5.1) and target (see section 4.5.2) architectures of the technical perspective are analysed. Once again, pACT and LC are incorporated into the target architecture as specific solution components, and requirements are derived in section 4.5.3.

4.5.1 Baseline Architecture

Based on the baseline application architecture, the currently employed technical architecture is limited. Figure 24 illustrates a simplified overview of the technical baseline based on Workshops W21 and W26 and the KDB's short specification[95]. The architecture is simplified due to the lack of both publicly and project internally available information on the KDB. Both the supplier system and the KDB utilize a secure file transfer component for the transmission of catalogue and order instances. This component is realized through a file transfer service that employs HTTP/S, TCP/IP and SMTP /S MIME protocols for secure communication of the systems over the internet. Furthermore, both systems realize their respective application components for electronic catalogues and orders via services that stem from their procurement document management systems.

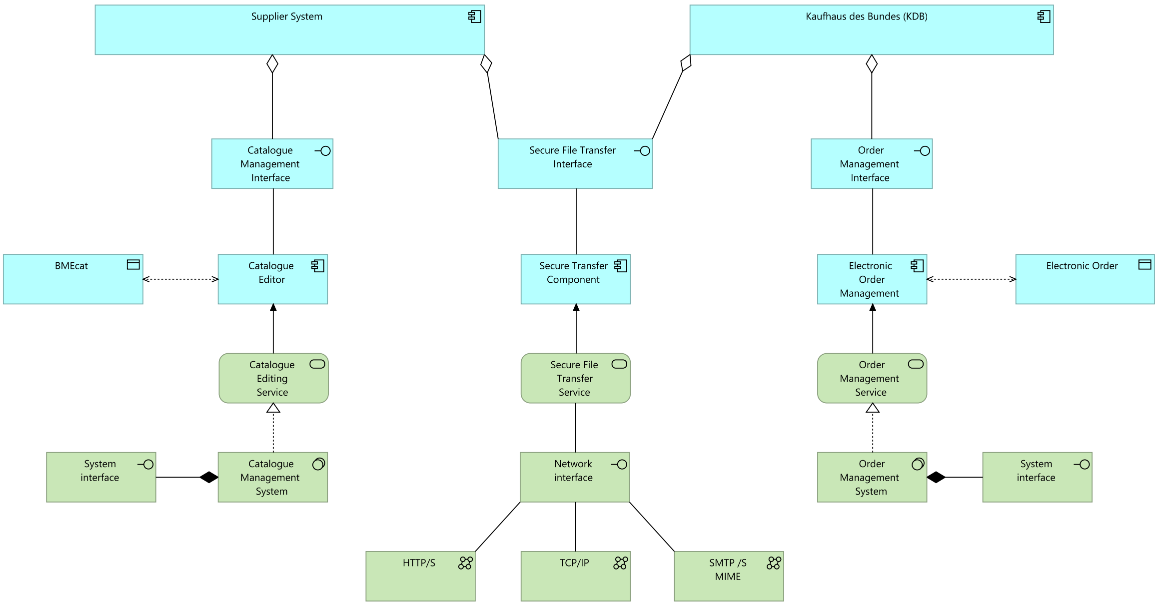

Figure 24: Baseline Technical Architecture, own depiction based on workshops W21 and W26

95 https://www.verwaltung-innovativ.de/SharedDocs/Publikationen/Artikel/broschuere_kaufhaus_des_bundes.pdf?__blob=publicationFile&v=3 last access: 03.01.2025

4.5.2 Target Architecture

For the target technical architecture, the use of the Peppol eDelivery Network via the Peppol 4-Corner Model is identified as a solution component. First, the Peppol 4-Corner Model, used productively within Germany for electronic invoicing via the XRechnung already[96], can be used for the XKatalog's target technical architecture. It is important to note that the use of Peppol's e-delivery network through the 4-Corner Model requires the XKatalog to comply with Peppol's Business Interoperability Specification (BIS) for the Peppol Catalogue. As such, this further cements the XKatalog's need to be based on Peppol.

In line with internal documentation of CEN/TC 440 on the target technical architecture for Public E-Procurement in Europe[97], the 4-Corner Model is depicted in Figure 25 and consists of four corners: the sender (Corner 1), the sender's service provider or sender access point (Corner 2), the receiver's service provider or receiver access point (Corner 3), and the receiver (Corner 4). Additionally, two decentralized technology components in the Service Metadata Publisher (SMP) and the Service Metadata Locator (SML) are crucial for the transfer of files over the Peppol network. In the simplified context of this thesis, the sender represents the originator of an XKatalog instance who wants to send it to a receiver. The sender is tasked with ensuring compliance with the XKatalog standard and starts the information flow over the network by sending the catalogue to their designated service provider/access point. This actor is responsible for validating if the received data conforms to the XKatalog and acts as an intermediary in the model. If the validation fails, the XKatalog will be refused and returned to the sender alongside information on its validation errors. If the validation is successful, a metadata look-up in the SMP is conducted via the SML to check whether the receiver has a targetable service provider/access point within the DNS registry or not. Once again, if this check fails, the XKatalog will be returned to the sender alongside an error indicating that the recipient could not be located. However, if the check is successful, the SML returns the necessary DNS information on the receiver's service provider/access point to the SMP which then provides the routing information to the sender's service provider/access point. Afterwards, the file is encrypted and transmitted through a secure channel to the receiver's service provider or access point. Once received by the receiver's service provider/access point, Registered Electronic Mail (REM) evidence is automatically attached to the message to

96 https://en.e-rechnung-bund.de/e-invoicing-faq/peppol/ last access:03.01.2025

97 Internal document, CEN/TC 440 WG-1 N296 Technical architecture

provide legal and non-repudiable evidence that the message was successfully sent by Corner 2 and successfully received by Corner 3. The receiver's service provider/access point subsequently decrypts the data and sends it to the receiver, the fourth and last corner of the model, who may then open the received data and integrate it into relevant systems and processes.

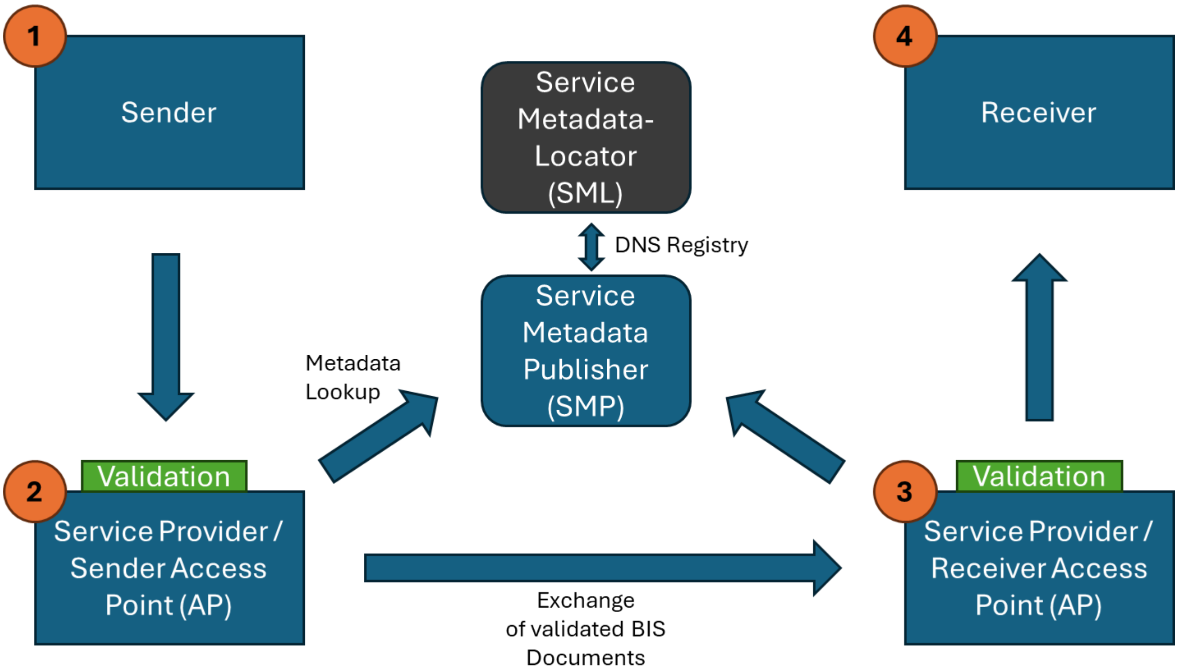

Figure 25: Peppol 4-Corner Model, retrieved from CEN/TC 440 WG-1 N296 Technical Architecture

In the following, Figure 26 depicts a simplified illustration of the XKatalog's target technical architecture with the integration of the Peppol 4-Corner Model. Upfront, all application components are realized through their respective services, software components and interfaces. Furthermore, both the EO and CA use interfaces between their systems and Peppol's access points to utilize the Peppol eDelivery Network for transferring XKatalog and XBestellung messages. The access points validate the messages based on their BIS in Corner 2, query the SMP for necessary DNS routing data that is located through the SML and subsequently transfer and receive the encrypted data in Corner 3. While out of scope for this thesis, results of the final workshop W26 indicate that the realization of this target architecture requires further in-depth analysis on the Peppol 4-Corner Model's technical components in the future.

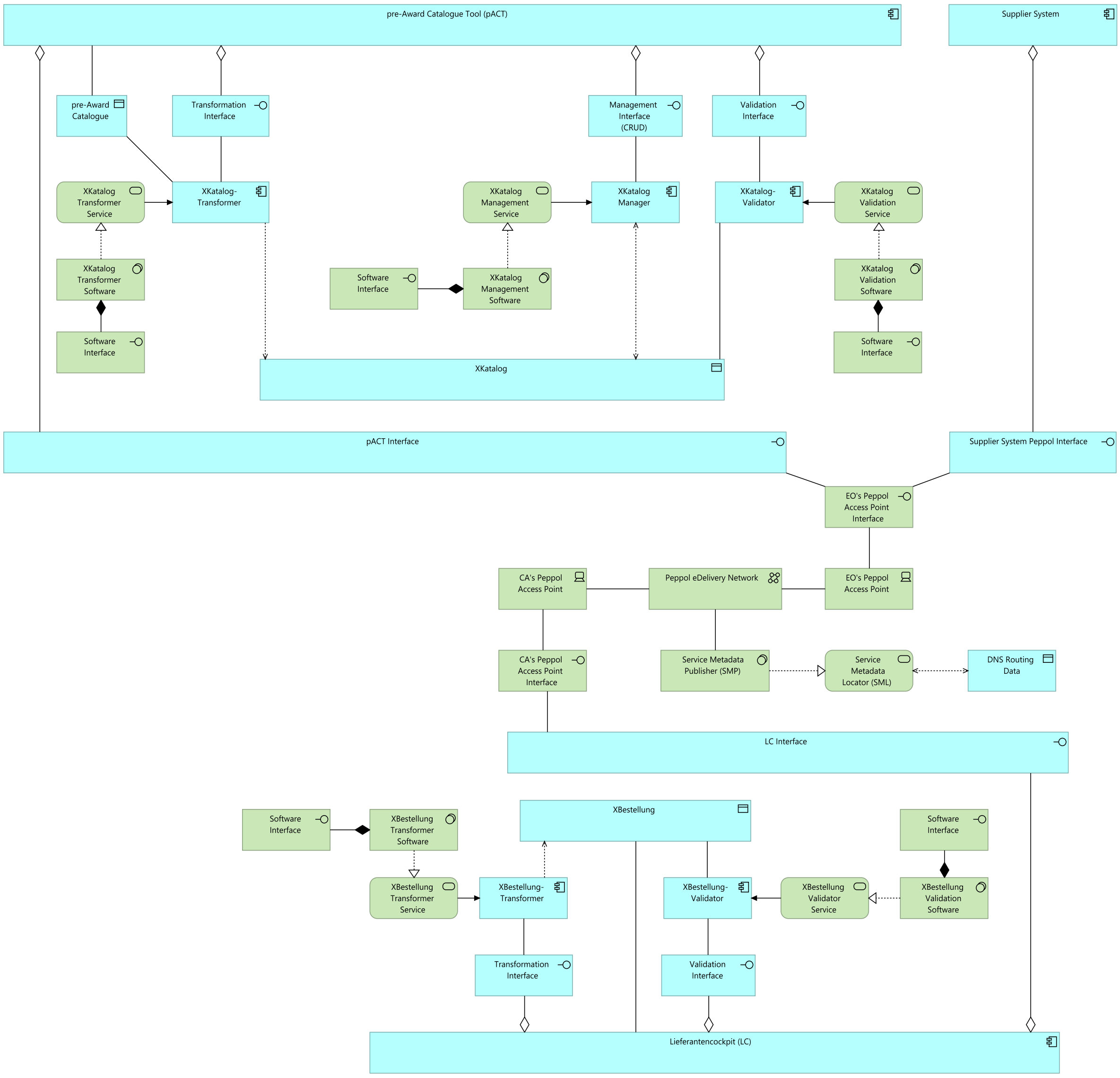

Figure 26: Target Technical Architecture, own depiction based on CEN/TC 440 N296 and workshops W21 and W26

4.5.3 Resulting Requirements

When synthesizing the technical perspective's baseline and target architecture, two requirements can be derived (see Table 13). In general, it must be possible to transmit XKatalog messages using any fitting network and technology. Insights from workshop W26 on the XRechnung highlight that, although suitable infrastructure in form of the Peppol eDelivery Network exists, many EOs still sent invoices via mail in practice. Consequently, while integrating the XKatalog into the Peppol eDelivery Network through Peppol's 4-Corner model is highly recommended for its target architecture, a significant portion of actors will realistically opt to send and receive the electronic catalogues via mail instead. Therefore, all suitable ways and channels of transmission must be enabled.

Table 13: XKatalog requirements derived from the technical perspective

ID	Title	Description	Priority			Workshop or Literature Reference
			Must-Have	Should-Have	Nice-to-Have	
T-REQ-1	Enable the transmission of messages via the Peppol eDelivery Network (4-Corner Model)	The transmission of XKatalog messages must be possible using the Peppol eDelivery Network (4-Corner model). This is the productively used infrastructure for XEinkauf standards and the recommended way of sending XKatalog instances.	X			W21
T-REQ-2	Enable the technology neutral transmission of messages	The transmission of XKatalog messages must be possible using any suitable technology used for file transfer. In particular, this explicitly includes electronic mail.	X			W26

4.6 Synthesis of the FISAD perspectives

The application of FISAD has led to several architectural insights and requirements that are relevant to the XKatalog's specification and thus research questions three and four. From a foundational perspective, it is important to note that the specification of the XKatalog mainly addresses the currently incomplete data validation and transformation flow in Public E-Procurement which has two main gaps, one within the pre-award phase, and one between the pre- and the post-award phases. The XKatalog can directly address the data flow gap between the pre- and post-award phases by achieving compatibility with both the Peppol pre-award Catalogue and the XBestellung to allow data from the pre-award to get carried over into the post-award. While it cannot directly fix the pre-award specific gap, its usage can lead to the re-usability of structured information during the specification of needs and requirements for further, similar procurements of a CA. Additionally, the seamless transfer of data from the pre- to the post-award leads to a smoother process transition between the two phases. As such, the XKatalog must ensure compatibility with existing E-Procurement standards to fix the data transformation flow and achieve a seamless process transition, thereby reducing transaction costs and increasing (SME) competition. When considering the business perspective, it is important to maintain legacy compatability to the baseline process of utilizing the KDB for the execution of framework agreements while simultaneously realizing the target processes of a continuous catalogue management and a streamlined Public E-Procurement procedure. To enable this, the transformation of the XKatalog out of the pre-award Catalogue as well as the XBestellung out of the XKatalog must be possible. This is crucial in the context of the data perspective, as the realization of these requirements requires utmost interoperability with Peppol due to both the pre-award Catalogue and XBestellung being based on the standard. Since legacy standards such as the BMEcat are in public use as well, the XKatalog must carefully assess to which degree baseline compatibility can be maintained while achieving interoperability with Peppol to realize its core target goals. In line with these considerations, the application perspective requires several application components in the systems to implement features such as the transformation and validation of documents that enable the XKatalog's vision. As discussed in Workshops W17 and W23, in conjunction with neusta enterprise services GmBH, required systems and components were identified and utilized to pilot a minimal transition process from the XKatalog to the XBestellung. A simple catalogue management tool can be used alongside the Lierantencockpit as application systems in a productive environment to confirm the possibility of realizing the XKatalog's solution objectives in practice. Lastly, from a technical perspective, the integration of the XKatalog into the Peppol eDelivery Network via Peppol's 4-Corner Model enables a simple and secure exchange of XKatalog messages during the procedure, which further highlights the XKatalog's need to be based on the Peppol Catalogue. However, transfer via other suitable means must also be ensured, as insights from workshop W26 confirm the prevalence of exchanging standardized procurement documents through electronic mail in practice (XRechnung).

In conclusion, this chapter represents the architectural foundation for the XKatalog's specification and hence research questions three and four. All considerations and requirements of this chapter are synthesized in section 5.5 (see Table 17) in order to assess the extent to which they can be implemented, realized or enabled through the specification of the XKatalog alongside its technical components, thereby answering the two remaining research questions.

5 Specification of the XKatalog and its technical components

In this chapter, the specification of the XKatalog as a national E-Catalogue standard for Public Procurement in Germany is discussed. First, the XKatalog's standardization approach is discussed by synthesizing the KoSIT's standardization philosophy with the rigorous and relevant foundations of this work, namely the application of DSR, FISAD and the EIF (see section 5.1). Afterwards, the XKatalog's specification in SeMoX can be discussed in section 5.2 by elaborating on overall results and notable design choices for its Semantic Datatypes (see section 5.2.1), Codelists (see section 5.2.2), Business Terms (see section 5.2.3), Structure (see section 5.2.4), Rules (see section 5.2.5), and Syntax Binding (see section 5.2.6). Subsequent interoperability mappings to the Peppol pre-award Catalogue (see section 5.3.1) and the XBestellung (see section 5.3.2) illustrate its achieved interoperability towards these standards and a validation environment, consisting of an XKatalog-Validator (see section 5.4.1) and a Testsuite (see section 5.4.2), demonstrates how messages of the XKatalog can be validated in practice. Finally, a synthesis of this chapter is provided in section 5.5, reflecting on the XKatalog's standardization approach, adherence to the EIF, and implementation of requirements in both its specification and validation components, thereby answering research questions three and four.

5.1 Standardization approach

To better understand how the Coordination Office for IT-Standards in Germany specifies Public E-Procurement standards (XEinkauf), an interview with Renzo Kottmann from the KoSIT was conducted (see section 5.1). The insights from the interview serve to harmonize theoretical considerations such as the European Interoperability Framework and the Simple Semantic Modeling in XML method with experiences and best-practices from the KoSIT that have emerged over time. In the interview, it is pointed out that the KoSIT must meticulously plan standardization efforts such as the XKatalog by conducting a variety of preparations before the specification process itself starts. First, the KoSIT evaluates whether a relevant need within the field of Public E-Procurement exists that can be covered by a standard. It is emphasized that not all needs require standards, and it must be analysed in great detail if a system or software solution will satisfy the demand or not. If a standard is required, the KoSIT will subsequently conduct further preparation in line with the European Interoperability Framework. The KoSIT sticks very closely to the EIF as a standardization guideline and stresses the importance of understanding all layers of interoperability before specifying the standard itself; this is due to the philosophy of designing standards that allow all relevant systems using the standard to communicate seamlessly with each other, even if the KoSIT does not know about the existence of every single relevant system beforehand.

„Alle Standards, die wir machen, dienen dazu, dass die verschiedensten Systeme, die wir teilweise während der Standardisierung noch nicht mal kennen, miteinander reden können, wenn sie sich an diesen Standard halten."

In line with this philosophy, the KoSIT meticulously analyses the standards interoperability environment through the lens of all four of the EIF's main layers: legal interoperability, organizational interoperability, semantic interoperability and technical interoperability (see section 3.3.1.1). While most considerations directly follow the EIF's layers, the KoSIT emphasizes its role on the organizational layers as the main coordinating body responsible for harmonizing the interests of various organizations in expert panels via careful compromises between the stakeholders' different interests. Furthermore, Renzo Kottmann discusses the interplay between the semantic and technical layers, arguing that KoSIT standards are always specified from a semantic domain view that the technical implementation must measure itself against, although constant back- and forth dialogue between the layers is desirable.

„[…] wichtig zu beachten ist, die technische Ebene ist dazu da, die fachlichen Bedingungen, Voraussetzungen, Festlegungen umzusetzen und nicht zu diktieren."

For this reason, the KoSIT not only releases human-readable documentation for standards but also develops technical components such as validation tools to simplify the implementation of standards into an organization's productive environment.

Once these considerations are complete, the core standardization process starts. In the field of Public E-Procurement, for specifying XEinkauf standards, the process is in line with the SeMoX method as described in section 2.3.7 and works as follows. First, all relevant business terms and rules are defined from a domain perspective and evaluated iteratively in predefined batches during expert panels by domain experts to ensure semantic definitions are as accurate as possible. Second, the structure of business terms is determined to define their affiliation and placement among themselves and also evaluated iteratively by the experts. While the business terms' exact placement order is of secondary importance, further technical considerations foremost require that relevant business terms can simply be found somewhere in the structure. Third, datatypes are assigned to each of the terms to provide valuable information for the technical implementation in the form of permissible values and characters. While the SeMoX standardization approach suggests that more considerations such as Codelists and Syntax Bindings are necessary in practice, the explanation on the core standardization process is concluded in the interview to discuss the difference of semantic and technical evaluation. While the KoSIT emphasizes the importance of constantly having domain experts validate the domain accuracy of a standard, the evaluation of technical implementations is conducted through different methods. Preferably, the KoSIT itself wants to define how domain knowledge can be technically implemented; instead of directly validating technical components, domain experts are thus handed the results of technical considerations such as datatypes or cardinalities in sample procurement documents to review whether the depicted terms, their values and their overall structure are in line with industry expectations (see also section 5.4). This is due to their experience on a lack of technical knowledge from domain experts.

"Wir möchten im Expertengremium Experten haben und nach wie vor ist die Wahrscheinlichkeit gering, dass sie sowohl Experten ihrer Wissensdomäne sind, wie zum Beispiel dem Bereich der Vorzugsschlagserklärung, […] [als] auch wissen, was Datentypen sind und wie man sie typisiert. Deswegen machen wir […] ganze Beispieldokumente […]."

At some point, this iterative validation through experts must come to end so that the specified standard can be released. As pointed out during the interview, the definition of a standard being done varies from standard to standard and must be defined in accordance with its objectives. Given that a collection of all mandatory fields could be regarded as a standard in itself, defining a definition of done can be challenging in practice and must be subject to careful evaluation.

„[…] die Menge der Mussfelder ist sehr endlich in allen Standards. Damit hat man eigentlich schon eine minimale Definition of Done. Und man kann auch sagen, […] das ist schon eine veröffentlichungswürdige Version. Und weil man dann nämlich sagt, was gibt es denn noch für optionale weitere Möglichkeiten, […] dann wird's ein bisschen schwammig mit, was ist eigentlich definition of done? Insofern ist das wirklich immer eine pro Standard konkret zu beantwortende Frage. […] Also zum Beispiel XRechnung als

auch eForms-DE, sind sozusagen erst dann veröffentlicht, wenn sie auch im Bundesanzeiger erscheinen. Also das sind zwei Standards, die rechtlich der Verwaltung vorgegeben werden.“

On average, the core standardization process takes about two years. However, depending on the scale of the standard, this duration may vary quite a lot in practice. Finally, once the standard is released, the KoSIT is tasked with maintaining the standard and improving it over time, particularly in regard to changes in the legislative environment.

“Teil des Auftrags der Koordinierungsstelle für Standards in der IT, eben der KoSIT, ist es Standards auch zu betreiben und zu pflegen und die Aufgabe wird auch gefasst als, <u>auch zu verbessern</u>, also nicht einfach nur das ist festgehalten, ein Standard ist ein Standard und der wird nie geändert. Es gibt solche Standards, die auch wirklich nicht so schnell geändert werden sollten, aber gerade im Datenbereich ist das sehr wichtig, das zu implementieren und sozusagen einen sehr kontinuierlichen, […] klar geregelten Change-Prozess zu machen, weil Gesetzeslagen sich ändern.“

When synthesizing the interview results with the scope of this thesis, several conclusions can be drawn. First, the KoSIT’s meticulous standardization approach matches the Design Science Research philosophy of this thesis. While the KoSIT’s clear focus lies on analysing and enabling interoperability in accordance with the EIF before specifying a standard, this preparation is further supplemented in this work by additionally building a rigorous foundation from literature during the DSR’s rigor cycle (see chapter 1). Moreover, all of the XKatalog’s architectural implications and requirements are analysed in line with the FISAD (see chapter 4). Architectural artifacts, resulting requirements, and the XKatalog specification itself are constantly validated and improved upon during the DSR’s relevance and design cycles in expert workshops (see section 2.3.2) via the application of steps three to five of the DSRM. Therefore, it can be deduced that the standardization efforts on the XKatalog as presented within this thesis are perfectly in line with the standardization approach of the German Coordination Office for IT-Standards. Second, however, this work cannot produce a perfectly polished XKatalog standard due to the limited number of resources available. While not inherent limitations of this thesis itself, it cannot be expected that the significantly lower number of participating E-Catalogue experts during the workshops and the much shorter development timespan of only about six months can lead to a final XKatalog standard that is ready for use in practice immediately. As such, lastly, in line with the FISAD’s sixth process step (see section

2.2.2), both the architectural considerations of chapter 4 as well as the SeMoX specification of the XKatalog alongside its technical components are to be used as a reference architecture by the KoSIT for further development on the XKatalog standard in the future.

5.2 SeMoX Specification

This section discusses general results of and notable design choices on the XKatalog's specification in SeMoX [23]. Upfront, it is important to highlight that multilingualism, in line with both the EIF [10] as well as Schmitz and Leukel [96] and thus requirement F-REQ-8, is implemented for all SeMoX components via the use of the 'xml:lang' attribute. For all texts, both English and German translations are provided and marked up with their respective country codes of 'en' for English and 'de' for German in the model. This way, when generating the specification, either English or German can be indicated as a language of choice for the resulting PDF-file. Translations between both languages are conducted via the translation tool DeepL[98] and manually edited to ensure correctness. In this context, it is important to highlight that the current PDF-generator component of SeMoX does not support full multilingualism yet. While most basic texts can be generated based on the chosen generation language, not all headers, sections and tables can be translated in the PDF in SeMoX's current version. This is a known issue, and future work on SeMoX may aim to enable fully multilingual PDF-generation. Moreover, in line with the FISAD synthesis conducted in section 4.6, Peppol is utilized as the foundation for all SeMoX components. In the following, all components are discussed.

5.2.1 Semantic Datatypes

First, the XKatalog's SeMoX model describes Semantic Datatypes via an identifier, a name and a description. Notably, a distinction between primitive datatypes and non-primitive datatypes is made. The primitive datatypes 'binary', 'decimal' and 'string' are based on common datatypes of software and programming language and depicted in Figure 27. Additionally, the primitive datatype 'any' can be used as a placeholder to express that absolutely no restriction on data values is made.

---

[98] https://www.deepl.com/en/products/translator last access: 14.01.2025

```xml
<m:datatype id="binary" minOccurs="1" maxOccurs="1">
    <m:name xml:lang="de">Binary</m:name>
    <m:name xml:lang="en">Binary</m:name>
    <m:description xml:lang="de">
        Ein primitiver Datentyp. Eine Menge binärer Ziffern mit begrenzter Länge.
    </m:description>
    <m:description xml:lang="en">A primitive data type. A set of binary digits with
        a limited length.</m:description>
</m:datatype>
<m:datatype id="decimal" minOccurs="1" maxOccurs="1">
    <m:name xml:lang="de">Decimal</m:name>
    <m:name xml:lang="en">Decimal</m:name>
    <m:description xml:lang="de">Ein primitiver Datentyp. Eine Untergruppe der reellen Zahlen,
        die durch dezimale Numerale abgebildet werden kann.</m:description>
    <m:description xml:lang="en">A primitive data type. A subgroup of real numbers that can be
        represented by decimal numerals.</m:description>
</m:datatype>
<m:datatype id="string" minOccurs="1" maxOccurs="1">
    <m:name xml:lang="de">String</m:name>
    <m:name xml:lang="en">String</m:name>
    <m:description xml:lang="de">Ein primitiver Datentyp. Eine endliche Folge von Zeichen.</m:description>
    <m:description xml:lang="en">A primitive data type. A finite sequence of characters.</m:description>
</m:datatype>
```

Figure 27: Primitive Datatypes, retrieved from the XKatalog's SeMoX-Model

Based on these basic datatypes, all other datatypes can be described semantically by describing how they further restrict the permitted value range of the primitive datatype they are based on. Additionally, examples may be provided for each Semantic Datatype to ensure a better understanding of its semantic intent. For instance, as depicted in Figure 28, the datatype 'url' restricts the primitive datatype 'string' by defining that only sequences of characters that describe an electronic address in the form of a uniform resource locator are permitted. Additionally, the datatype 'percentage' restricts the primitive datatype 'decimal' by only permitting numeric information in the form of percentages. All Semantic Datatypes are either directly based on the datatypes used in Peppol, the UBL datatypes[99], or semantically adapted versions of these datatypes as specified in the XRechnung [22].

[99] https://www.datypic.com/sc/ubl21/s-UBL-UnqualifiedDataTypes-2.1.xsd.html last access: 05.01.2025

```xml
<m:datatype id="url" restricts="string" minOccurs="1" maxOccurs="1">
    <m:name xml:lang="de">URL</m:name>
    <m:name xml:lang="en">URL</m:name>
    <m:description xml:lang="en">This field shall contain an electronic address, typically a uniform resource
        locator (e.g. a web address).
    </m:description>
    <m:description xml:lang="de">Dieses Feld enthält eine elektronische Adresse, in der Regel einen Uniform
        Resource Locator (z. B. eine Webadresse).
    </m:description>
    <m:example>https://xeinkauf.de/</m:example>
</m:datatype>
<m:datatype id="percentage" restricts="decimal" minOccurs="1" maxOccurs="1">
    <m:name xml:lang="de">Percentage</m:name>
    <m:name xml:lang="en">Percentage</m:name>
    <m:description xml:lang="en">Numeric information that is assigned or is determined by calculation, counting,
        or sequencing and is expressed as a percentage.
    </m:description>
    <m:description xml:lang="de">Numerische Information, die durch Berechnung, Zählung oder Sequenzierung
        zugewiesen oder bestimmt wird und als Prozentsatz ausgedrückt wird.
    </m:description>
    <m:example>50.84</m:example>
</m:datatype>
```

Figure 28: Examples of Semantic Datatypes, retrieved from the XKatalog's SeMoX-Model

Lastly, Semantic Datatypes may also have an assigned cardinality via the use of 'MinOccurs' and 'MaxOccurs'. The reason as to why datatypes can be assigned with a cardinality is mostly rooted in the concept of datatype components, which Peppol refers to as attributes. Components are used to further indicate the type of information expected within the permitted value range of a given datatype, for example, as illustrated in Figure 29, a 'scheme-id' may be used alongside an 'identifier' datatype to indicate that both the identifier itself as well as its scheme pattern in the form of another identifier are required. In this context, the 'scheme-id' component's cardinality of 0..1 is used to illustrate that each 'identifier' may have zero to one 'scheme identifiers', depending on the context in which the element is used. A further discussion on the use of components in the XKatalog's data structure can be found in section 5.2.4.

```xml
<m:datatype id="identifier" restricts="string" minOccurs="1" maxOccurs="1">
    <m:name xml:lang="de">Identifier</m:name>
    <m:name xml:lang="en">Identifier</m:name>
    <m:description xml:lang="en">This field shall contain a set of information allowing unique identification.
    </m:description>
    <m:description xml:lang="de">Dieses Feld enthält Informationen, die eine eindeutige Identifizierung
        ermöglichen.
    </m:description>
    <m:example>abc:123-DEF</m:example>
    <m:component id="scheme-id" restricts="string" minOccurs="0" maxOccurs="1">
        <m:name xml:lang="de">Scheme identifier</m:name>
        <m:name xml:lang="en">Scheme identifier</m:name>
        <m:description xml:lang="de">Mit dieser Eigenschaft wird die Kennung des verwendeten Bildungsmusters
            angegeben. Die Kardinalität der Eigenschaft ist im Kontext eines Informationselements, das auf dem
            Datentyp Identifier basiert, spezifiziert.</m:description>
        <m:description xml:lang="en">This property is used to specify the identifier of the pattern used by the
            element. The cardinality of the property is specified in the context of a BT that has the identifier
            data type.</m:description>
        <m:example>GLN</m:example>
    </m:component>
```

Figure 29: Example of a ‘scheme-id’ component, retrieved from the XKatalog's SeMoX-Model

5.2.2 Codelists

Codelists are a necessary, logical extension to realize the semantic intent of the datatype ‘code’, which is depicted in Figure 30. The datatype itself indicates that only a value that matches one of the values from a predefined list, a so called Codelist, is allowed.

```xml
<m:datatype id="code" restricts="string"  minOccurs="1" maxOccurs="1">
    <m:name xml:lang="de">Code</m:name>
    <m:name xml:lang="en">Code</m:name>
    <m:description xml:lang="en">This field shall contain values from a predefined list.</m:description>
    <m:description xml:lang="de">Dieses Feld enthält Werte aus einer definierten Codeliste.</m:description>
    <m:example>ABC123</m:example>
</m:datatype>
```

Figure 30: The Semantic Datatype 'code', retrieved from the XKatalog's SeMoX-Model

As such, a total of 17 Codelists are currently utilized in the XKatalog to enforce several standardized permitted value ranges. For example, Figure 31 illustrates the ‘icd’ Codelist that standardizes scheme identifiers (see section 5.2.1) in compliance with ISO/IEC 6523. Each Codelist within the XKatalog’s SeMoX-Model has a name, description, link and version; this allows users of the standard to quickly navigate towards the relevant Codelist and determine which permitted values they may use in their specific context.

```xml
<m:codelist id="icd">
    <m:name xml:lang="en">ISO/IEC 17 6523 ICD</m:name>
    <m:name xml:lang="de">ISO/IEC 17 6523 ICD</m:name>
    <m:description xml:lang="de">Identifier scheme code (kompatibel zu ISO 6523)</m:description>
    <m:description xml:lang="en">Identifier scheme code (compatible with ISO 6523)</m:description>
    <m:link>https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:icd_5</m:link>
    <m:version>5</m:version>
</m:codelist>
```

Figure 31: Example of an 'icd' Codelist, retrieved from the XKatalog's SeMoX-Model

Most of the XKatalog's Codelists are directly based on the Codelists of the Peppol Catalogue. However, whereas Peppol points towards external sources for most of its Codelists, the XKatalog references the KoSIT's internal XRepository[100] whenever possible due to it being readily accessible, actively maintained and providing various output formats. Since the XRepository does not contain all Codelists, discussions on how to handle Codelists for the XKatalog took place during workshop W11. For the scope of this thesis, the XKatalog will point toward external sources for Codelists not maintained in the XRepository for now; in the future, the KoSIT plans to incorporate all Codelists that relevant to the scope of the XKatalog in the XRepository as well. Lastly, as pointed out in section 2.3.7, the model itself only indicates that Codelists must be adhered to; the technical implementation of whether Codelists are actually adhered to in XKatalog instances is done via the XKatalog-Validator (see section 5.4.1).

5.2.3 Business Terms

A total of 161 Business Terms (BTs) are used to capture the semantics of relevant concepts in the XKatalog. Figure 32 illustrates the 'Catalogue provider identifier' as an exemplary term. Each BT requires an id, a name and a description. Notably, since the XKatalog is directly based on the Peppol Catalogue, BTs with roots in the Peppol standard are annotated with 'p:id' references that indicate their corresponding identifier in Peppol. This direct referencing ensures that no ambiguities on a BT's origin arises to comply with the EIF's core interoperability principle on transparency (see section 3.3.1.2). Furthermore, a datatype is assigned to each term to restrict its permitted value range in line with its semantic intent. If a Semantic Datatype component such as a scheme identifier is required to provide further indications on the expected data values of the BT's Semantic Datatype, it is provided as an additional datatype within the term's definition. While this is not a clear-cut solution for implementing components, possible improvements have been discussed during workshop W14. In the future, the addition of a dedicated component reference within SeMoX's definition sections for BTs is planned.

[100] https://www.xrepository.de/ last access: 05.01.2025

```xml
<m:term datatype="identifier" id="BT-14" p:id="tir19-010">
    <m:name xml:lang="en">Catalogue provider identifier</m:name>
    <m:name xml:lang="de">Catalogue provider identifier</m:name>
    <m:description xml:lang="en">Use in the absence of or in addition to the party name. Use an identifier known
        to the document recipient.
    </m:description>
    <m:description xml:lang="de">Verwendung in Abwesenheit des Namens oder zusätzlich zu diesem.
        Es sollte ein Identifikator verwendet werden, der dem Empfänger des Dokuments bekannt ist.</m:description>
    <m:datatype id="bt-14-scheme-id" minOccurs="0" maxOccurs="1">
        <m:name xml:lang="de">Scheme identifier</m:name>
        <m:description xml:lang="de">Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten
            Bildungsmusters angegeben.</m:description>
        <m:description xml:lang="en">This property is used to specify the identifier of the pattern used by the
            element.</m:description>
    </m:datatype>
</m:term>
```

Figure 32: Example of the 'Catalogue Provider Identifier' as a BT, retrieved from the XKatalog's SeMoX-Model

Moreover, the datatype ‘group’ can be used to indicate that a term is a group of other terms, a Business Group (BG). While the XKatalog’s list of definitions is flat, indications on whether a term is a group of other terms are necessary for building its structure. Figure 33 depicts the ‘Catalogue provider’ as an example.

```xml
<m:term datatype="group" id="BG-3">
    <m:name xml:lang="en">Catalogue provider</m:name>
    <m:name xml:lang="de">Catalogue provider</m:name>
    <m:description xml:lang="en">The party that sends the catalogue. The seller or a catalogue repository.
    </m:description>
    <m:description xml:lang="de">Die Geschäftspartei, die den Katalog bereitstellt.
        Ein Verkäufer oder ein Katalog-Repository.</m:description>
</m:term>
```

Figure 33: Example of the 'Catalogue Provider' as a BG, retrieved from the XKatalog's SeMoX-Model

Further discussions on the semantics, structure and origin of BTs are placed in the next section.

5.2.4 Structure and Data Model

Through defining the affiliation of all terms amongst each other as well as their cardinality, the XKatalog’s full Structure can be specified. The Structure is one of the XKatalog’s most essential components as it illustrates all of its BTs, where exactly they belong in the message and whether they can exist exactly once (0..1), must exist exactly once (1..1), can exist multiple times (0..n) or must exist at least once (1..n). An excerpt of the XKatalog’s structure in SeMoX is shown in Figure 34. There are several design choices to note here. First, the message is constructed by simply referencing the flat lists of terms via their ID in the desired place and order; the inherent nesting capabilities of XML are utilized to specify the desired parent BG and layer for every BT. In Practice, this way of defining the message has led to a very robust and agile change management for the XKatalog’s Structure as references can be changed at any time immediately by simply adjusting the reference IDs and/or nesting in line with the desired changes. Second, ‘p:rule’ annotations indicate corresponding Peppol rules on cardinality for a given BT. As such, any BT with a ‘p:rule’ annotation references the exact Peppol rule that specifies its cardinality as mandatory, thereby significantly increasing the transparency of the XKatalog’s Structure in line with the EIF’s core interoperability principles (see section 3.3.1.2). A further discussion on the design choices for rules is placed in section 5.2.5. Third, the default cardinality is set to 1..1, meaning that any BG or BT without the specific mention of ‘minOccurs=0’ or ‘maxOccurs=unbounded’ is automatically defined as a mandatory 1..1 element in the model. This helps to keep the structure clear and concise.

```xml
<m:structure id="xkatalog">
    <m:name>XKatalog</m:name>
    <m:type>semantic</m:type>
    <m:description>Full semantic structure of the XKatalog.</m:description>
    <m:message>
        <m:group ref="BG-1">
            <m:term ref="BT-1" p:rule="PEPPOL-T19-B00101"/>
            <m:term ref="BT-2" p:rule="PEPPOL-T19-B00102"/>
            <m:term ref="BT-3" p:rule="PEPPOL-T19-B00103"/>
            <m:term ref="BT-4" minOccurs="0"/>
            <m:term ref="BT-5" minOccurs="0"/>
            <m:term ref="BT-6" p:rule="PEPPOL-T19-B00104"/>
            <m:term ref="BT-7" minOccurs="0"/>
            <m:term ref="BT-8" minOccurs="0"/>
            <m:term ref="BT-9" minOccurs="0"/>
            <m:term ref="BT-158" minOccurs="0"/>
            <m:term ref="BT-10" minOccurs="0"/>
            <m:group ref="BG-2" p:rule="PEPPOL-T19-B00105">
                <m:term ref="BT-11" minOccurs="0"/>
                <m:term ref="BT-12" minOccurs="0"/>
            </m:group>
```

Figure 34: Excerpt of the XKatalog’s structure, retrieved from the XKatalog's SeMoX-Model

Most notably, as a data standard, the XKatalog’s Structure is one of its most important components. There have been numerous changes to its Structure as highlighted in section 2.3.2. An overview of the XKatalog’s data model as a UML-Class Diagram is depicted in Figure 35. Most of the XKatalog’s structure is directly based on the Peppol Catalogue. While slight adjustments to the ordering and nesting of Peppol BTs has been made (see section 5.2.6), both their semantics and affiliations remain unchanged. All Classes with BTs that are direct adaptions from the Peppol Catalogue are highlighted in blue and all classes with extension BTs that are not part of the Peppol Catalogue are highlighted in beige.

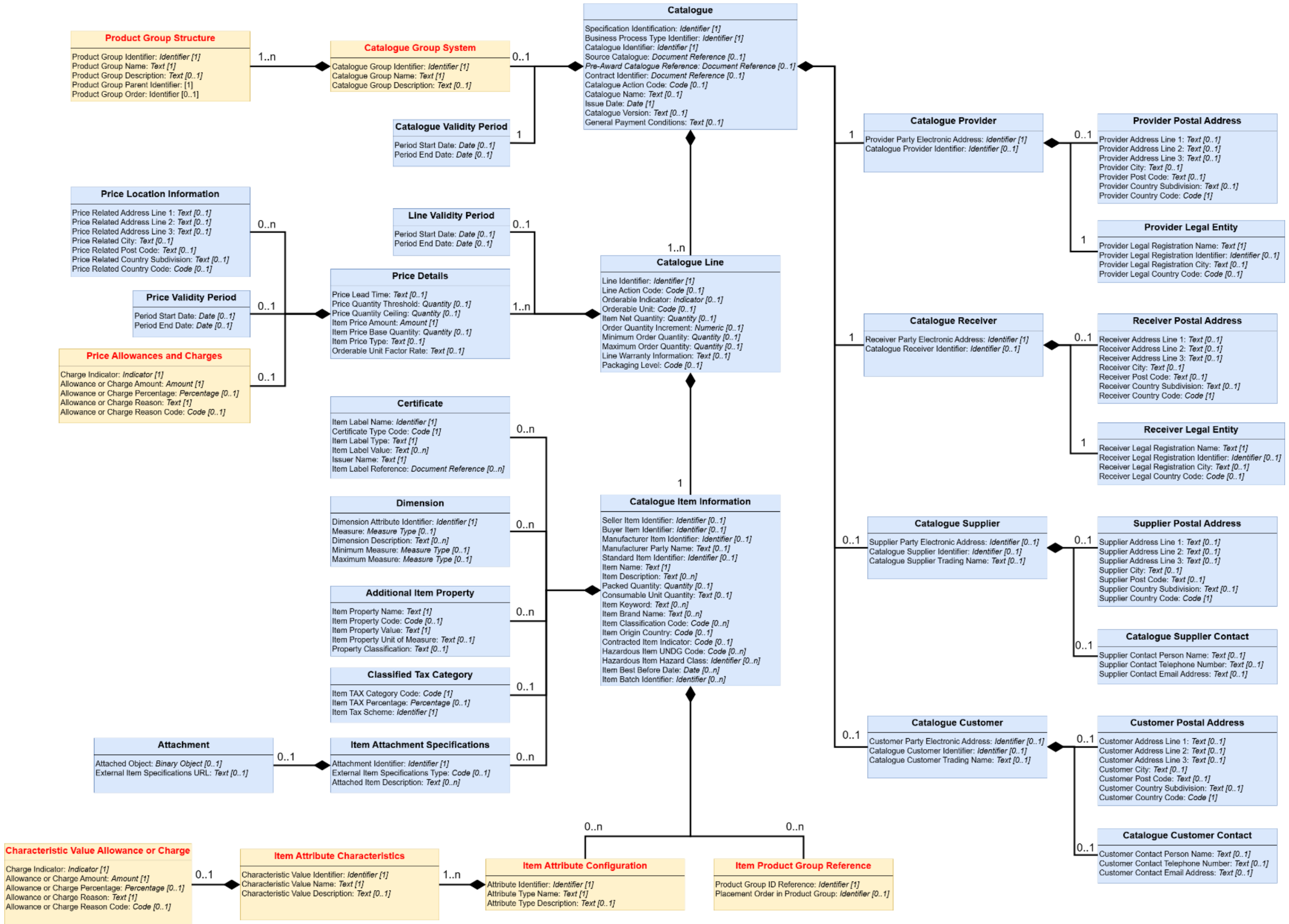

Figure 35: Data Model of the XKatalog, own visualization based on the structure of the XKatalog's SeMoX-Model

In order to discuss the XKatalog's overall Structure, the semantics of its BTs and their origins holistically, the following design choices are discussed hereafter:

1. **Peppol Catalogue**
    a. Which BTs are based on the Peppol Catalogue and why?
    b. Which BTs of the Peppol Catalogue are unused in the XKatalog and why?
2. **BMEcat**
    a. Which BTs are based on the BMEcat and why?
    b. How are they integrated into the underlying Peppol Catalogue Structure?
3. **XBestellung**
    a. Which BTs are based on the XBestellung and why?
    b. How are they integrated into the underlying Peppol Catalogue Structure?

1.a. Which BTs are based on the Peppol Catalogue and why?

Including the root Catalogue BG, a total of 26 of the 33 BGs, amounting to 135 out of 161 BTs, are directly based on the Peppol Catalogue, representing the vast majority of semantic definitions used within the XKatalog. The Peppol Catalogue can be interpreted as the XKatalog's skeleton, providing general catalogue and process related information in the root group (BG-1 excluding BT-158), incorporating all four possible catalogue related stakeholders (see also section 3.5.3) alongside their relevant party information (BG-3 to BG-14) and capturing line related information in the Catalogue Line (BG-17), which contains price related (BG-19, BG-20 and BG-22) and item related (BG-23 to BG-29) information. All incorporated BTs are evaluated to be suitable for national use in Germany, containing appropriate semantics and cardinalities. Therefore, the cardinalities and semantics of all 135 BTs are adopted from their respective counterpart in the Peppol Catalogue specification to ensure utmost interoperability with the standard.

1.b. Which BTs of the Peppol Catalogue are unused in the XKatalog and why?

While most of the Peppol Catalogue's definitions have been taken over into the XKatalog, some terms were deliberately excluded from the specification. These include all BTs of the 'Component related item', the 'Accessory related item', the 'Required related item' and the 'Replaced related item' Business Groups. As discussed during workshops W15 and W16, these four Item related BGs are excluded for the following reasons:

First, after analysing the Peppol Catalogue's specification and its sample XML-instances from Peppol, it is decided that neither their semantics, nor their use in practice, including the requirements they are supposed to fulfil, are sufficiently unambiguous. There are little to no sensible descriptions or examples provided in both the specification and example instances; even after consulting with one the EN17015 working group's convenors for the E-Catalogues transactions models, who is in charge of implementing definitions such as Peppol's related item classes into the XKatalog, this decision has remained firm. In general, these BGs aim to illustrate the connection of interrelated items to classify their purpose in relation to another item. While the reason as to why this helps EOs in describing their catalogue and CAs in reading it is evident, given that relations between items do exist in the real world and should thus also be depictable in the catalogue in an effort to capture the real world's semantics electronically, the concept's execution in the Peppol Catalogue is suboptimal. Given that an item may be interrelated with another item in a total of four possible ways, all four ways must be meticulously defined to ensure that an EO can unambiguously, ideally even instinctively, decide on the desired relation. This is not the case, as no targeted descriptions are provided for any of the related item BGs[101], and two of the three only semantic indications within the Catalogue's profile are directed towards logistical use-cases without mentioning which specific BG they even address[102].

Second, this means that the only way of defining relationships between items is on a line level. In practice, this leads to EOs having to specify all relationships in an ad-hoc manner while creating all of the singular item instances in the line; for each item specified in the line, the EO must go through each singular item instance again and specify to which other singular item instances that item is related to. If changes to these relations are needed, there is no central location in the XML that simplifies the change management process. While catalogue management tools may aid in this tedious work, it can be seen as unintuitive to require all relationships to be specified on per item instance per line level. A further discussion of how this approach was improved to allow for the specification of hierarchical product trees in line with the BMEcat is placed in the answer to design choice 2.a.

Due to these two arguments, the BTs of all four related item classes remain unused in the XKatalog for this thesis. While the EN strives to implement the related item classes in its transaction model in an improved version for the post-award catalogue, further

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[101] For example: https://docs.peppol.eu/poacc/upgrade-3/syntax/Catalogue/cac-CatalogueLine/cac-AccessoryRelatedItem/ last access: 05.01.2025

[102] https://docs.peppol.eu/poacc/upgrade-3/profiles/1-catalogueonly/#related-items last access: 05.01.2025

evaluations on their suitability for integration into the XKatalog must be conducted by the KoSIT in the future, at the latest upon the EN's release.

2.a. Which BTs are based on the BMEcat and why?

In line with the target data architecture (see section 4.3.2), several national requirements are implemented in accordance with the BMEcat's syntax and semantics. As a result, a total of five BGs with a total of 16 BTs are derived: the 'Catalogue group system' (BG-15) alongside its 'Product group structures' (BG-16) and 'Item product group references' (BG-30) and the 'Item attribute configuration' (BG-31) alongside its 'Item attribute characteristics' (BG-32).

BG-15, BG-16 and BG-30 realize the definition of hierarchical product trees (see W4), mainly through the definition of item parents and children via the 'Product group parent identifier' (BT-71) of BG-16. In general, BG-15 is based on the BMEcat's 'CATALOG_GROUP_SYSTEM', BG-16 on the BMEcat's 'CATALOG_STRUCTURE' and BG-30 on the BMEcat's 'PRODUCT_TO_CATALOGGROUP_MAP'.

BG-31 and BG-32 implement configurable products via the use of configurable attributes and characteristics. Although not explicitly mappable to just one element of the BMEcat due to its very complicated configurability feature (as highlighted during W18), BG-31 is based on the BMEcat's 'PRODUCT_CONFIG_DETAILS' and BG-32 is based on the BMEcat's 'CONFIG_STEP'.

Additionally, the specification of allowances and charges based on the selection of a certain attribute characteristic is also possible through the 'Characteristic value allowance or charge' (BG-33). However, since BG-33 is not based on the BMEcat, it is covered separately in design choice section 3.a. and 3.b.

2.b. How are they integrated into the underlying Peppol Catalogue Structure?

Since all Peppol standards are based on UBL, extensions to the Peppol Catalogue are integrated via UBL extension points[103]. For example, when integrating BG-15 into Peppol's UBL Catalogue structure, the 'ext:UBLExtensions' BG within the Catalogue's root[104] is used to insert the national extension at its designated place, one level below the root. Moreover, when integrating extensions that require a deeper extension point in the structure, a suitable extension point must be located at the desired level of the structure.

[103] https://www.datypic.com/sc/ubl21/e-ext_UBLExtensions.html last access: 05.01.2025

[104] https://www.datypic.com/sc/ubl21/e-ns11_Catalogue.html last access: 05.01.2025

For instance, in the case of BG-31, the group should be nested inside of the catalogue's 'Item' BG, where another 'ext:UBLExtensions' point is provided in the UBL structure[105]. Here, a complicated problem arises. The Peppol Catalogue is based on UBL 2.1; UBL 2.1 only has one extension point in the root. Therefore, only extensions to the Peppol Catalogue's root are possible, and all other extensions are forbidden. While UBL has fixed this issue in UBL 2.3, and all extensions of the XKatalog are possible in UBL 2.3, the Peppol Catalogue has not updated to UBL 2.3 yet. As such, interoperability between the XKatalog and the Peppol Catalogue remains complicated as long as this update has not been conducted by Peppol. As discussed in several workshops, Peppol must address this issue in a timely manner to allow national E-Catalogue standards such as the XKatalog to be fully compatible with Peppol. Otherwise, full interoperability is considered to be impossible. Alternatively, binding to UBL directly instead of Peppol may be advised for the future. In the following, the integration of the XKatalog's relevant adaptions of the BMEcat are discussed.

First, in terms of item and product hierarchies, the Peppol Catalogue operates on a per line basis to try and replicate the concept of item hierarchies. In contrast, the XKatalog utilizes an improved version of the BMEcat's catalogue group system to allow for a much more efficient specification of hierarchical trees. In the following, Figure 36 and Figure 37 illustrate a German example of hierarchical product trees from one of the XKatalog's test cases (see section 5.4.2). Similar to the concept of Business Terms and Structures in the XKatalog's SeMoX-Model, first, a flat list of all product groups is defined. This list contains no hierarchical information and solely exists for the purpose of collecting all desired product groups.

[105] https://www.datypic.com/sc/ubl23/e-cac_Item.html last access: 05.01.2025

```xml
<xkat:ProductGroups>
    <xkat:ProductGroup id="möbel">
        <xkat:Name>Möbel</xkat:Name>
        <xkat:Description>Die neusten Möbel aus dem Herbstkatalog der MusterMöbel GmbH.
        </xkat:Description>
    </xkat:ProductGroup>
    <xkat:ProductGroup id="möbel-büro">
        <xkat:Name>Büromöbel</xkat:Name>
        <xkat:Description>Die neusten Büromöbel aus dem Herbstkatalog der MusterMöbel GmbH.
        </xkat:Description>
    </xkat:ProductGroup>
    <xkat:ProductGroup id="regale-büro">
        <xkat:Name>Regale</xkat:Name>
        <xkat:Description>Mit Regalen kannst du deine Gegenstände zu Hause organisieren, lagern und
            präsentieren. Darüber hinaus können Regale auch als Gestaltungselemente dienen, um den
            Raum zu verschönern und persönlichen Stil auszudrücken.</xkat:Description>
    </xkat:ProductGroup>
```

Figure 36: Excerpt of a flat list of product groups, retrieved from an XKatalog test case

Subsequently, the hierarchical structure can simply be built by referencing all product groups in their desired order and nesting level. In line with SeMoX's own philosophy of targeted compartmentalization with clear references amongst its building blocks, hierarchical trees are thus built in a central place, through clear references to their corresponding product groups, thereby allowing users to easily read, maintain and change them whenever needed.

```xml
<xkat:Structure>
    <xkat:ProductGroup ref="möbel">
        <xkat:ProductGroup ref="möbel-büro">
            <xkat:ProductGroup ref="tische-büro">
                <xkat:ProductGroup ref="schreibtische-klassisch"/>
                <xkat:ProductGroup ref="schreibtische-eck"/>
                <xkat:ProductGroup ref="schreibtische-vstllbr"/>
            </xkat:ProductGroup>
            <xkat:ProductGroup ref="regale-büro">
            </xkat:ProductGroup>
            <xkat:ProductGroup ref="stühle-büro">
                <xkat:ProductGroup ref="stühle-büro-dreh"/>
                <xkat:ProductGroup ref="stühle-büro-ergo"/>
                <xkat:ProductGroup ref="stühle-büro-chef"/>
            </xkat:ProductGroup>
        </xkat:ProductGroup>
    </xkat:ProductGroup>
</xkat:Structure>
```

Figure 37: Building a hierarchical tree by referencing product groups, retrieved from an XKatalog test case

After defining such a structure, all that is left to do is for users to reference which product group(s) a product belongs to when defining an item in the line (see Figure 38).

```
<cac:Item>
    <ext:UBLExtensions>
        <ext:UBLExtension>
            <ext:ExtensionContent>
                <xkat:ItemAttributeExtension>
                    <xkat:ProductGroupReference ref="schreibtische-klassisch"/>
```
Figure 38: Referencing an item’s product group, retrieved from an XKatalog test case

Second, the configuration of products and attributes is realized through the simplification of the BMEcat’s product configuration component. Figure 39shows a German example retrieved from one of the XKatalog’s test case instances. In practice, the user simply defines what kind of attribute should be configured, for example, the material of an item, and then defines all desired characteristics of that attribute, for example, different types of woods. Due to feedback from workshop W18 regarding the complexity of the BMEcat’s product configurability, this solution is intentionally kept lightweight and extendable upon in the future. Additionally, characteristic values may have a positive or negative impact on an item’s prices, indicated via an allowance or charge. However, since this BG is not based on the BMEcat, it is covered in section 3.a. in detail.

```
<xkat:AttributeConfiguration id="material">
    <xkat:Name>Material des Tisches</xkat:Name>
    <xkat:Description>Als Material stehen mehrere potenzielle Auswahlmöglichkeiten zur
        Verfügung.</xkat:Description>
    <xkat:CharacteristicValue id="eiche">
        <xkat:Name>Eichenholzplatte</xkat:Name>
        <xkat:Description>Eine Tischplatte aus deutschem Eichenholz.</xkat:Description>
        <xkat:AllowanceOrCharge>
            <xkat:ChargeIndicator>true</xkat:ChargeIndicator>
            <xkat:Amount currencyID="EUR">30</xkat:Amount>
            <xkat:Reason>Hochqualitative Eiche.</xkat:Reason>
        </xkat:AllowanceOrCharge>
    </xkat:CharacteristicValue>
    <xkat:CharacteristicValue id="fichte">
        <xkat:Name>Fichtenholzplatte</xkat:Name>
        <xkat:Description>Eine Tischplatte aus deutschem Fichtenholz.</xkat:Description>
```
Figure 39: Configuring a table with different materials, retrieved from an XKatalog test case

In Peppol, such a configuration is not possible. While the ‘Additional item property’ (BG-24), which is also taken over from the Peppol Catalogue into the XKatalog, could theoretically be used to imitate product configurability, its structure and semantics indicate that it is not fit for that purpose[106]. Only one property can be defined in each ‘Additional

[106] https://docs.peppol.eu/poacc/upgrade-3/profiles/1-catalogueonly/#additional-properties last access: 05.01.2025

item property' instance and no impact on its price can be defined[107]. Instead, Peppol opts to outsource this feature from the catalogue into the so called "Punch Out Process"[108] of using an external system simply for the purpose of configuring products and importing the configured products back into the Peppol Catalogue. Hence, it requires additional prerequisites, processes, data transactions[109] and, as a result, a whole new kind of standard. While the EN currently also opts to use this same solution for the integration of product configurability (see also W18), from a German perspective, this seems unnecessary. While the BMEcat's product configurability may be too complex for some EOs in practice, this feature is still commonly used in the KDB and KDL (see W4) in Germany and thus clearly identified as a national requirement. Requiring a whole new standardization effort that leads to a further media disruption to simply allow products to be configured when it is very well possible - and productively used - within the catalogue standard itself may be evaluated as a questionable choice.

3.a. Which BTs are based on the XBestellung and why?

Exactly one BG is adopted from the XBestellung and used twice within the XKatalog. Both the general 'Price allowances and charges' (BG-21) on a line level as well as the specific 'Characteristic value allowance or charge' (BG-33) for configured products are based on the XBestellung's 'Price discount information' (BG-T01-45) [21, p. 59]. As identified during workshops W4 and W8, it should be possible to specify price discounts and surcharges for items. This allows EOs to better describe and sell their products and CAs to easily identify variable pricing based on the EO's items. Additionally, both the XBestellung and XRechnung utilize the exact same allowance and charge related BTs that are realized in the XKatalog for the same reason. Hence, adopting them from the XBestellung into the XKatalog leads to an increase in reusable data for all further post-award transactions and implements an important use-case for E-Catalogues in general. Since price allowances and charges can also be specified in the Peppol BIS Billing and Peppol BIS Order, which the XRechnung and XBestellung are based on, it is noteworthy that this is currently not possible within the Peppol Catalogue. Given that the current draft of the transaction model

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[107] https://docs.peppol.eu/poacc/upgrade-3/syntax/Catalogue/cac-CatalogueLine/cac-Item/cac-AdditionalItemProperty/ last access: 05.01.2025

[108] https://docs.peppol.eu/poacc/upgrade-3/profiles/18-punchout/#use-case-3-user-configures-productservices last access: 05.01.2025

[109] https://docs.peppol.eu/poacc/upgrade-3/syntax/PunchOut/tree/ last access: 05.01.2025

for post-award E-Catalogues of the EN17015[110] also integrates price allowances and charges, this has been identified as a significant gap within the Peppol Catalogue and should be addressed by Peppol in the near future.

3.b. How are they integrated into the underlying Peppol Catalogue structure?

As described in 2.b., extension points are utilized to integrate both BG-21 and BG-33 into their corresponding place in the Peppol Catalogue structure. While the issue of unavailable extension points in UBL 2.1 persists, in UBL 2.3, everything can be implemented seamlessly. As depicted in Figure 40, BG-21 is bound to the price's extension point[111] to specify a discount of 1 Euro for the catalogue line. It must simply be specified whether an allowance or charge is made on the price via the 'Charge indicator' (BT-94), before an amount (BT-95) and a reason for the price allowance or charge (BT-97) are specified.

```xml
<cac:RequiredItemLocationQuantity>
    <cbc:LeadTimeMeasure unitCode="DAY">2</cbc:LeadTimeMeasure>
    <cac:Price>
        <ext:UBLExtensions>
            <ext:UBLExtension>
                <ext:ExtensionContent>
                    <xkat:AllowanceChargeExtension>
                        <xkat:ChargeIndicator>false</xkat:ChargeIndicator>
                        <xkat:Amount currencyID="EUR">1</xkat:Amount>
                        <xkat:Reason>Special Offer of Fall 2024.</xkat:Reason>
                    </xkat:AllowanceChargeExtension>
                </ext:ExtensionContent>
            </ext:UBLExtension>
        </ext:UBLExtensions>
```

Figure 40: Specifying a price allowance, retrieved from an XKatalog test case

When configuring products, impacts on prices can be described in the same way via BG-33. As previously described, for each attribute characteristic, an allowance or charge can be indicated via BT-156, the exact amount can be specified in BT-157 and the reason can be provided through BT-160.

An overview of all XKatalog BTs as well as their origin can be found in Table 14 below.

[110] EN17015-2, draft of December 2024

[111] https://www.datypic.com/sc/ubl23/e-cac_Price.html last access: 06.01.2025

Table 14: Origin of the XKatalog structure

Cardinality	ID	Name	Origin
1..1	BG-1	Catalogue	(root)
1..1	BT-1	Specification identification	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-2	Business process type identifier	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-3	Catalogue identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-4	Catalogue action code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-5	Catalogue name	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-6	Catalogue issue date	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-7	Catalogue version	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-8	Source catalogue identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-158	Pre-award catalogue reference	Based on similar Peppol References
0..1	BT-9	Contract identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-10	General payment conditions	Peppol Catalogue Transaction 3.2 (T19)
1..1	BG-2	Catalogue validity period	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-11	Catalogue validity period start date	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-12	Catalogue validity period end date	Peppol Catalogue Transaction 3.2 (T19)
1..1	BG-3	Catalogue provider	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-13	Provider party electronic address	Peppol Catalogue Transaction 3.2 (T19)

1..1	BT-13-scheme-id	Provider party electronic address @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-14	Catalogue provider identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-14-scheme-id	Catalogue provider identifier @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-4	Provider postal address	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-15	Provider address line 1	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-16	Provider address line 2	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-17	Provider address line 3	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-18	Provider city	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-19	Provider post code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-20	Provider country subdivision	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-21	Provider country code	Peppol Catalogue Transaction 3.2 (T19)
1..1	BG-5	Provider legal entity	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-22	Provider legal registration name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-23	Provider legal registration identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-24	Provider legal registration city	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-25	Provider legal registration country code	Peppol Catalogue Transaction 3.2 (T19)
1..1	BG-6	Catalogue receiver	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-26	Receiver party electronic address	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-26-scheme-id	Receiver party electronic address @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-27	Catalogue receiver identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-27-scheme-id	Catalogue receiver identifier @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-7	Receiver postal address	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-28	Receiver address line 1	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-29	Receiver address line 2	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-30	Receiver address line 3	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-31	Receiver city	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-32	Receiver post code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-33	Receiver country subdivision	Peppol Catalogue Transaction 3.2 (T19)

1..1	BT-34	Receiver country code	Peppol Catalogue Transaction 3.2 (T19)
1..1	BG-8	Receiver legal entity	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-35	Receiver legal registration name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-36	Receiver legal registration identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-37	Receiver legal registration city	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-38	Receiver legal registration country code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-9	Catalogue supplier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-39	Supplier party electronic address	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-39-scheme-id	Supplier party electronic address @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-40	Catalogue supplier identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-40-scheme-id	Catalogue supplier identifier @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-41	Catalogue supplier trading name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-10	Supplier postal address	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-42	Supplier address line 1	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-43	Supplier address line 2	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-44	Supplier address line 3	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-45	Supplier city	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-46	Supplier post code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-47	Supplier country subdivision	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-48	Supplier country code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-11	Catalogue supplier contact	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-49	Supplier contact person name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-50	Supplier contact telephone number	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-51	Supplier contact email address	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-12	Catalogue customer	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-52	Customer party electronic address	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-52-scheme-id	Customer party electronic address @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-53	Catalogue customer identifier	Peppol Catalogue Transaction 3.2 (T19)

0..1	BT-53-scheme-id	Catalogue customer identifier @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-54	Catalogue customer trading name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-13	Customer postal address	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-55	Customer address line 1	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-56	Customer address line 2	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-57	Customer address line 3	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-58	Customer city	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-59	Customer post code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-60	Customer country subdivision	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-61	Customer country code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-14	Catalogue customer contact	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-62	Customer contact person name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-63	Customer contact telephone number	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-64	Customer contact email address	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-15	Catalogue group system	BMEcat 2005.2
1..1	BT-65	Catalogue group identifier	BMEcat 2005.2
1..1	BT-66	Catalogue group name	BMEcat 2005.2
0..1	BT-67	Catalogue group description	BMEcat 2005.2
1..n	BG-16	Product group structure	BMEcat 2005.2
1..1	BT-68	Product group identifier	BMEcat 2005.2
1..1	BT-69	Product group name	BMEcat 2005.2
0..1	BT-70	Product group description	BMEcat 2005.2
1..1	BT-71	Product group parent identifier	BMEcat 2005.2
0..1	BT-72	Product group order	BMEcat 2005.2
1..n	BG-17	Catalogue line	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-73	Line identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-74	Line action code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-75	Orderable indicator	Peppol Catalogue Transaction 3.2 (T19)

0..1	BT-76	Orderable unit	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-77	Item net quantity	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-77-unit-code	Item net quantity @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-78	Order quantity increment	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-79	Minimum order quantity	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-79-unit-code	Minimum order quantity @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-80	Maximum order quantity	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-80-unit-code	Maximum order quantity @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-81	Line warranty information	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-82	Packaging level	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-18	Catalogue line validity period	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-83	Catalogue line validity period start date	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-84	Catalogue line validity period end date	Peppol Catalogue Transaction 3.2 (T19)
1..n	BG-19	Price details	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-85	Price lead time	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-86	Price quantity threshold	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-87	Price quantity ceiling	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-88	Item price amount	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-88-currency-id	Item price amount @currencyID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-89	Item price base quantity	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-90	Item price type	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-91	Orderable unit factor rate	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-20	Price validity period	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-92	Price validity period start date	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-93	Price validity period end date	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-21	Price allowances and charges	XBestellung 1.0
1..1	BT-94	Charge indicator	XBestellung 1.0
1..1	BT-95	Allowance or charge amount	XBestellung 1.0

1..1	BT-95-currency-id	Allowance or charge amount @currencyID	XBestellung 1.0
0..1	BT-96	Allowance or charge percentage	XBestellung 1.0
1..1	BT-97	Allowance or charge reason	XBestellung 1.0
0..1	BT-98	Allowance or charge reason code	XBestellung 1.0
0..n	BG-22	Price location information	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-99	Price address line 1	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-100	Price address line 2	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-101	Price address line 3	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-102	Price city	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-103	Price post code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-104	Price country subdivision	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-105	Price country code	Peppol Catalogue Transaction 3.2 (T19)
1..1	BG-23	Catalogue item information	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-106	Seller item identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-107	Buyer item identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-108	Manufacturer item identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-109	Standard item identifier	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-109-scheme-id	Standard item identifier @schemeID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-110	Manufacturer party name	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-111	Item name	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-112	Item description	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-113	Item keywords	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-114	Item brand name	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-115	Item classification code	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-115-list-id	Item classification code @listID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-115-list-version-id	Item classification code @listVersionID	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-115-name	Item classification code @name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-116	Item origin country	Peppol Catalogue Transaction 3.2 (T19)

0..1	BT-117	Packed quantity	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-117-unit-code	Packed quantity @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-118	Consumable unit quantity	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-119	Contracted item indicator	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-120	Hazardous item UNDG code	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-121	Hazardous item hazard class identifier	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-122	Item best before date	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-123	Item batch identifier	Peppol Catalogue Transaction 3.2 (T19)
0..n	BG-24	Additional item property	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-124	Item property name	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-125	Item property code	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-125-list-id	Item property code @listID	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-126	Item property value	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-127	Item property unit of measure	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-127-unit-code	Item property unit of measure @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-128	Property classification	Peppol Catalogue Transaction 3.2 (T19)
0..n	BG-25	Certificate	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-129	Item label name	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-130	Certificate type code	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-131	Item label type	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-132	Item label value	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-133	Label issuer name	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-134	Item label reference	Peppol Catalogue Transaction 3.2 (T19)
0..n	BG-26	Dimension	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-135	Dimension attribute identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-136	Measure	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-136-unit-code	Measure @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-137	Dimension description	Peppol Catalogue Transaction 3.2 (T19)

0..1	BT-138	Minimum storage conditions	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-138-unit-code	Minimum storage conditions @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-139	Maximum storage conditions	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-139-unit-code	Maximum storage conditions @unitCode	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-27	Classified tax category	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-140	Item tax category code	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-141	Item tax percentage	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-142	Item tax scheme	Peppol Catalogue Transaction 3.2 (T19)
0..n	BG-28	Item attachment specification	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-143	Attachment identifier	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-144	External item specifications type	Peppol Catalogue Transaction 3.2 (T19)
0..n	BT-145	Attached item description	Peppol Catalogue Transaction 3.2 (T19)
0..1	BG-29	Attachment	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-146	Attached object	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-146-mime-code	Attached object @mimeCode	Peppol Catalogue Transaction 3.2 (T19)
1..1	BT-146-file-name	Attached object @filename	Peppol Catalogue Transaction 3.2 (T19)
0..1	BT-147	External item specifications	Peppol Catalogue Transaction 3.2 (T19)
0..n	BG-30	Item product group reference	BMEcat 2005.2
1..1	BT-148	Product group identifier reference	BMEcat 2005.2
0..1	BT-149	Placement order	BMEcat 2005.2
0..n	BG-31	Item attribute configuration	BMEcat 2005.2
1..1	BT-150	Attribute identifier	BMEcat 2005.2
1..1	BT-151	Attribute type name	BMEcat 2005.2
0..1	BT-152	Attribute type description	BMEcat 2005.2
0..n	BG-32	Item attribute characteristics	BMEcat 2005.2
1..1	BT-153	Characteristic value identifier	BMEcat 2005.2
1..1	BT-154	Characteristic value name	BMEcat 2005.2
0..1	BT-155	Characteristic value description	BMEcat 2005.2

0..1	BG-33	Characteristic value allowance or charge	XBestellung 1.0
1..1	BT-156	Charge indicator	XBestellung 1.0
1..1	BT-157	Allowance or charge amount	XBestellung 1.0
1..1	BT-157-currency-id	Allowance or charge amount @currencyID	XBestellung 1.0
0..1	BT-159	Allowance or charge percentage	XBestellung 1.0
1..1	BT-160	Allowance or charge reason	XBestellung 1.0
0..1	BT-161	Allowance or charge reason code	XBestellung 1.0

5.2.5 Rules

In the XKatalog, Rules are used to further assert constraints and restrictions on the use of BTs. The XKatalog groups these rules based on them being directly based on Peppol, a result of national extensions or enforcing Codelists and specified on which BTs they apply. In the XKatalog's PDF-specification (see Appendix C: German PDF-Specification of the XKatalo), this logical grouping of rules leads to dedicated rule tables for each group. Figure 41 depicts a simple example of a business rule that is directly adopted from Peppol. The Rule's identifier is identical to its Peppol ID, it is grouped in the Peppol rules, and it applies on the terms BT-11 and BT-12 to state that a validity period's end date must be later than or equal to its start date. In the rule description, another direct reference to the BTs is made to allow for cross-referencing and improved navigability in the PDF via just one click to jump to the specified terms.

```xml
<m:rule id="PEPPOL-T19-R001" groups="peppol-rules" on-terms="BT-11 BT-12">
    <m:description xml:lang="en">A catalogue validity period end date <m:termname>BT-12</m:termname> SHALL be
        later than or equal to its start date <m:termname>BT-11</m:termname>.
    </m:description>
    <m:description xml:lang="de">Das Enddatum des Gültigkeitszeitraums eines Katalogs
        <m:termname>BT-12</m:termname> muss größer oder gleich dem Anfangsdatum <m:termname>BT-11</m:termname>
        sein.</m:description>
</m:rule>
```

Figure 41: Simple example of a Business Rule from Peppol, retrieved from the XKatalog's SeMoX-Model

Codelist rules are enforced in a similar way. As seen in Figure 42, the use of Codelists on Terms is specified via references of both the Codelist itself and the BT it applies on. Once again, referencing within the description means that readers of the specification can jump to the Codelist or BT with just one click.

```xml
<m:rule id="PEPPOL-T19-B02001" groups="peppol-rules codelist-rules" on-terms="BT-14">
    <m:description xml:lang="en">Value of <m:termname>BT-14</m:termname> MUST be part of code list
        <m:codelistname id="icd">ISO/IEC 17 6523 ICD</m:codelistname>.</m:description>
    <m:description xml:lang="de">Der Wert von <m:termname>BT-14</m:termname> muss Teil der Codeliste
        <m:codelistname id="icd">ISO/IEC 17 6523 ICD</m:codelistname> sein.</m:description>
</m:rule>
```

Figure 42: Simple example of a Codelist Rule from Peppol, retrieved from the XKatalog's SeMoX-Model

Lastly, a notable design choice was made regarding cardinality rules. As touched upon in section 5.2.4, cardinalities are not enforced via business rules in the XKatalog; as opposed to Peppol, the XKatalog views cardinality rules as redundant when cardinalities themselves, defined via 'minOccurs' and 'maxOccurs' in the structure, provide all the required information for their correct implementation already. Hence, it was decided that no cardinality rules are defined in the rules section, and Peppol rules that enforce mandatory cardinalities are simply referenced via 'p:id' in the structure as previously seen to reduce data redundancy.

5.2.6 Syntax Binding

As illustrated in Figure 43, the XKatalog's full structure can be bound to the syntax of Peppol Catalogue XML instances to enable data parsing. A clear XML path of all BGs and BTs, queryable via XPath, is specified to locate their corresponding place in the XML instance. Once again, simply referencing the flat list of terms here allows for a simple and centralized maintenance of the Syntax Binding in the XKatalog. Since, an exact path is specified for all terms, the binding additionally contributes further towards increasing the XKatalog's transparency in line with the EIF's core principles. In the future, in line with the discussions of section 5.2.4, binding the syntax directly onto UBL 2.3 or 2.4 is recommended to overcome the extension point issues of UBL 2.1 that the Peppol Catalogue is based on and thus allow for national extensions to be specified. While theoretically possible already with minimal technical effort, this decision requires further discussions within the XKatalog's central IT-steering group. Moreover, there is no information on whether Peppol is currently aware of this issue and if or when an update to UBL 2.3 or 2.4 is planned. As such, this decision is defined to be out of the scope of this thesis and must be made in the future.

```xml
<m:binding>
    <m:structure>xkatalog</m:structure>
    <m:syntax id="peppol-full">
        <!--UBL 2.1 only has 1 extension point. Binding of all non-extension elements to Peppol-->
        <m:name>Full Binding to the Peppol Catalogue Transaction 3.2 (T19)</m:name>
        <m:type>xml</m:type>
        <m:query-language>xpath</m:query-language>
    </m:syntax>
    <m:term ref="BG-1" path="/Catalogue"/>
    <m:term ref="BT-1" path="/Catalogue/cbc:CustomizationID"/>
    <m:term ref="BT-2" path="/Catalogue/cbc:ProfileID"/>
    <m:term ref="BT-3" path="/Catalogue/cbc:ID"/>
    <m:term ref="BT-4" path="/Catalogue/cbc:ActionCode"/>
    <m:term ref="BT-5" path="/Catalogue/cbc:Name"/>
    <m:term ref="BT-6" path="/Catalogue/cbc:IssueDate"/>
    <m:term ref="BT-7" path="/Catalogue/cbc:VersionID"/>
    <m:term ref="BT-8" path="/Catalogue/cac:SourceCatalogueReference/cbc:ID"/>
    <m:term ref="BT-9" path="/Catalogue/cac:ReferencedContract/cbc:ID"/>
    <m:term ref="BT-10" path="/Catalogue/cac:TradingTerms/cbc:Information"/>
    <m:term ref="BG-2" path="/Catalogue/cac:ValidityPeriod"/>
    <m:term ref="BT-11" path="/Catalogue/cac:ValidityPeriod/cbc:StartDate"/>
```

Figure 43: Excerpt of the XKatalog's Syntax Binding to the Peppol Catalogue, retrieved from the XKatalog's SeMoX-Model

Furthermore, as depicted in Figure 44, components are also specified in the binding to specify their exact paths towards attributes in the XML instance. Currently, this is done suboptimally by referencing the same BT twice, once for the path with the component, which also includes an explanatory note, and once for the path without the component.

```
<m:term ref="BT-14" path="/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID/@schemeID">
    <m:note>Path to the schemeID component of BT-14.</m:note>
</m:term>
<m:term ref="BT-14" path="/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID"/>
```

Figure 44: Example for binding components to a syntax, retrieved from the XKatalog's SeMoX-Model

Since referencing the same BT twice instead of directly referencing the component itself leads to unambiguous references and redundancy, this has been identified as an issue within SeMoX. In future updates of SeMoX, direct referencing of components should be implemented in the Syntax-Binding to overcome this issue. A possible solution is mocked in Figure 45.

```
<m:term ref="BT-14" path="/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID">
    <m:component ref="bt-14-scheme-id" path="/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID/@schemeID"/>
</m:term>
```

Figure 45: Possible solution for referencing components in the Syntax-Binding, own depiction

5.3 Interoperability Mappings

Through the XKatalog's specification in SeMoX, interoperability Mappings of Business Terms in their respective Structure can now be conducted to ensure interoperability to the most relevant Public E-Procurement standards as synthesized in section 4.6, namely the Peppol pre-award Catalogue (see section 5.3.1) and the XBestellung (see section 5.3.2). For all mappings, the colour green indicates that an information element can be mapped without any problems, yellow indicates that mappability may be complicated or optional elements may not be fully mappable, and red indicates that mappability between the elements is not possible at all. Alongside these colours, further mapping information such as the path to the mapped element or comments on transformation feasibility are provided in the tables.

5.3.1 Peppol pre-award Catalogue

A complete syntax mapping with the Peppol pre-award Catalogue on value level, illustrated in Table 15 and validated during workshops W24 and W25, confirms that the XKatalog is able to carry over a highly significant amount of relevant procurement data from the pre-award to the post-award. A total of 115 out of 161 BTs of the XKatalog can be generated from transferring over pre-award Catalogue specific data. This includes generic catalogue information, all four possible actors that may interact with the catalogues and comprehensive data on the catalogue lines as well as their items, prices, allowances or charges and taxes. All of the 46 missing BTs are optional in the XKatalog and capture either post-award specific information or are part of the standard's national extension. As such, most missing BTs can be explained due to contractually specific information and a different significance of information about legal entities that are both unique to the post-award. Therefore, it can be concluded that there is a high interoperability between the Peppol pre-award Catalogue and the XKatalog which results in a significant amount of reusable pre-award data in the post-award.

Table 15: Complete syntax-mapping on value level between the XKatalog and the Peppol pre-award Catalogue, own mapping

XKatalog			Peppol pre-award Catalogue
Cardinality	**ID**	**Name**	**Mappability**
1..1	BG-1	Catalogue	/Catalogue
1..1	BT-1	Specification identification	/Catalogue/cbc:CustomizationID
1..1	BT-2	Business process type identifier	/Catalogue/cbc:ProfileID
1..1	BT-3	Catalogue identifier	/Catalogue/cbc:ID
0..1	BT-4	Catalogue action code	Missing, but optional and should be set manually
0..1	BT-5	Catalogue name	/Catalogue/cbc:Name
1..1	BT-6	Catalogue issue date	/Catalogue/cbc:IssueDate
0..1	BT-7	Catalogue version	/Catalogue/cbc:VersionID
0..1	BT-8	Source catalogue identifier	Missing, but optional
0..1	BT-158	Pre-award catalogue reference	Missing, but optional (national extension); */ContractDocumentReference/cbc:ID might also be usable
0..1	BT-9	Contract identifier	/Catalogue/cac:ReferencedContract/cbc:ID
0..1	BT-10	General payment conditions	/Catalogue/cbc:Note
1..1	BG-2	Catalogue validity period	/Catalogue/cac:ValidityPeriod

0..1	BT-11	Catalogue validity period start date	/Catalogue/cac:ValidityPeriod/cbc:StartDate
0..1	BT-12	Catalogue validity period end date	/Catalogue/cac:ValidityPeriod/cbc:EndDate
1..1	BG-3	Catalogue provider	/Catalogue/cac:ProviderParty
1..1	BT-13	Provider party electronic address	/Catalogue/cac:ProviderParty/cbc:EndpointID
1..1	BT-13-scheme-id	Provider party electronic address @schemeID	/Catalogue/cac:ProviderParty/cbc:EndpointID/@schemeID
0..1	BT-14	Catalogue provider identifier	/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID
0..1	BT-14-scheme-id	Catalogue provider identifier @schemeID	/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID/@schemeID
0..1	BG-4	Provider postal address	/Catalogue/cac:ProviderParty/cac:PostalAddress
0..1	BT-15	Provider address line 1	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:StreetName
0..1	BT-16	Provider address line 2	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:AdditionalStreetName
0..1	BT-17	Provider address line 3	/Catalogue/cac:ProviderParty/cac:PostalAddress/cac:AddressLine/cbc:Line
0..1	BT-18	Provider city	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:CityName
0..1	BT-19	Provider post code	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:PostalZone
0..1	BT-20	Provider country subdivision	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:CountrySubentity
1..1	BT-21	Provider country code	/Catalogue/cac:ProviderParty/cac:PostalAddress/cac:Country/cbc:IdentificationCode
1..1	BG-5	Provider legal entity	BG is not 100% mappable, name can be carried over but the semantics are slightly different
1..1	BT-22	Provider legal registration name	/Catalogue/cac:ProviderParty/cac:PartyName/cbc:Name
0..1	BT-23	Provider legal registration identifier	Missing, but optional
0..1	BT-24	Provider legal registration city	Missing, but optional
0..1	BT-25	Provider legal registration country code	Missing, but optional
1..1	BG-6	Catalogue receiver	/Catalogue/cac:ReceiverParty

1..1	BT-26	Receiver party electronic address	/Catalogue/cac:ReceiverParty/cbc:EndpointID
1..1	BT-26-scheme-id	Receiver party electronic address @schemeID	/Catalogue/cac:ReceiverParty/cbc:EndpointID/@schemeID
0..1	BT-27	Catalogue receiver identifier	/Catalogue/cac:ReceiverParty/cac:PartyIdentification/cbc:ID
0..1	BT-27-scheme-id	Catalogue receiver identifier @schemeID	/Catalogue/cac:ReceiverParty/cac:PartyIdentification/cbc:ID/@schemeID
0..1	BG-7	Receiver postal address	/Catalogue/cac:ReceiverParty/cac:PostalAddress
0..1	BT-28	Receiver address line 1	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:StreetName
0..1	BT-29	Receiver address line 2	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:AdditionalStreetName
0..1	BT-30	Receiver address line 3	Missing, but optional
0..1	BT-31	Receiver city	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:CityName
0..1	BT-32	Receiver post code	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:PostalZone
0..1	BT-33	Receiver country subdivision	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:CountrySubentity
1..1	BT-34	Receiver country code	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cac:Country/cbc:IdentificationCode
1..1	BG-8	Receiver legal entity	BG is not 100% mappable, name can be carried over but the semantics are slightly different
1..1	BT-35	Receiver legal registration name	/Catalogue/cac:ReceiverParty/cac:PartyName/cbc:Name
0..1	BT-36	Receiver legal registration identifier	Missing, but optional
0..1	BT-37	Receiver legal registration city	Missing, but optional
0..1	BT-38	Receiver legal registration country code	Missing, but optional
0..1	BG-9	Catalogue supplier	/Catalogue/cac:SellerSupplierParty/cac:Party
0..1	BT-39	Supplier party electronic address	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyIdentification/cbc:ID
1..1	BT-39-scheme-id	Supplier party electronic address @schemeID	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyIdentification/cbc:ID/@schemeID

0..1	BT-40	Catalogue supplier identifier	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyIdentification/cbc:ID
0..1	BT-40-scheme-id	Catalogue supplier identifier @schemeID	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyIdentification/cbc:ID/@schemeID
0..1	BT-41	Catalogue supplier trading name	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyName/cbc:Name
0..1	BG-10	Supplier postal address	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress
0..1	BT-42	Supplier address line 1	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:StreetName
0..1	BT-43	Supplier address line 2	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:AdditionalStreetName
0..1	BT-44	Supplier address line 3	Missing, but optional
0..1	BT-45	Supplier city	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:CityName
0..1	BT-46	Supplier post code	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:PostalZone
0..1	BT-47	Supplier country subdivision	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:CountrySubentity
1..1	BT-48	Supplier country code	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cac:Country/cbc:IdentificationCode
0..1	BG-11	Catalogue supplier contact	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact
0..1	BT-49	Supplier contact person name	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact/cbc:Name
0..1	BT-50	Supplier contact telephone number	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact/cbc:Telephone
0..1	BT-51	Supplier contact email address	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact/cbc:ElectronicMail
0..1	BG-12	Catalogue customer	/Catalogue/cac:ContractorCustomerParty/cac:Party
0..1	BT-52	Customer party electronic address	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyIdentification/cbc:ID
1..1	BT-52-scheme-id	Customer party electronic address @schemeID	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyIdentification/cbc:ID/@schemeID
0..1	BT-53	Catalogue customer identifier	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyIdentification/cbc:ID
0..1	BT-53-	Catalogue customer	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyIdentification/cbc:ID/@schemeI

	scheme-id	identifier @schemeID	D
0..1	BT-54	Catalogue customer trading name	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyName/cbc:Name
0..1	BG-13	Customer postal address	Missing, but optional
0..1	BT-55	Customer address line 1	Missing, but optional
0..1	BT-56	Customer address line 2	Missing, but optional
0..1	BT-57	Customer address line 3	Missing, but optional
0..1	BT-58	Customer city	Missing, but optional
0..1	BT-59	Customer post code	Missing, but optional
0..1	BT-60	Customer country subdivision	Missing, but optional
1..1	BT-61	Customer country code	Missing, but optional (conditional-mandatory)
0..1	BG-14	Catalogue customer contact	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact
0..1	BT-62	Customer contact person name	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact/cbc:Name
0..1	BT-63	Customer contact telephone number	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact/cbc:Telephone
0..1	BT-64	Customer contact email address	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact/cbc:ElectronicMail
0..1	BG-15	Catalogue group system	Missing, but part of the national extension
1..1	BT-65	Catalogue group identifier	Missing, but part of the national extension
1..1	BT-66	Catalogue group name	Missing, but part of the national extension
0..1	BT-67	Catalogue group description	Missing, but part of the national extension
1..n	BG-16	Product group structure	Missing, but part of the national extension
1..1	BT-68	Product group identifier	Missing, but part of the national extension
1..1	BT-69	Product group name	Missing, but part of the national extension
0..1	BT-70	Product group description	Missing, but part of the national extension
1..1	BT-71	Product group parent identifier	Missing, but part of the national extension

0..1	BT-72	Product group order	Missing, but part of the national extension
1..n	BG-17	Catalogue line	/Catalogue/cac:CatalogueLine
1..1	BT-73	Line identifier	/Catalogue/cac:CatalogueLine/cbc:ID
0..1	BT-74	Line action code	Missing, but optional
0..1	BT-75	Orderable indicator	/Catalogue/cac:CatalogueLine/cbc:OrderableIndicator
0..1	BT-76	Orderable unit	/Catalogue/cac:CatalogueLine/cbc:OrderableUnit
0..1	BT-77	Item net quantity	/Catalogue/cac:CatalogueLine/cbc:ContentUnitQuantity
1..1	BT-77-unit-code	Item net quantity @unitCode	/Catalogue/cac:CatalogueLine/cbc:ContentUnitQuantity/@unitCode
0..1	BT-78	Order quantity increment	/Catalogue/cac:CatalogueLine/cbc:OrderQuantityIncrementNumeric
0..1	BT-79	Minimum order quantity	/Catalogue/cac:CatalogueLine/cbc:MinimumOrderQuantity
1..1	BT-79-unit-code	Minimum order quantity @unitCode	/Catalogue/cac:CatalogueLine/cbc:MinimumOrderQuantity/@unitCode
0..1	BT-80	Maximum order quantity	/Catalogue/cac:CatalogueLine/cbc:MaximumOrderQuantity
1..1	BT-80-unit-code	Maximum order quantity @unitCode	/Catalogue/cac:CatalogueLine/cbc:MaximumOrderQuantity/@unitCode
0..1	BT-81	Line warranty information	/Catalogue/cac:CatalogueLine/cbc:WarrantyInformation
0..1	BT-82	Packaging level	/Catalogue/cac:CatalogueLine/cbc:PackLevelCode
0..1	BG-18	Catalogue line validity period	/Catalogue/cac:CatalogueLine/cac:LineValidityPeriod
0..1	BT-83	Catalogue line validity period start date	/Catalogue/cac:CatalogueLine/cac:LineValidityPeriod/cbc:StartDate
0..1	BT-84	Catalogue line validity period end date	/Catalogue/cac:CatalogueLine/cac:LineValidityPeriod/cbc:EndDate
1..n	BG-19	Price details	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity
0..1	BT-85	Price lead time	Missing, but optional
0..1	BT-86	Price quantity threshold	Missing, but optional
0..1	BT-87	Price quantity ceiling	Missing, but optional
1..1	BT-88	Item price amount	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cbc:PriceAmount
1..1	BT-88-	Item price amount	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cbc:PriceAmount

	currency-id	@currencyID	/@currencyID
0..1	BT-89	Item price base quantity	Missing, but optional
0..1	BT-90	Item price type	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cbc:PriceTypeCode
0..1	BT-91	Orderable unit factor rate	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cbc:OrderableUnitFactorRate
0..1	BG-20	Price validity period	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:ValidityPeriod
0..1	BT-92	Price validity period start date	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:ValidityPeriod/cbc:StartDate
0..1	BT-93	Price validity period end date	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:ValidityPeriod/cbc:EndDate
0..1	BG-21	Price allowances and charges	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:AllowanceCharge
1..1	BT-94	Charge indicator	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:AllowanceCharge/cbc:ChargeIndicator
1..1	BT-95	Allowance or charge amount	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:AllowanceCharge/cbc:Amount
1..1	BT-95-currency-id	Allowance or charge amount @currencyID	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:AllowanceCharge/cbc:Amount/@currencyID
0..1	BT-96	Allowance or charge percentage	Missing, but part of the national extension
1..1	BT-97	Allowance or charge reason	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cac:AllowanceCharge/cbc:AllowanceChargeReason
0..1	BT-98	Allowance or charge reason code	Missing, but part of the national extension
0..n	BG-22	Price location information	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:ApplicableTerritoryAddress
0..1	BT-99	Price address line 1	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:ApplicableTerritoryAddress/cbc:StreetName

0..1	BT-100	Price address line 2	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:ApplicableTerritoryAddress/cbc:AdditionalStreetName
0..1	BT-101	Price address line 3	Missing, but optional
0..1	BT-102	Price city	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:ApplicableTerritoryAddress/cbc:CityName
0..1	BT-103	Price post code	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:ApplicableTerritoryAddress/cbc:PostalZone
0..1	BT-104	Price country subdivision	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:ApplicableTerritoryAddress/cbc:CountrySubentity
0..1	BT-105	Price country code	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:ApplicableTerritoryAddress/cac:Country/cbc:IdentificationCode
1..1	BG-23	Catalogue item information	/Catalogue/cac:CatalogueLine/cac:Item
0..1	BT-106	Seller item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:SellersItemIdentification/cbc:ID
0..1	BT-107	Buyer item identifier	Missing, but optional
0..1	BT-108	Manufacturer item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:ManufacturersItemIdentification/cbc:ID
0..1	BT-109	Standard item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:StandardItemIdentification/cbc:ID
1..1	BT-109-scheme-id	Standard item identifier @schemeID	/Catalogue/cac:CatalogueLine/cac:Item/cac:StandardItemIdentification/cbc:ID/@schemeID
0..1	BT-110	Manufacturer party name	/Catalogue/cac:CatalogueLine/cac:Item/cac:ManufacturerParty/cac:PartyName/cbc:Name
1..1	BT-111	Item name	/Catalogue/cac:CatalogueLine/cac:Item/cbc:Name
0..n	BT-112	Item description	/Catalogue/cac:CatalogueLine/cac:Item/cbc:Description
0..n	BT-113	Item keywords	/Catalogue/cac:CatalogueLine/cac:Item/cbc:Keyword
0..n	BT-114	Item brand name	/Catalogue/cac:CatalogueLine/cac:Item/cbc:BrandName
0..n	BT-115	Item classification code	/Catalogue/cac:CatalogueLine/cac:Item/cac:CommodityClassification/cbc:ItemClassificationCode
1..1	BT-115-list-id	Item classification code @listID	/Catalogue/cac:CatalogueLine/cac:Item/cac:CommodityClassification/cbc:ItemClassificationCode/@listID
0..1	BT-115-list-version-id	Item classification code @listVersionID	Missing, but optional

0..1	BT-115-name	Item classification code @name	Missing, but optional
0..1	BT-116	Item origin country	/Catalogue/cac:CatalogueLine/cac:Item/cac:OriginCountry/cbc:IdentificationCode
0..1	BT-117	Packed quantity	/Catalogue/cac:CatalogueLine/cac:Item/cbc:PackQuantity
1..1	BT-117-unit-code	Packed quantity @unitCode	/Catalogue/cac:CatalogueLine/cac:Item/cbc:PackQuantity/@unitCode
0..1	BT-118	Consumable unit quantity	/Catalogue/cac:CatalogueLine/cac:Item/cbc:PackSizeNumeric
0..1	BT-119	Contracted item indicator	Missing, but optional
0..n	BT-120	Hazardous item UNDG code	/Catalogue/cac:CatalogueLine/cac:Item/cac:HazardousItem/cbc:UNDGCode
0..n	BT-121	Hazardous item hazard class identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:HazardousItem/cbc:ID
0..n	BT-122	Item best before date	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cbc:BestBeforeDate
0..n	BT-123	Item batch identifier	Missing, but optional
0..n	BG-24	Additional item property	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty
1..1	BT-124	Item property name	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty/cbc:Name
0..1	BT-125	Item property code	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty/cbc:NameCode
1..1	BT-125-list-id	Item property code @listID	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty/cbc:NameCode/@listID
1..1	BT-126	Item property value	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty/cbc:Value
0..1	BT-127	Item property unit of measure	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty/cbc:ValueQuantity
1..1	BT-127-unit-code	Item property unit of measure @unitCode	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty/cbc:ValueQuantity/@unitCode
0..1	BT-128	Property classification	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:AdditionalItemProperty/cbc:ValueQualifier
0..n	BG-25	Certificate	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate

1..1	BT-129	Item label name	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:ID
1..1	BT-130	Certificate type code	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:CertificateTypeCode
1..1	BT-131	Item label type	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:CertificateType
0..n	BT-132	Item label value	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:Remarks
1..1	BT-133	Label issuer name	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cac:IssuerParty/cac:PartyName/cbc:Name
0..n	BT-134	Item label reference	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cac:DocumentReference/cbc:ID
0..n	BG-26	Dimension	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension
1..1	BT-135	Dimension attribute identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:AttributeID
0..1	BT-136	Measure	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:Measure
1..1	BT-136-unit-code	Measure @unitCode	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:Measure/@unitCode
0..n	BT-137	Dimension description	Missing, but optional
0..1	BT-138	Minimum storage conditions	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MinimumMeasure
1..1	BT-138-unit-code	Minimum storage conditions @unitCode	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MinimumMeasure/@unitCode
0..1	BT-139	Maximum storage conditions	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MaximumMeasure
1..1	BT-139-unit-code	Maximum storage conditions @unitCode	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MaximumMeasure/@unitCode
0..1	BG-27	Classified tax category	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory
1..1	BT-140	Item tax category code	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory/cbc:ID
0..1	BT-141	Item tax percentage	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory/cbc:Percent
1..1	BT-142	Item tax scheme	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory/cac:TaxScheme/cbc:ID
0..n	BG-28	Item attachment specification	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference
1..1	BT-143	Attachment identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cbc:ID
0..1	BT-144	External item specifications type	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cbc:DocumentTypeCode
0..n	BT-145	Attached item description	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cbc:Docu

			mentDescription
0..1	BG-29	Attachment	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment
0..1	BT-146	Attached object	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment/cbc:EmbeddedDocumentBinaryObject
1..1	BT-146-mime-code	Attached object @mimeCode	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment/cbc:EmbeddedDocumentBinaryObject/@mimeCode
1..1	BT-146-file-name	Attached object @filename	Missing (conditional mandatory); might be autogeneratable
0..1	BT-147	External item specifications	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment/cac:ExternalReference/cbc:URI
0..n	BG-30	Item product group reference	Missing, but part of the national extension
1..1	BT-148	Product group identifier reference	Missing, but part of the national extension
0..1	BT-149	Placement order	Missing, but part of the national extension
0..n	BG-31	Item attribute configuration	Missing, but part of the national extension
1..1	BT-150	Attribute identifier	Missing, but part of the national extension
1..1	BT-151	Attribute type name	Missing, but part of the national extension
0..1	BT-152	Attribute type description	Missing, but part of the national extension
0..n	BG-32	Item attribute characteristics	Missing, but part of the national extension
1..1	BT-153	Characteristic value identifier	Missing, but part of the national extension
1..1	BT-154	Characteristic value name	Missing, but part of the national extension
0..1	BT-155	Characteristic value description	Missing, but part of the national extension
0..1	BG-33	Characteristic value allowance or charge	Missing, but part of the national extension
1..1	BT-156	Charge indicator	Missing, but part of the national extension
1..1	BT-157	Allowance or charge amount	Missing, but part of the national extension

1..1	BT-157-currency-id	Allowance or charge amount @currencyID	Missing, but part of the national extension
0..1	BT-159	Allowance or charge percentage	Missing, but part of the national extension
1..1	BT-160	Allowance or charge reason	Missing, but part of the national extension
0..1	BT-161	Allowance or charge reason code	Missing, but part of the national extension

5.3.2 XBestellung

As depicted in Table 16, a syntax mapping of all mandatory BTs in the XBestellung, validated in workshop W23, illustrates that a valid XBestellung can be generated out of an XKatalog by migrating all relevant data and supplementing the quantity of ordered items. First, most mandatory information in the XBestellung's root group must be autogenerated for each order, independent from the XKatalog and other Public E-Procurement standards. These BTs include the 'Specification identification' (BT-T01-1), the 'Business process type identifier' (BT-T01-2), the 'Order identifier' (BT-T01-3), and the 'Order issue date'(BT-T01-5). Remaining information can be filled out by subsequently carrying over data from the XKatalog, and only the 'Ordered quantity' must be manually determined to indicate how many products should be ordered from each line (BT-T01-128). Since the ordered quantity is out-of-scope for the XKatalog as an electronic catalogue standard, and it must only be decided upon during the order and not in the catalogue, required interoperability between the XKatalog and the XBestellung is achieved.

Table 16: Mandatory syntax-mapping on value level between the XKatalog and the XBestellung, own depiction

XBestellung			XKatalog
Cardinality	**ID**	**Name**	**Mappability**
1..1	BT-T01-1	Specification identification	Autogenerateable, must always equal "urn:fdc:peppol.eu:poacc:trns:order:3"
1..1	BT-T01-2	Business process type identifier	Autogenerateable, must always equal "urn:fdc:peppol.eu:poacc:bis:order_only:3"
1..1	BT-T01-3	Order identifier	Autogenerateable on transformation
1..1	BT-T01-5	Order issue date	Autogenerateable on transformation
1..1	BT-T01-9	Currency	/Catalogue/cac:CatalogueLine/cac:RequiredItemLocationQuantity/cac:Price/cbc:PriceAmount/@currencyID
1..1	BG-T01-4	Buyer Information	/Catalogue/cac:ReceiverParty
1..1	BT-T01-21	Buyer party electronic address	/Catalogue/cac:ReceiverParty/cbc:EndpointID
1..1	BT-T01-21_1	Buyer party electronic address Scheme identifier	/Catalogue/cac:ReceiverParty/cbc:EndpointID/@schemeID
1..1	BG-T01-8	Buyer legal information	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity
1..1	BT-T01-33	Buyers legal registration name	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity/cbc:RegistrationName
1..1	BG-T01-11	Seller information	/Catalogue/cac:ProviderParty
1..1	BT-T01-40	Seller party electronic address	/Catalogue/cac:ProviderParty/cbc:EndpointID
1..1	BT-T01-40_1	Seller party electronic address Scheme identifier	/Catalogue/cac:ProviderParty/cbc:EndpointID/@schemeID
1..1	BG-T01-13	Seller Postal address	/Catalogue/cac:ProviderParty/cac:PostalAddress
1..1	BT-T01-49	Country	Autogenerable: /Catalogue/cac:ProviderParty/cac:PostalAddress/cac:Country
1..1	BT-T01-49_1	Country code	/Catalogue/cac:ProviderParty/cac:PostalAddress/cac:Country/cbc:IdentificationCode
1..1	BG-T01-14	Seller legal information	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity

1..1	BT-T01-50	Seller legal registration name	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity/cbc:RegistrationName
1..n	BG-T01-38	Order line	/Catalogue/cac:CatalogueLine
1..1	BT-T01-127	Line item identifier	/Catalogue/cac:CatalogueLine/cbc:ID
1..1	BT-T01-128	Ordered quantity	Missing, but must be determined manually anyway for each order
1..1	BT-T01-128_1	Ordered quantity unit of measure	Theoretically mappable through: /Catalogue/cac:CatalogueLine/cbc:ContentUnitQuantity/@unitCode
1..1	BG-T01-46	Item Information	/Catalogue/cac:CatalogueLine/cac:Item
1..1	BT-T01-148	Item name	/Catalogue/cac:CatalogueLine/cac:Item/cbc:name

Since the syntax mapping on value level has only assessed the mandatory interoperability between the standards to demonstrate technical feasibility, a graphical mapping as depicted in Figure 46 provides an estimated overview of the overall reusability of XKatalog BGs in the XBestellung. Since a full syntax mapping on value level between the two standards would exceed the current scope of the XKatalog and this thesis due to the standards ongoing development, the graphical mapping is deemed as sufficient in workshop W25. As for colours, green indicates direct mappability, yellow indicates some mappability (which may be complicated), and red indicates no direct mappability. In general, it can be noted that all non-catalogue specific information of the XKatalog can be carried over into the XBestellung. Due to not being required in the XBestellung, the XKatalog's root information on the catalogue (BG-1), its catalogue related national extensions (BG-15, BG-16, BG-30, BG-31, BG-32, BG-33), its validity periods (BG-2, BG-18, BG-20) and other catalogue specific data such as its Price location information (BG-22), Item dimensions (BG-26) and certificates (BG-25) are marked in red. As such, not being able to carry this information over is not critical and in fact simply unnecessary for the electronic order. Furthermore, because the XKatalog contains extensive and complex information on its lines (BG-17) and items (BG-23), not every single line or item related BT can be migrated to the XBestellung. Again, this is in line with the different scope of the standards and therefore expected and perfectly acceptable. Finally, it is estimated that data of all other BGs can be carried over into the XBestellung without any problems. Notably, this includes the BTs of all involved parties (BG-3 to BG-14), relevant item and tax related information (BG-24, BG-27, BG-28, BG-29), as well as details on the price (BG-19) and the national extension for line level allowances and charges (BG-21), specifically implemented for this purpose. Therefore, the total estimated reusability of information in the XBestellung is high, as all relevant ordering information can be transferred from the XKatalog, and no desired information is lost between the documents.

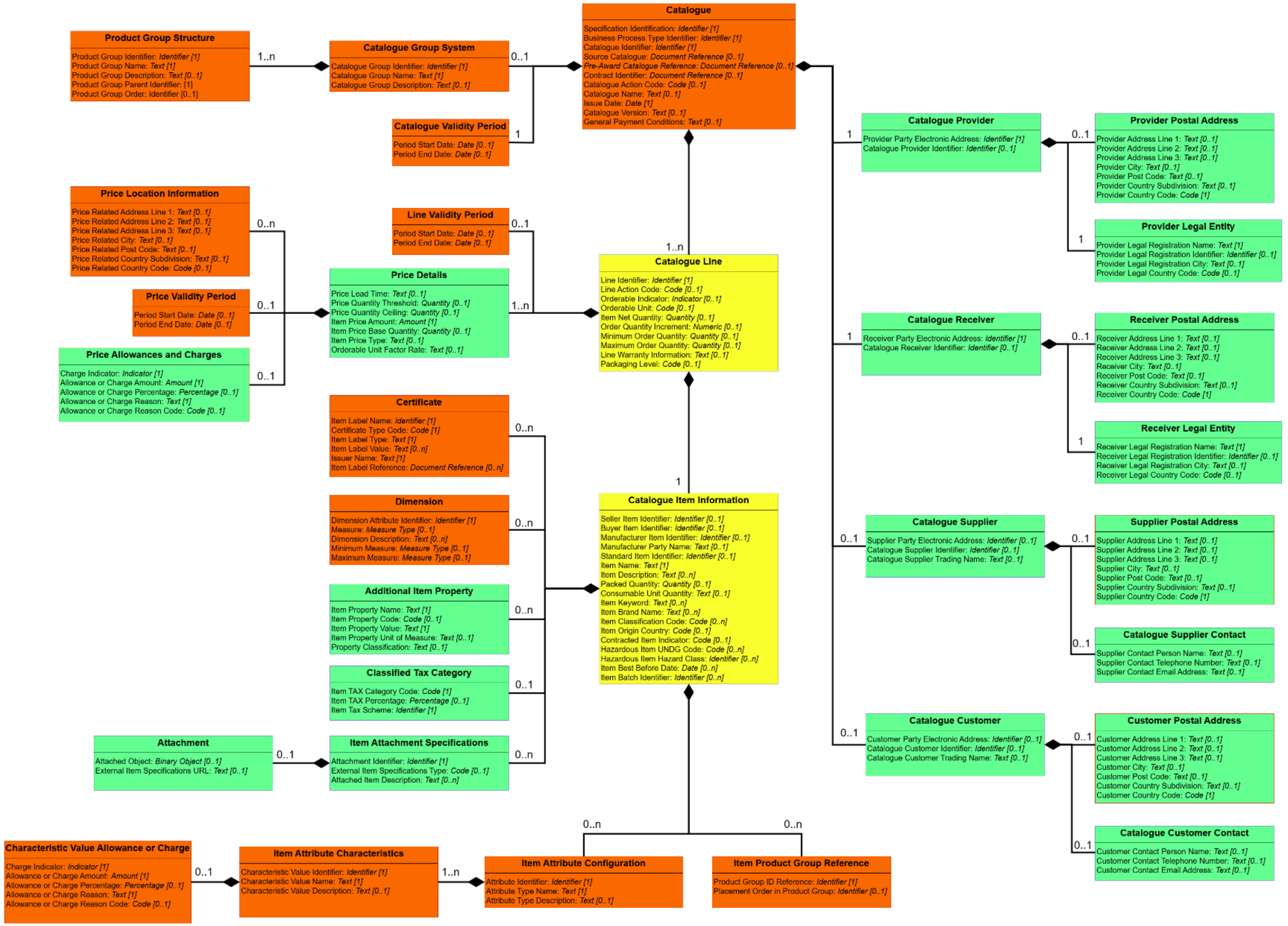

Figure 46: Reusability of XKatalog elements in the XBestellung, own depiction based on workshop W25

5.4 Validation environment

In order to get a better understanding of the KoSIT's way of developing validation environments for Public E-Procurement standards, an interview with Barbara Dewein of the KoSIT was conducted (see also section 2.3.3). In general, two main components of the validation environment are relevant for the XKatalog: the Validator-Configuration (see section 5.4.1) and the Testsuite (see section 5.4.2), which must both be developed at the same time. First, the Validator contains validation files in the form of XML-Schema and Schematron tests to validate an XML instance's schema, structure and business rules.

„Also erstmal wird geguckt, ist es valides XML, ist es Schema-valide, […] dann wird eben geguckt: Sind die Schematron-Regeln [der Nachricht] valide? Wenn es ein Extension-Szenario ist, dann werden die Regeln auch noch mit reingenommen […].“

Due to German Public E-Procurement standards being based on European top-down standards, the Validator contains both internal and external validation files. In the case of the XRechnung, for example, CEN validation files are integrated into the Validator-Configuration to validate all of the XRechnung's rules that are based on the top-down EN16931. As a result, only national extensions to the EN's specification must be implemented.

The Testsuite, on the other hand, can be seen as a collection of positive, standard conformant test instances of a given standard that can be used for two main purposes. First, it supplements the SeMoX specification of a standard by providing a further understanding of how concrete messages of the standard look in practice. Second, it is used to validate parts of the Validator configuration; since all test messages of the Testsuite are expected to be positive, if any error occurs during validation, the Validator-Configuration can be examined based on the negative validation results.

„Also das nach außen hin formulierte Ziel der Testsuite ist eben, ein Set an Referenznachrichten zur Verfügung zu stellen, die dann eben so als […] Orientierung dienen können, um das Verständnis […] für die Spezifikation zu schärfen. Also […] du hast dann eben Beispielrechnungen, an denen du dann auch nachvollziehen kannst, wie einzelne Zusammenhänge dann am besten oder eindeutig dargestellt werden […]. […] und wenn wir Schematron-Regeln ändern oder wenn sich an der Validator-Konfiguration etwas ändert, dann ist die Testsuite sozusagen der Posten, an dem uns spätestens angezeigt wird, wenn da irgendwo Fehler drinstecken.“

Moreover, a distinction between technical test cases and business test cases is made in the Testsuite. Technical test cases represent messages that are as extensive as possible, containing all optional BTs at least once and multiple elements of BTs that can exist more than once, whereas business test cases simply illustrate a domain accurate, coherent sample message. Therefore, the KoSIT often develops technical test cases themselves, whereas they commonly inquire external organisations for sample business cases to anonymize and use within their Testsuite. However, during the interview, it is also highlighted that, in the case of developing a standard alongside its Validator-Configuration and Testsuite from scratch, it is recommended to start by specifying a minimal test case from the semantic model, which may then be turned into a domain specific minimal business case with the help of external actors from that domain. Afterwards, technical test cases can also be developed incrementally to supplement the minimal business case.

„Deswegen wäre mein Ansatz […] mit einem minimalen Testfall anzufangen, also in einem Konstrukt, wo du weißt, also du hast das semantische Datenmodell und du leitest dir diesen minimalen Anwendungsfall ab, […] [und] dann müsstest du […] anfangen nach außen zu gehen und zu fragen, was sind wahrscheinliche Anwendungsfälle?“

Furthermore, it is highlighted that testing the Validator-Configuration requires more internal test messages outside of the Testsuite that can be constantly changed to test whether validation results that are expected to be positive or negative actually turn out to be positive or negative in practice. Notably, the KoSIT utilizes XMLMutate[112] for thorough testing of their Validator configuration via mutating test messages and comparing expected validation results against actual validation results; if a mismatch of expected and actual results occurs, the Validator-Configuration must be examined for possible oversights or mistakes in the code. In any case, Validator-specific test messages must be utilized to constantly check the assertions of each and every rule in Schematron.

„Es gibt [durch XMLMutate] die Möglichkeit, in einer Testdatei an verschiedenen Stellen […] unterschiedliche Szenarien zu erzeugen […]. Und da gibt es […] die Möglichkeit zu sagen, ich erwarte, dass folgende Schematron-Regeln valide sind oder invalide sind. […] Und wenn sich diese Erwartung erfüllt, dann hat sich […] die Erwartung an den Test erfüllt.“

[112] https://projekte.kosit.org/kosit/xml-mutate last access: 06.01.2025

Several implications can be drawn from synthesizing the interview about the KoSIT's validation environment. Upfront, it is important to note that the XKatalog-Validator and its Testsuite must be developed incrementally and in parallel. First, the XKatalog-Validator must be able to validate whether an XML is well-formed, XML-Schema valid and Schematron valid (see also Figure 8 in section 3.4.1). Since the XKatalog's schema is based on Peppol - and thus, UBL - UBL's XSD files are identified as relevant to validate the XML-Schema of XKatalog instances. In terms of enforcing the XKatalog's rules, codelists and structures that are directly adopted from Peppol, Peppol's Schematron files must be integrated into the Validator-Configuration; further Schematron files must be programmed to validate all national extensions. To fully validate an instance, all files must be executed in incremental succession. Furthermore, the Validator must be supplemented with constantly changing test messages of the XKatalog during development to verify all individual assertions of rules; for this purpose, the KoSIT uses XMLMutate. However, since the implementation of XMLMutate into the XKatalog's limited validation environment would exceed the scope of this thesis, the tool has not been integrated into XKatalog-Validator yet. Second, the Testsuite must provide positive test messages of the XKatalog in the form of business test cases and technical test cases. Since business cases are commonly acquired from practice and the XKatalog is not productive usage yet, minimal test messages in the context of office supplies serve as a starting point for the scope of this thesis. Technical test cases are adopted from Peppol and complemented by examples of all national extensions. In the following, section 5.4.1 discusses the XKatalog-Validator and section 5.4.2 the XKatalog's Testsuite.

5.4.1 XKatalog-Validator

The XKatalog-Validator is an amalgamation of different validation files that can be used to validate XML-instances of the XKatalog standard. It consists of three main parts that are executed in incremental succession. First, the UBL-Catalogue-2.4 XSD is used to validate the messages Schema. This ensures that the UBL's XML-Schema is adhered to and basic cardinalities, naming conventions and namespace definitions are correct in the test instance. In practice, this helps to quickly identify whether there are any careless mistakes such as typos or missing BTs in the message.

Second, a slightly modified version of the Peppol Catalogue's official Peppol Schematron is applied to assert all Peppol related rules on the XKatalog. Due to the aforementioned issue of Peppol binding on UBL 2.1, the Peppol Schematron must be adjusted to not throw errors for the German extension elements. To change this, all Peppol asserts for disallowing elements that are not part of the Peppol Catalogue's data model must be disabled at the extension points; the following rule asserts are affected: PEPPOL-T19-B00110, PEPPOL-T19-B17702, PEPPOL-T19-B16702. Furthermore, Peppol's assertion of not allowing any empty elements in the model at any point (PEPPOL-COMMON-R001) is changed to exclude all extension elements. This is implemented via a simple exclusion of all ancestors of extensions within the rule's context as depicted in Figure 47. This ensures that the previously discussed solution of defining product groups in a flat list and referencing them in the structure validates without unwanted errors from Peppol (see section 5.2.4).

```
<rule context="//*[not(*) and not(normalize-space()) and not(ancestor::ext:UBLExtensions)]">
    <assert id="PEPPOL-COMMON-R001" test="false()" flag="fatal">
        Document MUST not contain empty elements.
    </assert>
</rule>
```

Figure 47: Exclusion of extension elements from Peppol's PEPPOL-COMMON-R001 assert in Schematron

In general, it can be noted that Peppol's Schematron is very unspecific and requires optimization for its asserts. The test code is often autogenerated and does not follow good practices of Schematron code (for instance, see[113]) and error messages are unspecific and do not highlight the invalid values explicitly or point towards helpful resources. As such, some indications on how Peppol may improve their assert messages are illustrated in the following discussions.

Third, to assert national rules and requirements, supporting Schematron files are programmed. A total of three Schematron patterns have been added to cover codelists, cardinalities and extensions. In line with workshop W22, the Codelist Schematron pattern improves Peppol's assertions for the XKatalog's most relevant codelists and adds pattern checks for values of the German VAT number and LeitwegID due to them being the most commonly used electronic address identifiers for EOs and CAs. Figure 48 illustrates a comparison between a national XKatalog-Schematron assert (top) and a Peppol-Schematron assert (bottom) for the same Codelist rule. Upfront, Peppol does not use comments inside of their Schematron; this is not just related to codelists specifically but every single line of code in the validation file. Since external parties may want to understand Peppol's logical grouping of asserts in patterns, their contexts or where something is retrieved from, this can be considered as bad practice. Furthermore, the test itself is unnecessarily complicated and requires several variables to simply check whether the value of a BT's schemeID matches a value inside of a Codelist. This can be achieved

113 https://projekte.kosit.org/xse/xse-build-common/-/blob/main/doc/schematron-xse-practice.md?ref_type=heads last access: 07.01.2025

through simply defining the Codelist variables themselves in an appropriate manner which allows the test to be conducted via a simple '=' operator. Lastly, the error message is highly unspecific. There are no indications towards which exact BT or component is meant, no references towards resources where valid values can be found and no information about which exact value is flagged as false in the test. All of these criticisms are addressed and improved upon in the XKatalog's assert. Since the scope of this thesis is limited, not all of Peppol's Codelist asserts have been improved as this would require a significant time and effort.

```
<!-- Catalogue provider identifier @schemeID codes -->
<!-- PEPPOL-T19-B02001 -->
<rule context="$ROOT-NODE/cac:ProviderParty/cac:PartyIdentification/cbc:ID[@schemeID]">
    <!--Codes retrieved from https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:icd_5-->
    <assert id="CL-BT-14" dep:on-terms="BT-14"
        test="normalize-space(@schemeID) = $icd-codes"
        role="error">[CL-BT-14] The value of <value-of select="name()"/>[@schemeID]
        must be one from https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:icd_5.
        Invalid value: '<value-of select="@schemeID"/>'
    </assert>
</rule>

<rule context="/ubl:Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID">
    <assert test="not(@schemeID) or (some $code in $clICD satisfies $code = @schemeID)"
        flag="fatal"
        id="PEPPOL-T19-B02001">Value MUST be part of code list 'ISO 6523 ICD list'.</assert>
</rule>
```

Figure 48: Comparison between XKatalog (top) and Peppol (bottom) asserts for the same Codelist rule, code is taken out of its original context for demonstration purposes

Moreover, pattern checks for values of the German VAT number and LeitwegID have been added in the Schematron's Codelist pattern as depicted in Figure 49. To check the VAT pattern, it is tested whether the value of BT-13 is specified in the context of schemeID="9930", which indicates the German VAT number, and matches the format of starting with 'DE' with nine subsequent digits that may range from one to nine. To check the LeitwegID pattern, it is tested whether the value of BT-26 is specified in the context of schemeID="0204", which indicates the LeitwegID, and matches the LeitwegID's quite complex format of one to twelve spaces of general addressing followed by one to thirty spaces of fine addressing and ending with two verification digits[114]. Both asserts specify the provided value, a comprehensive warning message and point towards an example or outside source.

[114] https://xeinkauf.de/app/uploads/2022/11/Leitweg-ID-Formatspezifikation-v2-0-2-1.pdf#page=5.46 last access: 07.01.2025

```
<!-- Check BT-13-scheme-id for German VAT pattern -->
<assert id="CL-BT-13-GER-VAT" dep:on-terms="BT-13"
    test="not(@schemeID = '9930') or matches(normalize-space(.), '^DE[0-9]{9}$')"
    role="warning">[CL-BT-13-GER-VAT]
    The @schemeID="9930" indicates the German VAT Number ("Umsatzsteuernummer"). The provided value: '<value-of select="."/>'
    does not seem to match the German VAT pattern. The German VAT number begins with "DE" and is followed by nine digits,
    for example 'DE123456789'.
</assert>

<!-- Check BT-26-scheme-id for LeitwegID pattern -->
<assert id="CL-BT-26-GER-LID" dep:on-terms="BT-26"
    test="not(@schemeID = '0204') or matches(normalize-space(.), '^[A-Za-z0-9]{1,12}-[A-Za-z0-9]{1,30}-[A-Za-z0-9]{2}$')"
    role="warning">[CL-BT-26-GER-LID] The @schemeID="0204" indicates the German LeitwegID.
    The provided value: '<value-of select="."/>' does not seem to match the LeitwegID pattern.
    For more information on the LeitwegID pattern, consult:
    https://xeinkauf.de/app/uploads/2022/11/Leitweg-ID-Formatspezifikation-v2-0-2-1.pdf#page=5.46
```

Figure 49: Asserting patterns of the German VAT number (top) and LeitwegID (bottom) in Schematron, code is taken out of its original context for demonstration purposes

While Peppol correctly asserts all cardinalities that are not part of the extension already, once again, its Schematron code can be improved to provide clearer error messages. To illustrate this, some examples have been added manually. Furthermore, not using the 'exists' function may be considered as bad practice due to an unnecessary lack of clarity in the code when simply checking for an element via a direct XPath expression[115]. An exemplary comparison is provided in Figure 50.

```
<rule context="$ROOT-NODE/cac:ProviderParty">
    <assert id="CR-BT-13" dep:on-terms="BT-13"
        test="exists(cbc:EndpointID)"
        role="error">[CR-BT-13] The Provider party electronic address ('cbc:EndpointID') must exist in <name />.</assert>
    <assert id="CR-BG-5" dep:on-terms="BG-5"
        test="exists(cac:PartyLegalEntity)"
        role="error">[CR-BG-5] The Provider legal entity ('cac:PartyLegalEntity') must exist in <name />.</assert>
</rule>

<rule context="/ubl:Catalogue/cac:ProviderParty">
    <assert test="cbc:EndpointID" flag="fatal" id="PEPPOL-T19-B01601">Element 'cbc:EndpointID' MUST be provided.</assert>
    <assert test="cac:PartyLegalEntity" flag="fatal" id="PEPPOL-T19-B01602">Element 'cac:PartyLegalEntity' MUST be provided.</assert>
</rule>
```

Figure 50: Comparison between XKatalog (top) and Peppol (bottom) asserts for the same cardinality rule, code is taken out of its original context for demonstration purposes

Lastly, the Validator's extension pattern enforces all extension specific rules (see section 5.2.5) and cardinalities (see section 5.2.4) on XKatalog instances. An excerpt is illustrated in Figure 51.

[115] IBID KoSIT Schematron good practices

```
<rule context="$TREE-EXTENSION-NODE/xkat:CatalogueGroup/xkat:ProductGroups">
    <!--Enforce list and structure split of BG-16-->
    <assert id="CR-BG-16-1" dep:on-terms="BG-16"
        test="exists(xkat:ProductGroup)"
        role="error">[CR-BG-16-1] Product groups ('<name/>') must contain at least one Product group ('xkat:ProductGroup').
    </assert>

    <assert id="CR-BG-16-2" dep:on-terms="BG-16"
        test="exists(xkat:Structure)"
        role="error">[CR-BG-16-2] Product groups ('<name/>') must contain at least one Structure ('xkat:ProductGroup').
    </assert>
</rule>

<rule context="$TREE-EXTENSION-NODE/xkat:CatalogueGroup/xkat:ProductGroups/xkat:ProductGroup">
    <!--Enforce cardinalities of flat list in the context of BG-16-->
    <assert id="CR-BT-68" dep:on-terms="BT-68"
        test="exists(@id)"
        role="error">[CR-BT-68] Each Product group ('xkat:ProductGroup') must have an ID attribute. Example: 'xkat:ProductGroup id="Group1"'
    </assert>

    <assert id="CR-BT-69" dep:on-terms="BT-69"
        test="exists(xkat:Name)"
        role="error">[CR-BT-69] Each Product group ('xkat:ProductGroup') must have a Name ('xkat:Name').
    </assert>
</rule>
```

Figure 51: Short excerpt of the national extension pattern that enforces national extension cardinalities and rules

As depicted in Figure 52, all patterns of all Schematron files are subsequently included in one main validation file, the ‘xkatalog-validation.sch’, via references to enable a complete Schematron validation from one central location. In practice, this means that a single instance can be validated in just two steps by simply validating its XML-Schema via UBL first and all of its further rules and cardinalities via the ‘xkatalog-validation.sch’ second.

```
<!--This is the main validation file. All test-patterns are included via references to the other files.-->

<!--Reference to external patterns-->
<include href="Peppol-mod-xkat.sch"/>
<include href="xkatalog-codes.sch"/>
<include href="xkatalog-extension.sch"/>

<!--Include all patterns-->

<phase id="xkatalog-phase">
    <active pattern="peppol-mod"/>
    <active pattern="codelists"/>
    <active pattern="cardinality-pattern"/>
    <active pattern="extension"/>
</phase>
```

Figure 52: Utilization of a single Schematron validation file that includes all patterns

5.4.2 Testsuite

The XKatalog’s Testsuite consists of one minimal business case that was created and expanded upon in conjunction with neusta enterprise services GmbH during workshops W17, W19 and W23 and two technical test cases that are based on example files from Peppol[116] and completed by adding all national extension elements. All test cases can be

[116] https://docs.peppol.eu/poacc/upgrade-3/ see section “Downloads”, last access: 07.01.2025

found in the KoSIT'S GitLab[117]. Since illustrating the whole test cases would require depicting hundreds of lines of XML and all notable design choices have been discussed with illustrative examples in section 5.2 already, the messages are only described briefly in this section. The German business case was developed in incremental fashion in cooperation with Neusta by specifying a minimal XKatalog instance first, containing only mandatory elements. Afterwards, the message was expanded with relevant optional information such as 'Additional item properties' (BG-24) and a 'Catalogue group system' (BG-15) with hierarchical product groups (BG-16) alongside their respective references (BG-30). Most notably, the business test case contains accurate Provider and Receiver information such as a real VAT-number (BT-26) and a real LeitwegID (BT-13), real ECLASS[118] identifiers for the catalogue items' 'Standard item identifier' (BT-109) and a coherent business case for office supplies in the form of pens. While the XKatalog's business case does not match the granularity or accuracy of current business cases utilized by the KoSIT for the XRechnung[119], it may serve as a starting point for more comprehensive business messages of the XKatalog in the future.

Both technical test cases, on the other hand, simply represent extensive XKatalog instances that include as much information as possible. Based on Peppol's test cases and expanded with further information such as the XKatalog's national extensions, they can be consulted to gain a better understanding of the whole XKatalog-Specification and used for thorough testing of the XKatalog-Validator by adjusting its BTs in relation to rule asserts that should be tested.

5.5 Synthesis of the XKatalog-Specification

To lay the foundation for the specification and validation of an optimal E-Catalogue standard in Germany, chapter 4 has analysed and synthesized (see section 4.6) relevant requirements for the XKatalog. These requirements, synthesized in line with the DSR's rigor and relevance cycles and based on the discussions of research questions one (see section 3.6) and two (see section 4.1), have served as the basis for the XKatalog's specification in SeMoX (see section 5.2), its interoperability mappings (see section 5.3) and its validation environment (see section 5.4). A synthesis of these incrementally

117 https://projekte.kosit.org/xkatalog/xkatalog-specification/-/tree/main/src/main/examples?ref_type=heads last access: 07.01.2025

118 https://eclass.eu/ last access: 07.01.2025

119 https://github.com/itplr-kosit/xrechnung-testsuite/tree/master/src/test/business-cases/standard last access: 07.01.2025

developed sections of the DSR's design cycle in the context of the DSRM is conducted in the following to answer research questions three and four.

Standardization approach

The optimal specification of an E-Catalogue standard requires considerations that go beyond the addressable scope of the specification itself. Interoperability must be analysed through a holistic lens, by following core principles and evaluating its implications on all layers. This requires rigorous (see chapter 1) and relevant (see sections 2.3.2 and 2.3.3) foundations, rooted within literature, law and practice, that contribute towards an understanding of Public E-Procurement in its entirety, in Germany, Europe and worldwide. Subsequently, analysing the impact of such a standard from all architectural perspectives is imperative, and understanding what it must, should or could do to overcome existing issues of central importance. Compatibility to legacy systems and target visions must be carefully balanced, iteratively reviewed and slowly consolidated. Only then, as demonstrated in this thesis, can an E-Catalogue standard be developed incrementally (see sections 2.3.2 and 5.2) to achieve its desired level of interoperability (see section 4.6), thereby solidifying itself as a possible solution component that can contribute towards improving the domain of Public E-Procurement in practice.

Adherence to the European Interoperability Framework

In this work, interoperability has been analysed from the perspective of all relevant layers [10, pp. 21–31]. To ensure legal interoperability, existing legislation is screened for legal barriers in both German and European legislation, and no barriers are identified (see 3.5.2). For organizational interoperability, the requirements of all stakeholders are analysed (see sections 2.3.2 and 4.6) on all architectural layers (see chapter 4). Semantic interoperability is warranted by standardizing the XKatalog's syntax and semantics in line with all relevant Public E-Procurement standards (see sections 4.3.2 and 5.2) and technical interoperability is achieved by integrating exclusively open specifications and standards into the XKatalog and its technical components, which thereby become open themselves as well. Furthermore, public service governance is integrated via the establishment of a central IT-steering group of KoSIT, Uni Koblenz, LBM and CEN/TC 440 (see also Figure 3) that coordinates the XKatalog's standardization effort on all four interoperability layers. Finally, considering the research design (see chapter 2) and standardization approach (see section 5.1) of this thesis, holistic interoperability governance is achieved.

In addition, the EIF's interoperability principles [10, pp. 9–20] have been integral to the XKatalog. Its technology neutral (principle 5) and bilingual (principle 9) specification and validation environment will be open and accessible for everyone to study and use in the future, including all other European member states (principle 2). Furthermore, Peppol is deeply incorporated into the XKatalog's design to reuse existing specifications, concepts and solutions (principle 4). All design choices, including the origin of all Codelists, Rules and Business Terms are directly annotated in the SeMoX-specification and thoroughly discussed within this thesis to foster transparency (principle 3). Through the integration of the XKatalog in the Public E-Procurement process, administrative processes are simplified (principle 10) and initial assessments from literature [16], [17], [19] and workshops (see W4 and W23) forecast its ability to reduce costs and increase competition (principle 12).

Implementation of Requirements

The XKatalog has considered the implementation of a variety of requirements as depicted in Table 17. A data standard cannot directly realize the requirements of all architectural perspectives within its specification. However, by considering all requirements, the XKatalog can strategically enable or, at the very least, not hinder, their implementation in practice. As most other requirements are directly facilitated by the realization of data requirements, these are discussed first hereafter.

The XKatalog achieves high interoperability with the Peppol pre-award Catalogue (D-REQ-1) and the XBestellung (D-REQ-2) by choosing the Peppol Catalogue as its foundation (see section 5.2). All non pre-award specific definitions of the Peppol pre-award Catalogue can be migrated into the XKatalog resulting in a total of 115 BTs that can be carried over from pre- to post-award (see Table 15). Afterwards, all non-catalogue specific BTs can also be carried over into the XBestellung, which notably includes the XKatalog's extension of Allowances and Charges in the form of BG-21 (see Figure 46). A minimal XBestellung can be created by simply specifying the order amount for any given item (see Table 16). Legacy compatibility with the BMEcat (D-REQ-3) is retained by adopting its catalogue and product group systems (BG-15, BG-16 & BG-30) as well as its item configurability (BG-31, BG-32 & BG-33). Furthermore, interoperability with other existing E-Catalogue standards in the form of the GAEB catalogue (D-REQ-4), the BreKat (D-REQ-5) and the VMS Excel (D-REQ-6) is intentionally excluded from the XKatalog's scope for the purpose of this thesis. The GAEB catalogue is used for the procurement of works, while the XKatalog is used for the procurement of products, and both the BreKat and VMS catalogues are small and generic island solutions that do not require specific considerations in practice.

The realization of these requirements has direct implications for all other architectural perspectives. By choosing the Peppol Catalogue as the basis for the XKatalog, product procurement procedures are made possible by design (B-REQ-1), and the transmission of its messages via the Peppol eDelivery Network is strategically enabled (T-REQ-1). Since the messages themselves are simple XML instances that do not depend on specific technologies or systems, all other technological channels are also suitable for their exchange (T-REQ-2). Furthermore, Peppol's catalogue (BT-4) and line action codes (BT-74) lay the foundation for the XKatalog's target catalogue management process via CRUD operations directly within the standard (B-REQ-5). Achieving a high interoperability with the Peppol pre-award Catalogue enables the transformation of pre-award Catalogues into XKatalog instances, thereby facilitating a crucial part of the target business (B-REQ-3.1) and application architecture (A-REQ-2). In this context, the accomplishment of high interoperability with the XBestellung leads to similar results, contributing significantly towards the realization of business (B-REQ-3.3) and application (A-REQ-5) requirements through the transformability of XBestellung messages out of XKatalog instances. Moreover, by retaining interoperability with the BMEcat, the XKatalog's legacy compatibility with the baseline business architecture (KDB) also remains intact (B-REQ-2), and overall interoperability with all relevant standards is ensured (F-REQ-4). Supplementing the XKatalog's specification with a suitable validation environment, open and accessible for everyone to use, allows EOs to incorporate technology neutral validation files into their system (A-REQ-3) and thus bridges the remaining validation gap (B-REQ-3.2) for enabling a streamlined Public E-Procurement target process (B-REQ-3) and an uninterrupted data transformation and validation flow (F-REQ-2). A streamlined Public E-Procurement process subsequently achieves a seamless process transition (F-REQ-3) and reduces transaction costs (F-REQ-1), thereby increasing competition (F-REQ-5) and fostering SME participation (F-REQ-6). Additionally, this may lead to an overall increase of structured data for CAs to reuse across similar procedures (F-REQ-7). Finally, the specification of the XKatalog in both English and German has implemented Bilingualism to foster cross-border understanding of electronic catalogues in Europe (F-REQ-8).

It is important to note that the XKatalog does not directly realize only two of the relevant requirements in its current state, both of which concern the consultation on catalogue messages between the CA and EO (B-REQ-6, A-REQ-4). However, due to knowing of their existence, the XKatalog does not hinder their implementation either. In fact, by building on top of the Peppol Catalogue, the foundation towards enabling these requirements in the future is laid already. Peppol commonly utilizes two transactions for a given standard to incorporate the concept of an information request and response, for instance in the form of tender clarification questions and answers in the pre-award[120]. Consultation may thus be implemented in the XKatalog itself by integrating the concept of transactions into SeMoX and specifying consultation request and response transactions.

Validation environment

To answer research question four, validating instances of this standard has required the development of a suitable validation environment, consisting of an XKatalog-Validator and a Testsuite that feed into each other. The XKatalog-Validator represents a collection of files and patterns for enforcing schema and asserting business rules, cardinalities and codelists. It validates XML-messages through the incremental execution of UBL's Catalogue XML-Schema, Peppol's Catalogue T19 Schematron patterns, and the XKatalog's Codelist and extension Schematron files. Consequently, for each XML, it is checked whether the message is well-formed, UBL-schema-valid, Peppol-Schematron-valid and XKatalog-Schematron-valid. As each assert itself requires testing, test cases must be written and constantly changed against expected behaviour to ensure a correct Schematron implementation. Specifying two technical and one minimal business test cases in the Testsuite further contributes towards facilitating understanding of the XKatalog as a standard and helps to illustrate notable design choices. By keeping this validation environment technology neutral and open for everyone to use in the future, all EOs and CAs can efficiently validate XKatalog instances without having to rely on third-party solutions.

Result

Ultimately, using a holistic research and specification approach, by conducting Design Science Research, adhering to the EIF's interoperability layers and principles, applying the FISAD, and utilizing SeMoX alongside an open validation environment, all relevant requirements were successfully identified and implemented in this thesis. Consequently,

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120 https://test-docs.peppol.eu/pracc/Pre-Award_Catalogue/profiles/p005/index.html#_business_process last access: 10.01.2025

the XKatalog’s specification can be regarded as the optimal foundation for releasing a productive electronic catalogue standard for Public E-Procurement in Germany.

Table 17: Synthesis of all XKatalog requirements

ID	Title	Description	Priority			Implementation
			Must-Have	Should-Have	Nice-to-Have	
Architecture Foundation (F)						
F-REQ-1	Reduce transaction costs	The XKatalog must contribute towards reducing transaction costs for Public E-Procurement procedures.	X			Implemented through realization of B-REQ-3 and B-REQ-4
F-REQ-2	Fix the data validation/transformation flow	The XKatalog must bridge the gaps in Public E-Procurement's data validation and transformation flow, most crucially between the pre- and post-award phases.	X			Implemented through realization of D-REQ-1, D-REQ-2 and A-REQ-2, A-REQ-5.
F-REQ-3	Achieve a seamless process transition	The XKatalog must contribute towards a seamless process transition from pre- to post-award.	X			Implemented through realization of B-REQ-3
F-REQ-4	Ensure compatibility with existing standards	Compatibility with existing Public E-Procurement standards must be ensured. This includes the Peppol pre-award Catalogue, the XBestellung/XRechnung and	X			Implemented through realization of D-REQ-1, D-REQ-2 and D-REQ-3

		other productively used E-Catalogue standards in Germany such as the BMEcat.				
F-REQ-5	Increase competition	The XKatalog should contribute towards an increase in competition during Public E-Procurement procedures.		X		Possible by design through realization of B-REQ-3 and B-REQ-4
F-REQ-6	Increase SME participation	The XKatalog should contribute towards increasing the participation of SMEs in Public E-Procurement procedures.		X		Possible by design through realization of B-REQ-3 and B-REQ-4W4
F-REQ-7	Improve data quality for the specification of needs and requirements	The XKatalog's contribution towards reusing structured information for the specification of needs and requirements in across similar procedures is desirable.			X	Possible by design, see sections 5.2 and 5.4.2.
F-REQ-8	Enable multilingualism	The XKatalog should enable multilingualism to foster cross-border understanding of E-Catalogues in Europe.		X		Implemented by design, see sections 5.2 and 5.4.2.
Business Perspective (B)						
B-REQ-1	Enable product procurement procedures	The XKatalog must enable Public E-Procurement procedures for products.	X			Implemented by design, see section 5.2.
B-REQ-2	Retain legacy compatibility	The XKatalog should ensure legacy compatibility with the baseline KDB process.		X		Implemented through realization of D-REQ-3 and T-REQ-2.

	with the KDB					
B-REQ-3	Enable streamlined Public E-Procurement process	The XKatalog must enable a streamlined Public E-Procurement process with a seamless transition from pre- to post-award.	X			Implemented through realization of B-REQ-3.1, B-REQ-3.2 and B-REQ-3.3.
B-REQ-3.1	Enable XKatalog transformation	The XKatalog must be transformable out of a pre-award Catalogue; the dedicated standard for pre-award Catalogues is the Peppol pre-award Catalogue	X			Proven to be possible in Table 15.
B-REQ-3.2	Enable XKatalog validation	The XKatalog must be validatable.	X			XKatalog-Validator, see also section 5.4.1.
B-REQ-3.3	Enable e-Order transformation	The XKatalog must be transformable into an electronic order; the dedicated standard for electronic orders in Germany is the XBestellung.		X		Proven to be possible in Table 16, Figure 46 and W23.
B-REQ-4	Enable continuous catalogue management process	The XKatalog must enable a continuous catalogue management process that includes create, read, update and delete operations.	X			Supported in the XKatalog via BT-4 and BT-74.

B-REQ-5	Enable catalogue browsing and shopping	The XKatalog must enable the process of browsing and shopping from E-Catalogue instances.	X			Possible by design, see section 5.2.
B-REQ-6	Enable consultation	The XKatalog should contribute towards enabling the consultation of CAs by EOs.		X		Implementable in the future via request and response transactions due to the adoption of the Peppol Catalogue as the XKatalog's foundation.
Data Perspective (D)						
D-REQ-1	Ensure interoperability with the Peppol pre-award Catalogue	The XKatalog must be interoperable with the Peppol pre-award Catalogue.	X			Adoption of the Peppol Catalogue as the XKatalog's foundation. See also Table 15.
D-REQ-2	Ensure interoperability with the XBestellung	The XKatalog must be interoperable with the XBestellung.	X			Adoption of the Peppol Catalogue as the XKatalog's foundation. National extension for Allowances and Charges (BG-21). See also Table 16 and Figure 46.
D-REQ-3	Ensure legacy compatibility	The XKatalog should ensure legacy compatibility with the BMEcat.		X		National extension for hierarchical product trees (BG-15, BG-16 & BG-

	with the BMEcat					30). National extension for item configurability (BG-31, BG-32 & BG-33).
D-REQ-4	Ensure legacy compatibility with the GAEB	Legacy compatibility between the XKatalog and GAEB is desirable.			X	Excluded/ignored due to niche context for work procedures. The XKatalog is designed to be used for product procurements.
D-REQ-5	Ensure legacy compatibility with the BreKat	Legacy compatibility between the XKatalog and BreKat is desirable.			X	Excluded/ignored due to generic information; island solution.
D-REQ-6	Ensure legacy compatibility with the VMS	Legacy compatibility between the XKatalog and the VMS Excel catalogue is desirable.			X	Excluded/ignored due to generic information; island solution.
Application Perspective (A)						
A-REQ-1	XKatalog-Management Component	The XKatalog must be manageable using a management component by the system.	X			Possible by design as technology neutral XML instances. CRUD is also supported in the XKatalog itself via BT-4 and BT-74.
A-REQ-2	XKatalog Transformation Component	The XKatalog must be transformable from a pre-award Catalogue using a transformation component by the system.	X			Proven to be possible in Table 15.

A-REQ-3	XKatalog Validation Component	The XKatalog must be validatable using a validation component by the system.	X			XKatalog-Validator, see also section 5.4.1.
A-REQ-4	Secure Consultation Component	A consultation component by the system should enable secure consultation of the XKatalog.		X		Implementable in the future via request and response transactions due to the adoption of the Peppol Catalogue as the XKatalog's foundation.
A-REQ-5	XBestellung Transformation Component	The XKatalog must be transformable into an XBestellung using a transformation component by the system.	X			Proven to be possible in Table 16, Figure 46 and W23.
		Technical Perspective (T)				
T-REQ-1	Enable the transmission of messages via the Peppol eDelivery Network (4-Corner Model)	The transmission of XKatalog messages must be possible using the Peppol eDelivery Network (4-Corner model). This requires interoperability with the Peppol Catalogue BIS.	X			Adoption of the Peppol Catalogue as the XKatalog's foundation. See also section 5.2.4 under 1.a. and 1.b.
T-REQ-2	Enable the technology neutral	The transmission of XKatalog messages must be possible using any suitable technology used for file transfer. In particular, this	X			Technology neutral specification: XKatalog messages can be sent and received through any suitable

	transmission of messages	explicitly includes electronic mail.				electronic channel.

6 Recommendations

This thesis has yielded several recommendations. Upfront, it is imperative to acknowledge that the findings of this work do not represent a finished standardization effort. In line with FISAD (see 6a in Figure 1), all architectural considerations (see chapter 4), technical components (see section 5.4), and the XKatalog specification itself (see section 5.2) are thus to be regarded as a reference architecture for the Coordination Office for IT-Standards. Consequently, the artefacts of this thesis may serve as the optimal foundation for continued standardization efforts on electronic catalogues in Germany by the KoSIT. In the future, the KoSIT may seek to conduct further interoperability checks with the ongoing EN17015 to align the XKatalog's and the EN17015-2's transaction models and ensure that no discrepancies occur between the European and German e-catalogue standards. Additionally, further evaluation with relevant stakeholders during the standard's continued development may be advisable, and piloting efforts with interested Economic Operators could analyse the XKatalog's suitability for different scenarios in practice. Moreover, the development and open provision of XSL transformations between the Peppol pre-award Catalogue, XKatalog and XBestellung - based on the conceptual interoperability mappings of section 5.3 - may improve the XKatalog's adoption in the future. Finally, it is recommended to further enhance the XKatalog's validation environment, particularly through the incorporation of XMLMutate, in order to ensure a more robust testing process.

Moreover, significant issues within Peppol require the timely attention of OpenPeppol. First, the Peppol Catalogue still utilizes UBL 2.1 instead of more recent and established versions such as 2.3 or 2.4, leading to only one available extension point in the standard. The severity of this issue becomes apparent when evaluating the feasibility of the XKatalog, as its message requires multiple extension points at different locations in the structure. With UBL 2.1, the XKatalog's extensions cannot be mapped to the Peppol Catalogue, deeming a coherent implementation impossible. Second, structural inconsistencies between different Peppol standards require harmonization. For instance, the Peppol Catalogue does not enable the definition of allowances and charges on items. This is striking, as specifying discounts and surcharges on products has been identified as a common and generic requirement for electronic catalogues during Workshops W4 and W8, and both the Peppol pre-award Catalogue and the Peppol BIS Order already allow their specification in line with UBL 2.1[121] and 2.3[122]. Reusable, structured information for orders is thus crucially lost when transitioning from pre- to post-award catalogues, indicating that the ‘AllowanceCharge’ BG’s addition to the Peppol Catalogue is highly recommended. On top of this, attributes, also referred to as components in this thesis, are inconsistent across Peppol Standards. While not critical, possible attributes for the same terms may vary between standards. When comparing the Peppol pre- and post-award Catalogue on the definition of Item classification codes, only a list identifier can be provided within the pre-award[123], whereas a list version identifier and a name can additionally be used in the post-award[124]. Investigating these findings is recommended to OpenPeppol.

As outlined in this thesis, the XKatalog can only achieve its target vision through productive use in practice. Several studies have highlighted the dependence of Public E-Procurement standards on legislation, thereby indicating the need for recommendations towards legislative bodies. Considering this, without proper legislation, future adoption of the XKatalog will be limited. It is thus recommended that Germany further contributes towards EN17015 and ensures that, similar to EN16931 for electronic invoices, the norm’s structure, target vision and legal obligations are able to stimulate the adoption of electronic catalogues in a sufficient manner. Furthermore, careful considerations on how to overcome change resistance are to be made. Since both Economic Operators and Contracting Authorities must interact with the XKatalog to realize its full potential, information on how to integrate the XKatalog into existing processes and systems must be provided, and subsequent change management endeavours supported.

[121] https://www.datypic.com/sc/ubl21/e-cac_Price.html last access: 10.01.2025

[122] https://www.datypic.com/sc/ubl23/e-cac_Price.html last access: 10.01.2025

[123] https://test-docs.peppol.eu/pracc/Pre-Award_Catalogue/syntax/catalogue/cac-CatalogueLine/cac-Item/cac-CommodityClassification/cbc-ItemClassificationCode/ last access: 10.01.2025

[124] https://docs.peppol.eu/poacc/upgrade-3/syntax/Catalogue/cac-CatalogueLine/cac-Item/cac-CommodityClassification/cbc-ItemClassificationCode/ last access: 10.01.2025

7 Conclusion

In this thesis, Design Science Research (DSR) [25], [26] is utilized to specify the XKatalog as the optimal foundation for releasing a national E-Catalogue standard for Public E-Procurement in Germany. The rigorous and relevant foundations for designing the XKatalog as a national E-Catalogue standard within the Design Science Research Methodology (DSRM) [25] are provided by the iterative application of three Design Science Research cycles [26], the rigor, relevance and design cycle.

For the first research question, the current status of standardized E-Catalogues in Public E-Procurement is researched by conducting a highly structured literature analysis [27], [28], [29] in the DSR's rigor cycle and expert workshops [30] in the DSR's relevance cycle. When synthesizing the findings of both cycles, it becomes apparent that current E-Catalogue implementation and adoption is suboptimal. While scholars indicate E-Catalogue's potential to harmonize Public E-Procurement [11] by reducing administrative costs [19], [97], [100], increasing competition [17], [19], [20] and bridging the gap between the pre- and post-award phases [13], [16], their adoption rates and added value remain low in practice when not designed and executed properly [101]. However, recent research has highlighted that, when designed and executed properly, savings of up to 8% in transaction costs could be achieved in the case of Chile, amounting to 74 million US Dollars [19]. Two productively used E-Catalogue standards are of utmost relevance to the XKatalog's specification, the Peppol pre- and post-award Catalogues and the BMEcat (see W4). As an internationally relevant family of standards, Peppol is used as a foundation by the Coordination Office for IT-Standards (KoSIT) in Germany to specify national Public E-Procurement standards such as the XRechnung for electronic invoicing and the XBestellung for electronic ordering. Notably, the pre- and post-award Catalogues can be used to bridge the gap between the pre-award to the post-award phases by carrying over data from the pre- into the post-award Catalogue. On the other hand, the BMEcat is specifically used to execute framework agreements between Contracting Authorities of the federal state of Germany and awarded Economic Operators within the Kaufhaus des Bundes (KDB). As such, the XKatalog must balance using Peppol as a foundation for its specification while retaining compatibility with the productively used BMEcat.

To answer research question two, how standardized E-Catalogues can be used to overcome current challenges in Public E-Procurement, another structured literature analysis is employed in conjunction with additional workshops in line with the DSR's rigor and relevance cycles. Public E-Procurement's problem environment is complex, as E-

Catalogues must deal with a variety of issues they cannot directly address. Their adoption not only depends on optimal design [101] but also explicit laws and regulations [60], change resistance [59], [62], [64], [69], and cyber- and data security [67], [68], [69], thereby requiring a holistic understanding of interoperability on all layers [10]. In the case of the XKatalog, its implementation into the Public E-Procurement procedure bridges the currently critical gap between pre- and post-award by enabling the migration of data from the pre-award Catalogue into the post-award XKatalog, which can subsequently be transferred into an electronic order (XBestellung) and invoice (XRechnung) (see 4.1.2). As such, the data transformation flow is completed and a seamless process transition between phases is achieved, altogether resulting in reduced transaction costs [17], [18], [19], increased SME participation [20], and higher competition [13], [16], [20].

Knowing this, the optimal specification of an E-Catalogue standard for Public E-Procurement in the context of research question three has necessitated the analysis of its impact from all architectural perspectives in line with the Framework for Interoperable Service Architecture Development (FISAD) [31]. Through FISAD application, the XKatalog's integration into architectural baseline and target layers constitutes notable requirements that concern its existence as a data standard. All FISAD artifacts, as well as the XKatalog specification itself, are designed incrementally in the DSR's design cycle in accordance with the DSRM. In iteration, artifacts are designed, demonstrated in their relevant application context and assessed against their initial solution objectives until evaluation results are positive during workshops (see 2.3.2). Resulting requirements ground the XKatalog in holistic considerations on interoperability and enable its specification via the Simple Semantic Modeling in XML (SeMoX) approach. The specification contains information on the XKatalog's Semantic Datatypes, Codelists, Business Terms, Structure, Rules and Syntax Binding (see 5.2). The Peppol Catalogue is adopted as the XKatalog's foundation to ensure utmost interoperability with both the Peppol pre-award Catalogue and the XBestellung, thereby allowing all relevant information to be transmitted from pre- to post-award and bridging the critical process and data transition phase (see 5.3). Additionally, to realize national requirements and achieve legacy compatibility with the BMEcat, national extensions are supplemented to the Peppol base to enable the definition of allowances and charges, hierarchical product trees, and configurable products with adjustable prices (see 5.2.4). Consequently, the XKatalog is capable of directly implementing or strategically enabling all of its requirements. The standard contributes to a streamlined Public E-Procurement process, ensures a complete data transformation and validation flow, and can thus lead to reduced transaction costs, increased competition and higher SME participation (see 5.5).

Finally, the validation of XKatalog messages in the context of research question four has necessitated the establishment of a validation environment that consists of an XKatalog-Validator and Testsuite. The validator successively asserts schema, rules, cardinalities and codelists on XML instances of the XKatalog by incorporating XML-Schema and Schematron files into its configuration. Developed in parallel, the Testsuite contains complete technical and minimal business XKatalog test cases that foster an understanding of its specification and can be used to test all rules of the validator configuration by changing the messages against expected validation behavior.

In consideration of these findings, several limitations arise from the scope of this thesis. The validation of all artifacts has been conducted in workshops whose participants consisted of experts on electronic catalogues and standardization in Public E-Procurement. Together, a holistic approach on interoperability for the XKatalog was undertaken, and design artifacts constantly validated against their solution objectives and requirements. However, while all layers of interoperability are analysed in this thesis, organisational interoperability is underrepresented. Due to this thesis' scope on designing the XKatalog's reference architecture and specification for the KoSIT to use for further improvements and implementation into practice, relevant organisations such as experienced EOs, SMEs and CAs have not been involved in most of the workshops. While neusta enterprise services GmbH and the State Administration for Mobility in Rhineland-Palatinate (LBM) have made notable contributions to the XKatalog, future research must address its lack of organizationally validated interoperability by conducting workshops, interviews, and surveys with relevant EOs and CAs from practice. Furthermore, the European Committee on Standardization (CEN) and Peppol utilize the concept of two transactions for a given standard to enable information request and response messages. This is not yet possible in SeMoX, and as a result, requirements for consultation about the catalogue could not be implemented in this thesis. Integrating the concept of transactions into SeMoX would enable the specification of request and response transactions for a given message, thereby facilitating a standardized consultation on the XKatalog and subsequently increasing interoperability of all German XEinkauf standards towards specifications of CEN and Peppol. Therefore, future Design Science Research should address the lack of transactions in SeMoX. Finally, in line with the EIF, it is recommended that future research assesses the XKatalog's effectiveness in practice in order to confirm its potential in increasing competition and reducing transaction costs, since the scope of this thesis did not allow for the practical validation of these factors.

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Appendix A: Literature Artifacts

Table 18: Literature Spreadsheet

ID	Reference	Relevant key findings for thesis	QA Rating (if applicable)
Concepts (Theoretical Background)			
[1]	Wimmer, M. A., Pereira, G. V., Ronzhyn, A., & Spitzer, V. (2020)	**Digital Transformation** The digital transformation of the public sector aims to modernize government and public service provisioning through ICT. **E-Government and Digital Government** Electronic government and digital government can be used synonymously in this thesis	n/a
[2]	Fang, Z. (2002)	**E-Government** Definition for this thesis	n/a
[3]	Uyarra, E., & Flanagan, K. (2010)	**Public Procurement** Definition for this thesis	n/a
[4]	Tatsis, V., Mena, C., van Wassenhove, L. N., & Whicker, L. (2006)	**Public E-Procurement** Public E-Procurement => conduct Public Procurement process via the use of electronic means (Web based applications)	n/a
[5]	Bobowski, S., & Gola, J. (2018)	**Public E-Procurement** Analysis of the European Public E-Procurement procedure. Process phases are discussed.	n/a

[6]	Prałat, E. (2019)	**Public E-Procurement** Analysis of the European Public E-Procurement procedure. Process phases are discussed.	n/a
[7]	Prier, E., & McCue, C. P. (2008)	**Public Procurement** Discussion of definitional issues. Saving costs and increasing process efficiency is imperative in Public Procurement.	n/a
[8]	Bulut, C., & Yen, B. P.-C. (2013)	**Public E-Procurement** Global overview of Public E-Procurement implementations from 2013. Good insights into status of E-Catalogue adoption. Also, Public E-Procurement is in dire need of interoperable solutions. Note: I could not find a more recent study unfortunately.	n/a
[9]	Simon, K. D. (2005)	**Open Standards for Governments** The public sector has a high need for interoperable solutions and open standards that foster digitalization endeavours. This is due to several reasons, e.g., the public sector must not develop a reliance on singular interventions solutions.	n/a
[41]	Kutzner, K., Schoormann, T., & Knackstedt, R. (2018)	**Digital Transformation** Taxonomy of research characteristics, topics and clusters for digital transformation. Digital transformation in the public sector commonly investigates the adoption of innovation and technology as well as changes in the public sector work culture. The public sector is particularly affected by the effects of digital transformation and thus faces a high necessity for extensive research.	n/a
[42]	Brunetti, F., Matt, D. T., Bonfanti, A., de Longhi, A., Pedrini, G., & Orzes, G.	**Digital Transformation** Standalone interventions are insufficient for digital transformation. It requires a holistic view from a systemic perspective. Also, high cooperation among stakeholders through frequent and	n/a

	(2020)	extensive communication is needed. Also, developing digital skills within public organizations is needed.	
[43]	Campmas, A., Iacob, N., & Simonelli, F. (2022)	**Interoperability framework** Analysis of interoperability frameworks. Empirical validation: positive effect for the interaction between governments and citizens	n/a
[44]	Chun, S. A., Shulman, S., Sandoval, R., & Hovy, E. (2010)	**E-Government** E-Government and Digital Government can be used as synonymous terms.	n/a
[45]	Yildiz, M. (2007)	**E-Government** Analysis of E-Government definitions, barriers and future research needs	n/a
[46]	Carter, L., & Bélanger, F. (2005)	**E-Government** Benefits: government accountability to citizens, greater public access to information and a more costeffective government. Realization: Governments should focus on ease of use, compatibility and trustworthiness of the solutions.	n/a
[47]	Abu Bakar, N., Peszynski, K., Azizan, N., & Sundram, V. P. K. (2016)	**Public E-Procurement** Discussion of multiple Public Procurement and Public E-Procurement definitions. Use for definition of Public E-Procurement in this thesis!	n/a
[48]	Prentza, A., Leontaridis, L., Stergiou, A., Berler, A., & Kaggelides, K. (2011)	**Public E-Procurement** Standardization of pre-award procedures. Standardization is required in Public E-Procurement to save costs and increase process efficiency.	n/a
[50]	Eyo, A. (2017)	**Dynamic Purchasing Systems**	n/a

		Analysis of (legal) foundations for DPS. Impact of DPS in the UK is positive.	
[53]	Giosa, P. (2020)	**Dynamic Purchasing Systems** DPS are most useful when used for the execution of existing framework agreements where a contracting authority establishes contracts for continual purchasing of goods from Economic Operators for a given period of time.	n/a
[54]	Özbilgin, İ. G., & Imamoğlu, M. Y. (2011)	**Dynamic Purchasing Systems** The term DPS simply refers to an electronic process, usually within a restricted procedure, and is not limited to a singular system. Description of the whole DPS process.	n/a
[74]	Margariti, V., Stamati, T., Anagnostopoulos, D., Nikolaidou, M., & Papastilianou, A. (2022)	**Interoperability** Interoperability is crucial for the successful digital transformation of public administrations and governments. Interoperability is a key enabler for effective and transparent government services and a prerequisite for open data policies and services.	n/a
[75]	Pardo, T. A., Nam, T., & Burke, G. B. (2012)	**Interoperability** Interoperability enables seamless services between public and non-public bodies and cross boundary collaboration (of traditionally often rigid structures). A high level of interoperability is fundamental for governments to achieve a high E-Government maturity.	n/a
[71]	DeNardis, L. (2010)	**Interoperability** Efforts that want to increase interoperability must follow guiding interoperability frameworks.	n/a
[76]	Lisboa, A., Soares, D. (2014)	**Interoperability** Overview of E-Government interoperability frameworks.	n/a
[77]	de Vries, H. (1997)	**Standardization** Definition for this thesis.	n/a

[78]	Gal, M., Rubinfeld, D. (2019)	**Standardization** Standardization requires a common consensus of all involved parties. This consensus regulates attributes, terminology, structure or use of data in a specific context. Consequently, a standard for that data is set based on that consensus.	
[79]	Floridi, L. (2005)	**Standardization: Semantics** Very philosophical discussion on what semantic information actually means. Only list/cover briefly, do not discuss.	n/a
[80]	Gardner, S. (2005)	**Standardization: Semantics** Overview of ontologies and semantics of data. A bit out of scope, only list/cover briefly.	n/a
[81]	Veltman, F. (1984)	**Standardization: Semantics** Philosophical discussion of data semantics. Oldschool paper. Probably out of scope to discuss but should be listed in the thesis.	n/a
[82]	Wood, J. (1985)	**Standardization: Semantics** Very simple definition: Semantics = meaning and use of data. Outside of that, should not be discussed more in the thesis. Pretty historic paper again.	n/a
[83]	Seth, A. (1997)	**Standardization: Semantics** Very cool discussion. Not too philosophical, keeps a good balance between insights from practice and philosophy. Use for definition!	n/a
[84]	Janner, T., Lampathaki, F., Hoyer, V., Mouzakitis, S., Charalabidis, Y., &	**Standardization: Syntax and Semantics** When both syntax and semantics are standardized, data becomes easily machine readable and interpretable!	n/a

	Schroth, C. (2008)		
[85]	Bray, T., Paoli, J., Sperberg-McQueen, C. M., Maler, E., & Yergeau, F. (1997)	**Standardization: XML** Historic XML-Paper. Discussions on parsed and machine-readable data, structure, markup, and XML in general (of course).	n/a
[89]	Bex, G. J., Neven, F., & van den Bussche, J. (2004)	**Standardization: Schema languages** Comparison between DTD and XSD. Initially, both schema languages were mostly used in an equivalent manner in practice. However, XSD has more features and possibilities. At the time of the paper, however, these were not used to their full extent.	n/a
[95]	Siegel, E. (2022)	**Standardization: Validation (through Schematron)** Extremely helpful book for developing Schematron. Although not peer-reviewed, some notable insights into the validation process with XSD and Schematron are given, as well as best practices and examples of good/bad design choices. Major source for coding Schematron for the Validator, and a pretty good read for a novel Schematron beginner like me.	n/a
		SLA RQ1: Status-Quo of E-Catalogue implementation and research	
[103]	Mehrbod, A., Zutshi, A., Grilo, A., & Jardim-Gonsalves, R. (2018)	**Mapping classifier** A supplier may use his product or services E-Catalogue as the search query to find matching call for tenders as potential markets for his products or services through the matching algorithm; to solve the opportunity search problem in E-Procurement marketplaces. **Challenges** The authors also discuss various challenges for E-Catalogues in e-marketplaces.	3.5
[104]	Lee, T., Lee, I.-H., Lee, S.,	**Ontology for E-Catalogue standards**	3.5

	Lee, S.-G., Kim, D., Chun, J., Lee, H., & Shim, J. (2006)	E-Commerce content ontology for E-Catalogues. The system will naturally function as a standard reference system for e-catalog construction, and supply tools and operations for managing catalog standards. The ontology can function as a knowledge base, not only for the design and construction of product databases but also for search and discovery of products and services; it includes the definitions, properties, and relationships of the concepts that are fundamental to products and services.	
[96]	Schmitz, V., & Leukel, J. (2003)	**Multilingualism in E-Catalogues** Strategy for establishing a harmonised methodology for multilingual E-Catalogues; important for the bilingualism of the XKatalog. **Analysis of existing E-Catalogues** Analysis of the early stages of the BMEcat and other catalogues, discussion of their basic building blocks. Pretty interesting.	3.0
[102]	Pitara, S. W., Bakhtiar, Garnida, H., Hendajany, N., Kusdian, R. D., & Suhanda, S. (2019)	**Use-Case: Procurement of consulting services through E-Catalogues** Not a high-quality source (short paper), but a good example of how E-Catalogues are utilized in Indonesia to procure expert consulting services for government projects. This works really well given how E-Catalogues can simplify the search and procurement process through standardization.	3.0
[97]	Pekolj, N., Hodošček, K., Valjavec, L., & Ferk, P. (2019)	**Benefits of E-Catalogues** Use of eCatalogues leads to a significant reduction in administrative burdens for both the CAs and the EOs, because their use can make preparation and then the comparison of tender documentation more effective, automatic and swift. In practice, when requiring the eCatalogues the challenge is to determine both their format and content. The interest in the use of	3.0

		eCatalogues is increasing in the Member States. **Basic functionality of E-Catalogues** This instrument can be used in pre-award and post-award stages of the Public Procurement procedure. Its use within framework agreements and DPS is particularly significant. Therefore, the rise in its popularity is not surprising.	
[99]	Varney, M. (2011)	**Barriers for procurement in relation to E-Catalogues** Major barriers for an expansion of electronic procurement, particularly across Member State borders, lies in the absence of a coherent supporting framework for the interoperability of E-Catalogues. **Analysis of E-Catalogue usage (EU)** The use of E-Catalogues in the EU varies widely, with some Member States encouraging their use in the procurement process, and other Member States generally making little use of the process. The recent Commission Staff Working Paper on E-Procurement notes that "E-Catalogues are being used and developed but on an ad hoc basis, rather than in a structured and re-usable format." **Benefits of E-Catalogues** A more widespread use of E-Catalogues could lead to some significant advantages in terms of cost reduction and an increase in the number of tenders for each call, but the present lack of harmonisation in terms of methods of providing and updating E-Catalogues appears to act as a barrier, particularly to contracting across Member State borders	3.5
[8]	Bulut, C., & Yen, B. P.-C. (2013)	**Analysis of E-Catalogue usage (world-wide)** Worldwide overview of E-Catalogue implementation across different countries. Allows for the	3.5

		statistic discussion of how many states actually have E-Procurement initiatives on E-Catalogues. Sadly, the Study is old (2013), but it is still useful to discuss it briefly. I could not find a more recent study unfortunately.	
[20]	Nurprismawan, H., Nurmandi, A., Misran, & Subekti, D. (2023)	**Benefits of E-Catalogues** Procurement of domestic products through electronic catalogs have an impact on the development of MSMEs by increasing transaction values, expanding markets and increasing capabilities and knowledge of the use of digital media in promotions and transactions. The improvement and development of MSMEs will ultimately have a positive influence on economic growth, which is triggered by an increase in the number of jobs and an increase in the amount of investment both in the region and nationally.	3.5
[103]	Mehrbod, A., Zutshi, A., Grilo, A., & Cruz-Machado, V. (2017)	**Benefits of E-Catalogues** The semantic E-Catalogue matching engine can improve search capabilities. This helps the suppliers to achieve better results in finding relevant tenders that can facilitate finding business opportunities in Public Procurement marketplaces. This further facilitates the need for productive E-Catalogues, as they are required to generate added value for suppliers.	3.0
[18]	Rahim, M. M., Ilhan, N., & Chen, X. (2011)	**Benefits of E-Catalogues (Use-Case)** Most managers suggest that the presence of E-Catalogues encourages council employees to benefit from their use of E-Procurement system. This is because E-Catalogues provide plenty of useful information which aids council employees' purchasing decision making. Moreover, with the E-Catalogues, council employees are able to see what they are actually ordering. This makes purchasing more time efficient.	3.0
[98]	Hartati, S., Sugiharto, I.,	**Benefits and challenges of E-Catalogues**	3.0

	Fakhri, J., Siswadi, Wekke, I. S., Azhari, & Roslina. (2020)	E-Catalogues help to make E-Procurement more transparent, effective and efficient compared to conventional systems, but the implementation is not optimal because, among other reasons, in the e-catalog there is no information on the number of items available, so the buyer does not know the stock directly. This is important for the XKatalog considerations.	
[101]	Krogstie, J. (2008)	**Challenges of E-Catalogues** Poorly designed and/or executed product catalogues lead to poor adoption of marketplaces and no added value in the process. It is also equally important to implement an accurate and user-friendly search via the catalogues (see also the matching systems from the papers above).	3.5
[17]	Vaidya, K., & Campbell, J. (2016)	**Benefits of E-Catalogues** Basic definition for E-Catalogues is provided here. As expected, the impact of E-Catalogue on efficiency was the most significant in the limited deployment level of the assimilation process, followed by the generalized deployment level. The results indicate that even the eCatalogue is yet to be fully assimilated in the Australian public sector in order to be able to perceive its highest impact on efficiency measures. Especially when utilized within e-marketplaces, very significant efficiency benefits are realized.	4.0
[19]	Olivares, M., Saban, D., Weintraub, G. Y., Lara, E., Zanocco, P., & Moreno, P. (2024)	**Benefits of E-Catalogues** Analysis of E-Catalogues in framework agreements for government procurement. Standardizing the product catalog using natural language processing algorithms lead to more competition in the auctions to select suppliers. It induced more intense competition in the auction stage and reduced transaction prices by 8%.	3.0

		Extrapolating the savings from the pilot redesign to all FAs of the Chilean government would amount to around $74 million in 2022. Thus, NLP might also be a future research need for the XKatalog to optimize its impact.	
[100]	Li, Y., & Georghiou, L. (2016)	**Challenges of E-Catalogues** In the case of China, E-Catalogues require a centralized, well-regulated procurement system to be implemented to realize their full benefits. Otherwise, they fail to hit their full potential. A further issue is that the public sector often needs customized technological solutions to deliver their services, rather than 'off-thE-Catalogue' products. This is an important factor to consider when designing E-Catalogues such as the XKatalog.	3.5
[13]	Pauken, C., Schmitz, A., & Wimmer, M. A. (2023)	**Benefits of E-Catalogues** The use of electronic catalogues can help to reduce the administrative effort within the procurement process for all parties involved, avoid media disruptions and fill the gap between pre-award and post-award. Furthermore, by structuring a product catalogue, SMEs can participate in several similar tenders with little additional effort. Their use is therefore recommended. **E-Catalogue standards** Also provides an overview of productive E-Catalogue standards for Public E-Procurement in Europe.	3.0
		SLA RQ2: Overview of challenges in Public E-Procurement	
[64]	Mohungoo, I., Brown, I., & Kabanda, S. (2020).	**Change resistance** Change resistance causes Public E-Procurement procedures to become more complex than intended, as technologies and systems are not adopted properly.	3.5

		SME issues SMEs lack suitable ICT infrastructures to participate in procedures and generally avoid Public E-Procurement procedures; also due to change resistance	
[69]	Eadie, R., Perera, S., & Heaney, G. (2010)	**Cybersecurity issues** Document tampering and information confidentiality are notable concerns for E-Procurement barriers in construction. **Change resistance** The public sector is very cautious in changing processes. Whereas the private sector must often adapt to change quickly because of economic pressure, public authorities require several layers of safeguards and systematic procedures to ensure that all laws are abided with, and tax money can be spent without consequences.	3.0
[59]	Wirtz, B., Lütje, S., & Schierz, P. G. (2009)	**Regulatory issues** The regulatory framework for Public E-Procurement implementations is too complex and must be eased. **Change resistance** Employees must be convinced to interact with new technologies. When no incentives (or penalties) are given, technologies will not be adopted. Convincing employees leads to lower change resistance and improves the realizability of benefits that arise from Public E-Procurement tools.	3.5
[56]	Gascó, M., Cucciniello, M., Nasi, G., & Yuan, Q. (2018)	**Regulatory issues** Regulatory issues present significant barriers in Public E-Procurement and require political commitment to enable businesses in their participation in procedures.	3.0

[63]	Babica, V., Sceulovs, D., & Rustenova, E. (2019)	**Awarding and SME issues** The contract awarding is often based on just the price instead of a comprehensive tender award criteria model, which leads to the lowest price commonly winning the contract award. This is problematic because SMEs usually cannot compete with the lowest available prices, and their participation is thus severely hampered. **Standardization issues** Functional/standardized tender descriptions and system dialogue transactions between suppliers and procurers are currently missing. As such, their implementation can address interoperability issues in the Public E-Procurement process.	3.0
[60]	Platis, C., Karafyllis, I., & Kaoura, G. (2019)	**Regulatory issues/change resistance** In the case of Greece, the adoption of E-Procurement often boils down to simply complying with the law without further considerations that would go beyond that regulatory compliance. As a result, internal procedures and practices are not changed, and systematic procedures and assessments necessary to realize the actual benefits of Public E-Procurement not put in place.	3.0
[65]	Saastamoinen, J., Tammi, T., & Reijonen, H. (2018)	**SME issues** SMEs are mostly burdened by too complex e-services and too high administrative costs. Thus, improvements to information exchanges (transactions) are needed. Interestingly, SMEs themselves prioritize them as less important compared to easing e-services and reducing administrative costs. (imo, both issues are improved upon by improving transactions)	4.0
[67]	Issabayeva, S., Yesseniyazova, B., & Grega, M. (2019)	**Cyber and data security** Public E-Procurement faces cyber and data security issues. Notable issues are document tampering, data protection (private/sensitive data), information confidentiality.	3.0

		Change resistance During the E-Procurement process, several actors conduct repetitive/redundant operations that stem from change resistance and a lack of understanding. This leads to unnecessarily high and administrative costs that should be avoided.	
[62]	Mavidis, A., & Folinas, D. (2022)	**SME issues** SMEs significantly struggle to participate in Public E-Procurement processes at all, mostly due to a lack of available information and knowledge on the procedure. **Cybersecurity issues** Public E-Procurement systems may be targeted by and vulnerable to cyber-attacks. **Stakeholder issues** A lack of skilled personnel and a lack of leadership and stakeholder engagement significantly hinder the progress of Public E-Procurement. **Change resistance** Some processes are unnecessarily repetitive, mostly due to change resistance. Since a plethora of inefficient and non-value-adding Public E-Procurement processes exist, business process reengineering is of utmost importance.	4.0
[57]	Khorana, S., Ferguson-Boucher, K., & Kerr, W. A. (2015)	**Regulatory issues** Political commitment must make an effort for regulatory laws and framework that enable a standardized ICT-infrastructure. **Standardization issues** E-Catalogue and e-invoicing standards are necessary to build trust in the reliability of Public E-Procurement procedures and ensure a smoother process and data flow.	3.5

[68]	Eadie, R., Perera, S., & Heaney, G. (2010)	**Cybersecurity issues** Identified barriers include document and data tampering, as well as vulnerability to cyber-attacks in general. Some more issues are discussed, but mostly from a construction perspective, which is not the main domain/usage environment of the XKatalog.	3.0
[58]	Spacek, D., & Spackova, Z. (2023)	**Regulatory issues** National policymakers must evaluate the quality of E-Procurement systems to develop more suitable laws on Public E-Procurement as a whole in the future, as the current regulatory landscape is not sufficient to enable all of Public E-Procurements benefits. **E-Procurement systems** Performance, ease of use and stability are the most important factors to consider when designing an E-Procurement system.	4.0
[13]	Pauken, C., Schmitz, A., & Wimmer, M. A. (2023)	**Standardization issues** Public E-Procurement faces several standardization issues. Examples include the unregulated transition between pre- and post-award, several media disruptions, information inconsistencies and disproportionate administrative burden. **E-Catalogues as a solution component** The integration of electronic catalogue standards can help to overcome overarching issues of Public E-Procurement, notably the process and data transition between pre- and post-award phases. This leads to a reduction in media disruptions, information inconsistencies and administrative burden.	3.0
[66]	Fernandes, T., & Vieira, V. (2015)	**SME issues** Significant SME barriers for Public E-Procurement are discussed, notably: The lack of	3.5

		technologically suitable solutions, digital signatures and language related issues	
[70]	Ferreira, I., & Amaral, L. A. (2016)	**Cybersecurity and technology issues** Digital signatures and certificates contribute towards fixing cybersecurity issues. However, they may also create constraints on public purchase management and the tendering process. Additionally, in Portugal, currently employed technologies and systems mostly act as standalone island solutions.	3.0
[61]	Raya, A. M., & González-Sánchez, V. M. (2020)	**Regulatory issues** The authors identify that current regulations do not explicitly cover electronic tender procedures yet. Regulations on Public E-Procurement must carefully balance between regulating enough to ensure a standardized infrastructure without notable gaps AND an easy implementation for all stakeholders. This is quite difficult. **Other issues** The ratio of unsuccessful tender procedures to total procurement procedures is surprisingly high. It requires further research.	4.0
[73]	Taoufik, A. O., & Azmani, A. (2022)	**Process related issues** Public E-Procurement faces several issues. A lack of thorough needs assessment, subjective selection criteria and inconsistent information access for stakeholders during the process significantly hinder possible benefits. Notably, this also leads to opaque/untransparent/shady procurement procedures.	3.5
[11]	Schmitz, A., Siapera, M., Prentza, A., & Wimmer, M. A. (2023)	**Interoperability and Standardization issues** Lack of structure in the pre-award phase. Unregulated transition between pre- and post-award. SMEs often struggle to participate in procedures.	3.5

		=>The XKatalog must be considered as a solution component for a holistic E-Procurement solution model instead of a singular intervention!!	
[14]	Loader, K. (2015)	**SME issues** SMEs struggle to participate in Public E-Procurement procedures in the UK.	3.0
[16]	Siapera, M., Schmitz, A., Wimmer, M. A., & Prentza, A. (2024)	**Interoperability and standardization issues** Unregulated transition between pre- and post-award, data is not carried over. **E-Catalogues as a solution component** E-Catalogues can bridge the gap between pre- and post-award. Structured information can be captured in the pre-award catalogue and then carried over into the post-award catalogue. Afterwards, it can be transferred to the order and invoice, thereby closing the whole transformation gap.	3.5

Appendix B: Interview Transcripts

Transcript of Interview 1 from 09.07.2024 with the Coordination Office for IT-Standards

I: So, okay, die Aufnahme ist gestartet. Dann, bist du mit der Aufnahme einverstanden?

T1: Ja, ich bin mit der Aufnahme einverstanden.

I: Bist du auch damit einverstanden, dass die Aufnahme dann bei uns über Whisper als Transkriptionsservice, also einmal über die Server der Uni für das Transkribieren läuft und dann anschließend als Transkript eben verbleibt, aber die Aufnahme dann gelöscht wird? Bist du damit auch einverstanden?

T1: Ja, auch damit bin ich einverstanden.

I: Super. Okay, dann fangen wir direkt an. Wie siehst du denn die aktuellen Entwicklungen allgemein zur öffentlichen Beschaffung in Deutschland? Bist du momentan eher enthusiastisch oder skeptisch eingestellt?

T1: (4) Kommt drauf an, auf welcher Ebene. Die vergaberechtliche Ebene kann ich gar nicht so sehr beurteilen, also habe ich keine größere Expertise als jeder normale Bürger in Deutschland. Ein bisschen mehr kriege ich mit. Ich weiß, dass es da neue Gesetzesinitiativen gibt mit dem Fokus der Vereinfachung. Das finde ich eher gut. Mein Blick auf die Beschaffung ist ja die Sicht der Standardisierung (..) und ich bin nicht skeptisch, sondern würde mich eher als vorsichtig enthusiastisch bezeichnen.

I: Alles klar. Was ist denn erstmal ganz allgemein die Aufgabe der Koordinierungsstelle für IT-Standards?

T1: Allgemein ist der Name Programm. Also die KoSIT, die Aufgabe ist, IT-Standards der Verwaltung, das ist schon die Eingrenzung, die nicht im Titel drin ist, zu erstellen, beziehungsweise eben den Erstellungsprozess und den Betriebsprozess zu koordinieren. Im Detail weicht dann wieder (unv.).

I: Ich kann dich gerade nicht mehr hören. Die letzten ein, zwei Sätze waren irgendwie weg.

T1: Jetzt wieder?

I: Ja.

T1: Das lag am Netzwerk. (…) Also allgemein ist der Name Programm, IT-Standards für die Verwaltung, Erstellung und Betrieb zu koordinieren. Das sieht dann von Standard zu Standard durchaus unterschiedlich aus. Auch in dem Sinne, dass einige Standards gar nicht von der KoSIT selber betrieben werden, sondern wir ja auch Methodiken der Standardisierung bereitstellen. Und teilweise sieht es so aus, dass wir selber entweder Standards übernehmen in einem sogenannten Betrieb, was wir viel bei XEinkauf machen, und oder sogar in der Entstehung von A bis Z begleiten und dann entweder gar nicht übernehmen, weil andere den Betrieb übernehmen oder wir übernehmen. Also auch um die Vielfalt zu kennzeichnen im Sinne von ja, koordiniert ist hier der Schwerpunkt.

I: Super, alles klar. Und welche Aufgaben umfasst jetzt deine Tätigkeit konkret bei der KoSIT momentan?

T1: (…) Ich habe zwei bis drei größere Tätigkeitsfelder. Also die große Klammer ist Koordinierungsstandards (..) in der Beschaffung oder im öffentlichen Einkauf jetzt auch genannt. Wir haben ein eigenes Projekt, sogar jetzt auch einen eigenen Abschnitt in dem Referat, wie die KoSIT ja organisiert ist, zu XEinkauf, die XStandards-Familie des öffentlichen Einkaufs. Da drinnen habe ich die spezielle Aufgabe, einmal die Standardisierungsinteressen Deutschlands auf der europäischen Ebene zu vertreten. Da gibt es eine Working Group für Standards im sogenannten Pre-Award-Bereich. Darf ich den Interviewer fragen? Was heißt das nochmal auf Deutsch? Ich vergesse immer das Deutsche.

I: Pre-Award ist vor der Zuschlagserteilung quasi.

T1: Vor der Zuschlagserteilung. Jetzt weiß ich auch, warum ich mir Pre-Award merke, weil das ist ein Wort (lacht). Vor der Zuschlagserteilung. Und das ist auch gespiegelt mit der Stellung für Standards vor der Zuschlagserteilung in Deutschland. Da bin ich derzeit hauptverantwortlich, also für die KoSIT, den Koordinierungsteil bei dem Standard eForms-DE. Das ist eine Übersetzung einer europäischen Durchführungsverordnungsvorgabe mit Anpassung an nationale Gegebenheiten. Und da drinnen, das sind jetzt meine zwei Teile, CEN, also auf EU vertreten allgemein, Dienststandard im Speziellen, da drinnen bin ich sozusagen projektfachlich Hauptverantwortlicher seitens der KoSIT, als aber auch technischer Lead im Sinne von, wie wird da genau der Standard entwickelt und auch Bereitstellung von Komponenten an Dritte, die den Standard selber dann ja auch benutzen sollen, müssen, können, dürfen, wollen.

I: Okay. Und du hast das ja jetzt auch schon so ein bisschen angeschnitten, auch mit E-Forms: Welche elektronischen Beschaffungsstandards hat die KoSIT denn bisher spezifiziert?

T1: Spezifiziert im Sinne auch von wirklich veröffentlicht, also in der Öffentlichkeit bereitgestellt ist es eForms-DE in der sogenannten Oberschwelle. Das heißt, wo die Auftragsvolumen überhalb bestimmter Mindestwerte sind. Dann im sogenannten Post-Award-Bereich, also nach Zuschlagserteilung, ist es ganz frisch XBestellung, also ein Standard zur Austausch von Bestelldaten. Und seit längerem, also existierte auch schon vor der Gründung von XEinkauf, den Standard XRechnung, der jetzt glaube ich im fünften Jahr oder im sechsten Jahr veröffentlicht ist.

I: Ja.

T1: Ja, das sind die drei erstmal. Ein paar sind noch in der Mache.

I: Genau, das wäre dann so ein bisschen auch die Folgefrage. Welche stehen denn jetzt noch in Aussicht? Welche sind in der Mache?

T1: (..) Auch da wieder unterschiedlich konkret. Es ist einmal im Pre-Award, also in dem Vorzuschlagserteilungsbereich, ist es E-Forms auch für die unterschwelligen Vergaben, also somit für alle Vergaben, weiterzuentwickeln. Dann gibt es die Initiative (unv.) Katalogstandard, also das ist so Level Idee machen. Also so (..), Entschuldigung, ich bin echt müde. Wir nennen das sozusagen Prototypen machen für eine Pilotierung, also dass auch getestet wird, dann in der Pilotierungsphase von echten Stakeholdern, also in einem echten Szenario. Das ist insofern spannend, als da sowohl eben den Übergang von der Vorzuschlagserteilung, da gibt es eine Katalogvariante oder soll es eine geben und wenn dann erteilt wurde, der Zuschlag, dann den Katalog so zu wandeln aus dem Vorzuschlagskatalogstatus, dass er auch für echte Bestellung gemacht wird. Die Bestellung haben wir schon. Und genau, jetzt einen kleinen Cut. Dann gibt es, was jetzt relativ stark konkret in der Mache ist, eine spezifische Version eines XRechnungs-Standards, den wir derzeit XRechnung CVD nennen, nämlich XRechnung Clean Vehicle Directive. Arbeitstitel. Da geht es darum, dass um das Monitoren, ob und wie weit, also statistische Daten darüber zu erfassen, wie sehr die öffentliche Hand bundesweit auf allen Ebenen, von Kommunal bis Bundes, saubere Fahrzeuge beschafft, die bestimmte Umweltkriterien erfüllen. Und da brauchst du, da gehe ich jetzt nicht in Detail ein, für bestimmte Konstellationen kann man erst der finalen Rechnung entnehmen, welche Fahrzeuge denn wirklich beschafft wurden. Und dafür dann sehr spezifisch, konkret kleinen, also kleinen im Mini-Standard mehr im Sinne von, da sind nur drei, vier Sachen fester geregelt als bei XRechnungen, nämlich hier dürfen nur Autos in der Rechnung drinnen stehen und folgende Daten eben über ihre Sauberkeit müssen vorhanden sein, um es zu beurteilen. Das wird ein kleiner, aber feiner Standard. Alles andere ist auf Level Idee. Also ich denke dann außerhalb des Scopes jetzt hier dieses Gesprächs.

I: Okay, alles klar. Und ich würde jetzt mal nochmal eine kleine Nachfrage stellen wollen. Du hattest ja eben auch einen Katalogstandard erwähnt auf der Ebene Idee und dann auch so ein bisschen diese Prozess-Transition angesprochen. Welchen Mehrwert würdest du denn glauben, wird es konkret geben, wenn man dann wirklich so Katalogstandards konzipiert und in die produktive Nutzung bringt?

T1: (…) Ja. Meines Erachtens, sozusagen (...) Auf der Flughöhe, wo ich hoffe, dass es dann auch ein normaler Steuerzahler sieht, zu sagen, derzeit ist es so, dass die ganze Welt der vor Zuschlagserteilung komplett getrennt läuft von der Welt nach der

Zuschlagserteilung. Hat ganz knapp gesagt im Wesentlichen historische Gründe. Und die Bewegung, die es überhaupt mit der Digitalisierung des gesamten öffentlichen Einkaufs gibt, ist halt eine komplette Prozesskette von dem (unv.) Vergabenwettbewerb um Zuschlagserteilung in den ganzen Bereich bis eben zu Bestellungen, jetzt werden Verträge auch wirklich ausgefüllt und es wird konkret beschafft, und diese beschafften Sachen dann auch konkret richtig bezahlt. Jetzt hab‘ ich meinen Gedanken ein bisschen verloren. Diese Kette fest als Gesamtheit zu denken, das ist genau der Katalog in diesen zwei Formen, die Schnittstelle, um diese Gesamtheit hinzukriegen. Konkret heißt es eben, dass dann viel effizienter, also bei bestimmten Vergaben, häufig gibt es ja so Vergaben, die grob die Art haben zu sagen, ich möchte einen Rahmenvertrag, wo ich in den nächsten fünf Jahren, das ist mal das Standardbeispiel, Büromöbel für die öffentliche Verwaltung bestellen kann. Also dass da klar ist, vertraglich geregelt, Mindestanzahl von Verfügbarkeit steht mir zur Verfügung, ich habe Liefergarantien, was auch immer dann in diesem Vorzuschlag ausgeschrieben wird und verlangt wird und dann auch verhandelt wird. Heißt ja, da ist dann Teil der Verhandlung auch zu sagen, ja, wir garantieren, dass immer 100 Stühle, 300 Bleistifte und 70 Tische zu Verfügung stehen. Und das kann man ja schon in einem Katalog festhalten. Das hat ja einen Katalog-Charakter. Also so ähnlich wie de facto hinter auch sowas riesigem wie Amazon steht natürlich ein Produktkatalog, aus dem die Webseiten generiert werden, wo steht, ah, hier, das kannst du kaufen. Noch so und so viel Stück verfügbar. Im Vorschlags-Sinne heißt es, das ist sozusagen: Wird der Katalog erstellt mit den Verhandlungen? Was kommt da rein? Kommen Bürostühle und Bleistifte rein? Ja, nein? In welcher Farbe? Und so weiter und so fort. Und wenn man das dann auch schon mal hat, diesen Katalog, dann geht es sozusagen, die Überführung in den Post-Katalog ist de facto eigentlich auch, je besser das Design ist, desto weniger Änderungen sind notwendig, um zu sagen, das ist jetzt der Katalog, aus dem Webseiten generiert werden und die Bestellung auch gemacht werden kann. Also heißt, da steht drinnen, ja, wir garantieren die Verfügbarkeit von 100 Bleistiften. Dann bestellt wer 50 Bleistifte, dann steht da danach in dem Katalog noch 50 Bleistifte sind übrig für die nächste Bestellung. Oder werden, in drei Wochen wird es wieder aufgefüllt oder was auch immer die genauen Kriterien sind. Und als Standard geht es darum, das allgemein interoperabel digital zu machen, nicht an spezifische Softwareanbieter zu binden, sondern wie das genau umgesetzt wird, dann auch dem freien Markt der Softwarelösung überlassen wird.

I: (…) Super, das sind super, ja, das sind super spannende Insights schon mal. Aber ich würde dann jetzt an der Stelle nochmal ein bisschen abkürzen und zu den nächsten Fragen weitergehen, aber sehr spannende Insights schon mal. (..) Welche Dinge müssen denn jetzt erstmal generell, bevor so ein Standardisierungsprozess losgestoßen wird für elektronische Beschaffungsstandards, beachtet werden?

T1: (..) Sehr viele (beide lachen). (…) Ich sage es mal so, es gibt ein eins plus eins Prinzip, nach dem wir Standards koordinieren, also auch von der Entwicklung her. Kurz vorher ist es das Wichtigste meines Erachtens, was überhaupt, bevor man eine Idee weiterentwickelt oder während man eine Idee entwickelt, ist die Frage Relevanz, Nützlichkeit, Nutzbarkeit und ja, was bringt ein Standard voran? Also insofern war die Frage davor eine konkrete Ausführung für, ja, dieser Nutzen ist wichtig und richtig genug und hat so eine Relevanz, dass sich die Investition, und es ist auch eine Investition, einen Standard zu machen, sich perspektivisch lohnt. Ob man es dann wirklich genau in Heller und Pfennig messen kann, sei dahingestellt, aber es muss sozusagen eine Bedarfsdeckung geben, also ein relevanter Bedarf muss gesehen werden und ist durch einen Standard deckbar. Und da gibt es durchaus mal Varianten, wo man sagt, gute Idee mit einem Standard, aber da brauchst du keinen Standard für, da reicht einfach eine Softwarelösung (unv.). Also das ist das Wichtigste. Jetzt sagt man, man sagt, Standard ist richtig, gut und wichtig. Wie macht man einen Standard, ist dann die Frage. Und was ist dabei bei dem Machen zu bedenken? Da haben wir, da gehen wir eigentlich sehr stark nach dem Prinzip des European Interoperability Frameworks vor. Also Interoperabilität ist eh das, was wir atmen. Alle Standards, die wir machen, dienen dazu, dass die verschiedensten Systeme, die wir teilweise während der Standardisierung noch nicht mal kennen, miteinander reden können, <u>wenn</u> sie sich an diesen Standard halten. Also das ist der Gedanke. Europa hat mal einen Report gemacht, gar nicht so sehr auf Standards basiert, aber eben auf öffentlichen Services. Was gibt es da zu beachten? Ein ganz wichtiger Leitfaden ist, dass man sagt, naja, wenn man einen Standard machen will, muss man die verschiedenen Ebenen der Interoperabilität, also dessen, wo ein gemeinsames Verständnis dessen, wodrum es in einem Standard geht, hergestellt wird, beachten. Die sage ich jetzt mal auf, ist jetzt ein bisschen schwer ohne Bild, aber ich versuche es mal. Es gibt sozusagen vier horizontale Balken, die aufeinander liegen. Ich mache es mal von oben nach unten. (..) Und die liegen alle vor einem gewissen Hintergrund. Es gibt den politischen Kontext, den darf man nicht vergessen, ne? Also nicht jeder Standard ist in jeder politischen Lage machbar. Also, ich sage es jetzt mal wirklich sehr vereinfachend. Europäische Standards kann man nur machen, seitdem es Europa gibt. Ich sag‘ nicht die negative Variante. Und dann gibt es zu beachten, dass gerade mal, nehmen wir mal extra, weil wir sehr stark auch fokussiert sind auf den europäischen Kontext. (…) Auf Englisch heißt es Legal Interoperability, also grob übersetzt, das Zusammenspiel (4), den Zusammenklang verschiedener Gesetzgebungen. Das ist auf europäischer Ebene immer ganz einfach erklärt. Europa besteht aus Nationalstaaten. Jeder Nationalstaat hat seine eigene Gesetzgebung. Wie vereinheitlicht man Vergabe? Man macht Vorgaben zu der Vergabe, die allgemein sind, auf jeden Nationalstaat passen, weil sie so allgemein sind und jedem Nationalstaat dann die Möglichkeit lassen, nationale Spezifika einzubauen. Wenn man das gut und richtig macht, geht ja sehr viel. XRechnung und die europäische Vorgabe EN 16931 ist ein sehr gutes Beispiel dafür, wie das geht. Das ist also auf legale, gesetzgeberische Interoperabilität mit in Betracht zu ziehen. Unter dem Layer gibt es den auch sehr wichtigen Bereich der organisatorischen Interoperabilität. Ein Standard, den eine einzige Organisation macht, ist seltenst, eigentlich fast nie ein Standard, sondern einfach eine Spezifikation, wo eine Organisation sagt, macht es so wie ich. Wir reden über Interoperabilität zwischen Systemen, also geht es darum, Standards zu machen von verschiedenen Organisationen. Jetzt kann man auch mal Stakeholder sagen, die die verschiedensten eigenen Interessen haben, die auch gut und richtig und wichtig sind. Und die unter einen Hut zu bringen, in der Art, dass die Organisationen sich auf ein Ziel einigen. Und dann ist zum Beispiel die Idee eines Standards, das in diesen Organisationen so voranzubringen, dass sie sagen, ja, wir sind gewillt, diesen Standard von der Entwicklung bis in die Umsetzung zu begleiten. Eine sehr wichtige Ebene, die zu beachten ist, und die auch gerade der KoSIT sehr, sehr wichtig ist, weswegen wir für die Ebene, und auch immer mit beachten, dass wir Expertengremien gründen, in denen auch viele Vertreter verschiedener Organisationseinheiten, es kann noch mehrere drum herum geben, je nachdem, dann auch zusammenführen und auch sagen, naja, gerade auf der Ebene, da sitzt die Expertise für den Standard. Also auch die zusammenzutragen und zu einem gemeinsamen, tragfähigen Standard zu kommen. Das bringt mich gleich zur nächsten, darunter liegenden Ebene. Wenn man die Leute hat, dann ist es ganz wichtig zu beachten, jetzt sage ich es mal schon in Bezug auf die letzte Ebene, die ist nämlich die technische Ebene, also die nächsten beiden sind die fachliche und die technische Ebene, genau das möglichst gut und möglichst klar zu trennen (..) in dem Bewusstsein, es gibt immer eine Verbindung zu einer Grauzone, alle Ebenen sind natürlich de facto miteinander verbunden, auf einer fachlichen Ebene und das ist da, wo wir Standards machen. Also die Standards, die man von uns liest, sind <u>fachlich</u> definiert. Also da stehen so Sachen drin. Ich nehme jetzt mal ein Beispiel aus der Rechnung. Eine Rechnung muss ein Rechnungsdatum haben. Ein Rechnungsdatum ist, das denkt man ja, ist ja trivial. Wo braucht es da einen Standard? Aber im Detail sind da viele Sachen zu beachten. Ist das Datum (unv.)? In Deutschland denkt man bei Datum immer nur Jahr, Monat, Tag. In anderen Ländern wird das sofort mit der Uhrzeit gleichgesetzt. Wie genau muss die Angabe sein? Nanosekundengenau oder tagesgenau? Es gibt Millionen von Arten und

Weisen, Daten aufzuschreiben. Nimmt man eine, lässt man mehrere zu und so weiter und so fort. Also an sowas, was erstmal fachlich trivial ist, hängen dann viele weitere fachliche Fragen dran. Mit ein paar, die auch einen technischen Geruch haben, so wie, wie schreibt man es auf? Deswegen ist auch die Kombination, dass da auch technisches Wissen vorliegt über Daten und wie strukturiert man Daten und so wichtig. Und deswegen springe ich mal gleich auf die technische Ebene, die aber wichtig zu beachten ist, die technische Ebene ist dazu da, die fachlichen Bedingungen, Voraussetzungen, Festlegungen umzusetzen und nicht zu diktieren. Gerne im Dialog, so nach dem Motto, ihr verlangt ja was fachlich, das technisch einfach, also nicht machbar gibt es in der Software nicht, aber so einen Aufwand erzeugt, (…) wenn man dann das anders machen würde, wäre der Aufwand weg. Solche, so was gibt es, aber im Wesentlichen hat die technische Ebene, die fachlichen Vorgaben umzusetzen, mit Feedback-Loop natürlich, Und da ist das Besondere bei der Koordinierungsstelle für Standards in IT, dass wir nicht nur einfach dann, ich nenne es immer den Papiertiger, eine Spezifikation rausgeben, auf der gedruckt für die Menschen steht, so sieht es fachlich aus, sondern wir auch, wir nennen es nicht nur so, sondern das ist auch die wichtige Bedeutung, technische Komponenten rausgeben. Also das läuft wirklich unter, was ist zu beachten. Wir geben diese technischen Komponenten heraus, weil wir mit betrachten und mit beachten, wie kann man Leuten, die dann einen Standard umsetzen, noch technische Hilfsmittel mit an die Hand geben, die es helfen und erleichtern, diesen Standard bei sich, jetzt sind wir wieder auf der dritten Ebene, oder zweiten, je nachdem, wie man zählt, auf der organisatorischen Interoperabilität Ebene, als Organisation diesen Standard zu implementieren. Und da geben wir mehrere technische Komponenten heraus, die sich im Wesentlichen um die Validierung von Datenstrukturen zum Nachrichtenaustausch zwischen verschiedenen Systemen da sind. Das war jetzt eine lange Antwort auf eine wichtige, aber eben halt deswegen kompliziert, weil wir wirklich sehr viel beachten.

I: Ja, und die Antwort war super, super wertvoll, deswegen vielen Dank auch für die lange Ausführung. Und du bist ja jetzt auch schon zum Teil so ein bisschen darauf eingegangen, wenn wir jetzt im konkreten Prozess denken, mit welchen Prozessschritten beginnt denn dann jetzt nach diesen ganzen langen und ausführlichen Vorüberlegungen dann der eigentliche Standardisierungsprozess für elektronische Beschaffungsstandards?

T1: Da muss ich erst mal eine Gegenfrage stellen. Was ist mit eigentlicher Standardisierungsprozess gemeint?

I: Das heißt, wenn jetzt quasi die Considerations abgeschlossen sind und man wirklich einsteigt in die konkrete Definition eines Standards, wie auch immer die jetzt aussehen mag.

T1: Ah, okay. Also jetzt aus meiner und in Bezug auf die Antwort davor, politischer Kontext ist klar, man hat natürlich im Kopf, dass man Gesetzesinteroperabilität haben will. Man hat ein Expertengremium und so viele Organisationen an der Hand, wo man denkt, das ist es, das reicht, damit können wir an den Start gehen. Also geht es los, man legt die Fachlichkeit fest. Jetzt hier auch wieder ein bisschen, muss ich ein bisschen ausführen. Ein bisschen durch Learning by Doing haben wir so etwas wie bei XEinkauf, da fangen wir an, einen relativ klaren, jetzt in den Worten, eigentlichen Standardisierungsprozess zu haben, der schlicht und ergreifend ist. Um dieses schlicht und ergreifend zu erklären, muss ich sagen, dass wir im XEinkauf einen Standard, also die Spezifikation, ich habe ja gesagt, es geht ums Fachliche, wir legen die Fachlichkeit fest, und das, wie wir Fachlichkeit festlegen, haben wir in mehrere Teile aufgeteilt. Wir legen entscheidende Begriffe, das nennen wir im Englischen immer Business Terms fest. Ich hatte eben schon ein Beispiel, Rechnungsdatum ist ein entscheidender, (..) oder die Experten legen fest, das ist ein entscheidender, wichtiger Begriff. Dann, ne das überspringen wir, weil es eher diese Grauzone zur Technik ist, dann legen wir fest, gibt es da gewisse fachliche Regeln, hatte ich ja eben schon angedeutet. Jetzt nehme ich mal eine andere, die heißt, naja, natürlich darf ein Rechnungsdatum nicht in der Zukunft liegen. Weil, ne?

I: Genau.

T1: Eine Rechnung, die jetzt aus Sicht eines Bezahlers, die muss in der Vergangenheit liegen. Vergangenheit, das kann hier auch definiert sein, als am selben Tag. Wenn man sich dann festgelegt hat, dass der Tag die ausreichende Genauigkeit des Rechnungsdatums ist. Ist es üblicherweise bei uns in Deutschland. Und das nennen wir Regeln, also fachliche Regeln festzulegen. Ich vereinfache es hier mal. Das sind die zwei allerwichtigsten Blöcke. Es gibt noch zwei andere Blöcke, drei. Die Grauzone, weil wir ja auch technische Komponenten beistellen, Hinweise auf die Grauzone geben. Das legen dann durchaus nicht unbedingt die Fachexperten selber mit, aber ich hatte ja schon angeführt, es gibt einen engeren Feedback-Zug zur Technik. Zum Beispiel legen wir fest, dort und dort in einer Datenstruktur, dort steht das Rechnungsdatum. (..) So, das sind die wichtigen Sachen. Das habe ich deswegen erklärt, weil ja, eigentlich habe ich es nämlich indirekt gesagt, jetzt sage ich es explizit. Der Standardisierungsprozess fängt an mit welcher Begriff ist relevant und wichtig. Ein Beispiel war jetzt Rechnungsdatum. Und tatsächlich habe ich auch die Reihenfolge gerade schon gesagt. Wir gehen auch so vor. Das Schöne ist, dass für die ersten beiden Fragen die Fachexperten auch wirklich nur Fachexperten sein müssen und von Standardisierung und Technik und Umsetzung nichts wissen müssen, um ordentlich, um zu ordentlichen, guten Standards den entscheidenden Beitrag zu liefern. Ja, ich glaube, das ist es eigentlich schon. Jetzt die Eigenschaften dieses Prozesses, iterativ, inkrementell. Man kann schon Standards festlegen mit nur einem einzigen Begriff. So (unv.).

I: Genau. Darauf zählen jetzt auch, denke ich, so ein bisschen meine Nachfragen ab. Also an welchem Punkt in diesem Prozess setzt denn dann wirklich so eine Iteration an? Ist das bereits dann so bei einer Begriffsdefinition, dass es da schon iterativ wirklich in die Diskussionsrunden geht? Ist das erst später so, wenn vielleicht technische Dinge festgelegt werden? Kannst du dazu vielleicht nochmal ein paar Ausführungen machen?

T1: Ich glaube, hier ist mal wichtig, den Unterschied zwischen Realität und logischem Prozess zu machen. In der Realität findet fast alles gleichzeitig statt, gerade am Anfang. Dann geht es aber darum, die Logik, wo ich gleich noch mal ein paar Worte dazu sage, sozusagen auch in die Praxis zu bringen. Und je besser ein Standardentwicklungsprozess funktioniert, desto schneller geht es. Die Sachen dann auch, die logische Reihenfolge auch in die praktische Reihenfolge zu bringen. Tatsächlich ist es wirklich so, (…) dass wir zum Beispiel bei E-Forms mit Begriffen losgelegt haben, aber nicht erst mit einem und dann kam der zweite und dritte, sondern wir, mir fällt nur das englische Wort ein, in Batches gearbeitet haben. Wir haben dann wirklich Expertengremien organisiert, wo wir gesagt haben, hier in dem nächsten Experten-Treffen, folgende 20 Begriffe diskutieren wir. Und woher haben wir diese Begriffe? Also das ist dann Teil der Koordinierung, dass wir sozusagen, selbst wenn wir uns im Gebiet nicht so auskennen, es gibt Gesetzesvorlagen, es gibt natürlich schon Papierprozesse, aus denen man natürlich auch ohne großes Fachwissen schon mal die wichtigen Stichwörter... die wohl wahrscheinlich auch die wichtigen Begriffe sein können, dann rausfiltert und sozusagen vorliegt eben zu dieser detaillierteren Besprechung. Ja, und das ist natürlich eine natürliche Reihenfolge. Man bespricht nie zwei gleichzeitig, sondern ein nacheinander, aber dann durchaus in so einem Batch-Prozess. Und der Batch-Prozess kann auch mal sein, wir gehen mal in einem Treffen folgende 100 durch (..) und bleibt dann halt hängen an, wo Diskussion stattfindet. Aber wichtig ist, logisch, welcher Begriff, wie genau ist er zu fassen, was ist die fachliche Definition dieses Begriffs, also bei Rechnungsdatum kann man auch die fachliche Relevanz für, dass das Rechnungsdatum deswegen auch sein muss in einem Datum, weil es dann durchaus für Verzugszinsen alles natürlich das wichtige Kenndatum ist. Sowas kann man dann sich überlegen, im Standard auch zu erwähnen oder auch nicht. Aber das sind alles die Aspekte, die Schritt für Schritt durchgegangen werden. Und nach den Regeln. Sagen wir mal so, für die Erste, und dann kann begleiten, fast gleichzeitig, und das ist auch unser Ideal, immer auch eine technische Umsetzung stattfinden, die aber immer den Sprung hat. Natürlich muss erstmal so ein bisschen grob die Fachlichkeit da sein. Da kann man einen ersten Aufschlag machen und dann geht durchaus eine Feedback-Loop los.

I: (4) Ja, vielen Dank. Ich brauche kurz noch eine Minute. Ich schreibe noch kurz was auf. (9) So, vielen Dank. Und dann jetzt nochmal so ein bisschen auf diese technische Sicht, hattest du jetzt auch schon ein, zwei Andeutungen gemacht, also wenn jetzt wirklich diese fachliche Basis schon mal zumindest grundfest steht, wo man anfängt, diesen technischen Prozess loszutreten, welche Dinge legt man da jetzt ganz konkret fest?

T1: Ja, da wir im Wesentlichen, also derzeit 100 Prozent eigentlich, Datenaustauschs-Standards machen, also festlegen, wie werden Daten zwischen verschiedenen Systemen ausgetauscht. Auf der fachlichen Inhaltsebene, also nicht, geht nicht um, sind die Daten verschlüsselt oder nicht, was auch festgelegt werden muss, aber das ist hier nicht der Fokus. Dann ist für das Technische, was ich eben schon mal erwähnt hatte, wichtig festzulegen, wo in der Struktur findet es sich. Also wenn man jetzt so an Reihenfolge denkt, ist das Rechnungsdatum das erste Element in so einer Struktur oder kommt es erst gar ganz am Ende? Oder ehrlich gesagt, es ist sogar egal. Hauptsache es ist da und man kann es finden in der Datenstruktur. (…) Das ist wichtig. Und das, was ich eben mal gesagt hatte, lasse ich mal außen vor, ist (…) zu versuchen, einem gewissen Business Term einem Datentypen zuzuweisen. Wie erklärt man jetzt Datentyp, ohne vorauszusetzen, man weiß, was ein Datentyp ist? Ja, man kennt es tatsächlich. Jeder, der rechnet und Mathematik gelernt hat, weiß, was Datentypen sind, insofern, dass man weiß, es gibt sowas wie natürliche Zahlen, es gibt sowas wie Bruchzahlen. Und das ist schon eine Typisierung von, in dem Fall Zahlen, der Zahlenwelt. Und bei Datum zum Beispiel kann man sagen, ein Jahr ist eine Zahl, Monat ist eine Zahl und ein Tag ist eine Zahl. Und dann sagen, mein Datentyp besteht aus drei Teilen. Jahr, das eine Zahl ist, Monat, der eine Zahl ist und Tag, der eine Zahl ist. Das ist ein ganz wichtiger Schritt in der Festlegung, Datentypen festzulegen, um mal zu sagen, da gibt es was festzulegen. Man könnte auch sagen, Jahr ist eine Zahl, Monat ist ein Wort, davon gibt es zwölf, Tag ist wieder eine Zahl. So, ginge auch. Hat alles Vor- und Nachteile, je nachdem wann, wo genau, welcher Standard für was festgesetzt wird, ist das eine durchaus dem anderen vorzuziehen. Das sind die wichtigen Dinge für die technische Umsetzung in Bezug auf den Standard selber.

I: Okay, und wenn jetzt dann, oder dann nochmal gefragt, da war ich mir jetzt auch nicht sicher, ob du das schon beantwortet hattest, bei der technischen, bei diesen technischen Festlegungen, dieser technischen Umsetzung, wird die <u>auch nochmal</u> dann mit Experten validiert in diesen Runden?

T1: (…) Nicht direkt.

I: Nicht direkt.

T1: Also auch, und zwar, weil wir eine Stärke haben möchten. Wir möchten im Expertengremium Experten haben und nach wie vor ist die Wahrscheinlichkeit gering, dass sie sowohl Experten ihrer Wissensdomäne sind wie zum Beispiel dem Bereich der Vorzugsschlagserklärung, also wie macht man als öffentliche Hand gute und gesetzeskonforme Ausschreibungen, es ist nach wie vor selten, dass die auch wissen, was Datentypen sind und wie man sie typisiert. Insofern können die ja gar nicht direkt sagen, jo, das ist die korrekte technische Umsetzung. Deswegen machen wir ein paar Indirektionen, die da drinnen bestehen, da kommen jetzt die technischen Komponenten dann auch zu tragen, dass wir dann nicht nur sagen, dort und dort in einer Datenstruktur ist das Rechnungsdatum, es hat den folgenden Datentyp, sondern auch sozusagen ganze Beispieldokumente machen, wo dann auch alle wichtigen Begriffe drin sind. Eine Rechnung ist nicht vollständig nur mit Rechnungsdatum. Machen wir solche Beispieldokumente, die aller Kunst der Technik entsprechen und die stellen wir wieder da, als sei es quasi wieder Papier oder webmäßig oder so, und dann können Fachexperten natürlich sowas beurteilen, wie, ja, sieht gut aus, stimmt, das Rechnungsdatum ist jetzt auch wirklich da. Oder auch, tatsächlich passieren solche Sachen, wie Experten haben gesagt, da muss man ein anderes Beispiel nehmen, eine Rechnungszeile ist verpflichtend. Eine Rechnung ohne mindestens eine Rechnungszeile ist keine Rechnung. Und dann kriegen Sie ein Beispiel vorgelegt, wo gar keine Rechnungszeile ist. Das ist jetzt ein bisschen konstruiertes Beispiel. Dann können Sie natürlich sagen, hier passt was nicht. Und umgedreht, umgedreht, auch Techniker, die von der Fachlichkeit keine Ahnung haben, da ist die Bindung etwas enger, weil die müssen ja das Fachliche lesen und auf die Idee kommen, wie setzen wir das technisch um, und die zwingen häufig die Fachexperten sozusagen dazu, die Sachen möglichst einfach darzustellen oder so lange zu bearbeiten, bis auch ein Techniker mindestens so die einzelnen Teile versteht, selbst wenn er natürlich nie irgendwie Vergabepraxis-Domänen-Experte wird. Das meine ich mit indirektem Feedback.

I: Super. Und wenn dann diese Validierung auch nochmal mit diesen ganzen Beispieldokumenten durch ist, nachdem diese technischen Sachen auch festgelegt werden, gibt es dann noch irgendwelche finalen Prozessschritte? Oder endet der Prozess dann einfach, sobald iterativ nichts mehr auszusetzen ist?

T1: Gute Prozesse sind die, die wirklich einen definierten und eher früheren als späteren Stopp haben. Wir sind ja bei der Erstellung eines Standards. Da gehört tatsächlich dazu, dass man relativ früh eigentlich auch schon mit den Fachexperten mitdiskutiert, was ist eine Definition of Done? Also wann ist ein Standard überhaupt fertig in dem Sinne? Da hilft auch das iterative Vorgehen insofern, als dass wir meistens so vorgehen, ich hatte ja schon erwähnt, dass wir so Batches machen, gerne in der Besprechung. Es gibt schon sowas wie eben die Menge an, wir nennen es immer Pflichtfeldern. Da habe ich ja schon gesagt, Rechnungsdatum muss tatsächlich auch nach altem Papierrechnungsgesetz sein auf deutschen Rechnungen. Das ist ein Muss. Fertig. So. Und die, ich könnte es jetzt noch ein bisschen informationstheoretisch sagen, die Menge der Mussfelder ist sehr endlich in allen Standards. Damit hat man eigentlich schon eine minimale Definition of Done. Und man kann auch sagen, in der Praxis machen wir es meistens nicht so, aber eigentlich ist das schon eine veröffentlichungswürdige Version. Und weil man dann nämlich sagt, was gibt es denn noch für optionale weitere Möglichkeiten, ich bleibe jetzt beim Rechnungsbeispiel, zur Gestaltung einer Rechnung. Und da gibt es manchmal dann viele Möglichkeiten und da versucht man auch von (.) optionalen Einrechnungen zugrunde liegen, optional, aber nur in spezifischen, ganz spezifischen Industriekontexten wichtige Elemente einer Rechnung, und so weiter und so fort. Dann wird's ein bisschen schwammig mit, was ist eigentlich Definition of Done? Insofern ist das wirklich immer eine pro Standard konkret zu beantwortende Frage, die wichtig zur Gestaltung des Prozesses ist, dessen Schritte aber immer dieselben sind.

I: Okay, und wenn dann jetzt der Prozess done ist, wie läuft dann die Maintenance eines Standards ab? Ist es so, dass das released wird und dann gibt es keine Maintenance, der Standard ist in der Version oder wird dann quasi nochmal an Verbesserungen gearbeitet? Wie läuft das ab?

T1: Letzteres, also (..) das ist, glaube ich, auch eine Besonderheit aller Standards der KoSIT, auch dementsprechend der XEinkaufsstandards. Und, wie soll man sagen, Teil des Auftrags der Koordinierungsstelle für Standards in der IT, eben der KoSIT, ist es Standards auch zu betreiben und zu pflegen und die Aufgabe wird auch gefasst als, <u>auch zu verbessern</u>, also nicht einfach nur das ist festgehalten, ein Standard ist ein Standard und der wird nie geändert. Es gibt solche Standards, die auch wirklich nicht so schnell geändert werden sollten, aber gerade im Datenbereich ist das sehr wichtig, das zu implementieren und sozusagen einen sehr kontinuierlichen, spätestens dann Change-Prozess und auch einen geordneten, klar geregelten Change-Prozess zu machen, weil Gesetzeslagen sich ändern. Erstes schlichtes verwaltungsspezifisches Argument dafür, warum gerade in der Datenwelt Standards kontinuierlich auch geändert werden sollten. Gemäß sich ändernder Vorgaben und fachlicher Anforderungen. Die Rate und wie viel (…) um es mit Einstein zu sagen, so viel und so schnell wie möglich und so wenig und so langsam wie nötig. Habe ich es jetzt richtig herum gesagt?

I: Ja, ja.

T1: Das ist dann auch Teil dessen, wo wir dann auch Erfahrungen sammeln und natürlich koordinierend tätig sind, zu sagen, bei XRechnung wurden zum Beispiel in den ersten Jahren wirklich durchaus wichtige Änderungen alle halbe Jahre rausgebracht. Aber das Ziel ist, das so festzulegen, dass idealerweise auch vielleicht mal Jahre nichts mehr geändert wird.

I: Super, sehr interessant. Also auch relativ individuell.

T1: Insofern braucht man einen (unv.) Prozess. Tschuldigung.

I: Alles gut. Ja, super. Dann würde ich direkt zur nächsten Frage übergehen. Hier einfach mal als grobe Einschätzung: Wie lange dauert denn so ein Standardisierungsprozess für elektronische Beschaffungsstandards ungefähr?

T1: Ich habe ja die Frage schon beantwortet, wie viele wir vor die Tür gebracht haben. Ich fange keine Statistik unter drei an. Wir haben eigentlich nur zwei, weil XBestellung so frisch ist (lacht). Okay, ja und wann war genau der Anfangspunkt, wann war jetzt genau der Endpunkt? Ist auch manchmal schwer zu bestimmen. Deswegen mag ich jetzt keine Zahlen sagen.

I: Ein grober Zeitraum, Einschätzungszeitraum. Sagen wir Jahre und Halbjahre zusammen.

T1: (5) Eher zwei als eins, eher zwei als drei Jahre.

I: Das ist doch eine Einschätzung, mit der man auf jeden Fall was anfangen kann.

T1: Aber wenn man jetzt den Durchschnitt aller nehmen würde, CVD wird wahrscheinlich eher unter 1 als bei 1 liegen, weil es ja nur eine kleine Besonderheit zu schon einem existierenden Standard ist. Insofern ist mir jetzt auch hier wichtig zu betonen, also das ist vielleicht ungefähr die grobe korrekte Zahl, aber wir sind an einer ständigen kontinuierlichen Effizienzsteigerung, Effektivitätssteigerung bei gegebener fachlicher Qualität der Standards interessiert. Und E-Forms ist ein Standard, da geht es um 700 Begriffe (Interviewer lacht). Kann man ja mal rechnen. Man trifft Experten einmal im Monat für drei Stunden. Ist durchaus unterschiedlich. Vier Stunden war es, glaube ich. Und man wäre so schnell wie fünf Minuten pro Begriff. Kann man ja schon ausrechnen, wie viele Monate man braucht, um einfach nur mal jeden Begriff einmal kurz beredet zu haben. Da haben wir noch keine Regeln, haben wir noch keine technische Umsetzung, haben wir die Problemfälle noch nicht, die man vorher nicht weiß und so weiter und so fort. Also nur auch um ein Gefühl zu geben, warum auch, wenn man sehr schnell ist, dass eher alles immer mit Monaten und Jahren als mit Tagen und Wochen zu tun hat.

I: Super, ja, vielen Dank für die Einschätzung und für die Erklärung. Dann jetzt mal im Anschluss nochmal ein bisschen in eine andere Richtung. Welche konkreten Mehrwerte schafft denn jetzt wirklich die Spezifikation bzw. die Profilierung eines solchen elektronischen Beschaffungsstandards?

T1: (5) Da weiß ich jetzt nichts zu antworten. Pro Standard gibt es spezifische Mehrwerte. (…) Ich hatte ja gesagt, ohne dass es einen Mehrwert sich versprochen wird, versuchen wir gar nicht jetzt anzufangen. Wir machen nicht Standards des Standardisierungswillen wegen. (..) Ich habe jetzt drei Möglichkeiten zu antworten. Ich kann es pro Standard nennen ((Interviewer nickt)). Ich sehe ein verbales Nicken (beide lachen). (unv.)

I: Ja, sehr gerne.

T1: Einmal pro Standard. Was ist der Mehrwert einer XRechnung? Wir definieren den als der dazugehörige Digitalisierungsprozess wird auch umgesetzt. Also es gibt, in der Rechnung besteht der Mehrwert da drin: Wenn der Rechnungssender eine elektronische Nachricht nach XRechnungs-Standard verschickt, fängt der Mehrwert beim, also es gibt auch beim Sender Mehrwert, aber, doch, also beim Sender fängt der Mehrwert schon an. Das wird wahrscheinlich eher Bruchteile eines Cents kosten, statt die Briefmarke, gegenüber dem Papierprozess. Das kostet einen Bruchteil einer irgendwie zu PDF gemachten, an eine E-Mail angehangenen Rechnung, wenn sie denn aus zum Beispiel einem Katalogmanagement in einem Bestellprozess automatisiert generiert wird. Ah, wir haben gerade folgende Bestellung abgeschickt, schicken wir, das ist die Rechnung dazu, fertig, gleichzeitig mit losgeschickt. Es braucht kein Mensch drauf gucken, wird einfach gemacht. Dann hat man Mehrwert beim Sender. Empfänger-Mehrwert ist, (..) es braucht kein Briefumschlag geöffnet werden und Leute, die das Papier durch die Gegend machen, sondern es landet in einem System, das idealerweise, (..) HKR-Verfahren, das hochautomatisiert digital die Bearbeitung dieser Rechnung, die durchaus je nach Verwaltungseinheit kompliziert sein können, ja, Rechnungen müssen gegengezeichnet werden, sachlich, fachlich korrekt geprüft werden und so weiter. Erster Mehrwert, dass die Rechnung alle Kriterien erfüllt, um überhaupt einer sachbearbeitenden Person zur weiteren Prüfung der Rechnung vorgelegt wird, können wir schon technisch automatisiert validierbar machen. Also nach dem Motto, eine Rechnung ohne Rechnungsdatum wird sofort zurückgeschickt, ohne dass irgendeine Person damit belästigt wurde. Weil automatisiert klar ist, die brauchen in dem weiteren Bezahlprozess überhaupt keinen Eingang finden. Tatsächlich kommt der Mehrwert auch schon beim Sender zustande. Der prüft schon, ob er seine Rechnung nach den Regeln der XStandards-Kunst gemacht hat und so weiter und so fort. Ich glaube, das reicht schon, um den Mehrwert zu sehen. Richtig im Sinne von Ersparnis von Kosten, ne andere Reihenfolge, Aufwand, Nerv und Kosten am Ende auch richtig in Euro gemessen. Was die Standards nicht in der Hand haben, ist, dass sie auch so benutzt werden. (.) Deswegen, der echte Mehrwert, wir können immer das Mehrwertpotenzial aufzeigen, wie viel Mehrwert es schafft, hängt an der konkreten Umsetzung. Deswegen (unv.) auch nochmals für Komponenten zur Hilfe dieser Umsetzung bereitstellen. XBestellung.

I: Ich denke, ich denke das reicht schon bei der XRechnung. (unv.)

T1: Das Grundprinzip ist auch bei den anderen dasselbe. Also gerade schon alleine, und das ist nach wie vor, und zu einem gewissen Grad muss es auch bleiben, das ist eine andere Geschichte, geht es auch gerade in der Verwaltung um den Ersatz des Papiers. Du kannst wirklich dann immer den Druck des Papiers schon immer als die Ersparnis zu den Bruchteilen eines Cent, die der Strom kostet, diese Daten von A nach B geschickt zu haben, gegenhalten und hast schon den Mehrwert.

I: Ja, super. Du hast jetzt am Ende das vielleicht auch so ein bisschen angedeutet, was für Herausforderungen ergeben sich denn jetzt bei der Spezifikation von elektronischen Beschaffungsstandards und vielleicht auch so ein bisschen im Hinblick dann auf die eigentliche Nutzung nach der Spezifikation?

T1: Ich fange von hinten an, weil das der Anschluss ist. Die Herausforderung ist, dass wir dann häufig beratend gefragt werden, ja, aber wie machen wir denn jetzt? Entschuldigung, ich bleibe jetzt mal bei meinem Standard XRechnung. Wie machen wir denn jetzt XRechnung? Da haben wir leider immer, <u>leider</u> zum gewissen Grad dieses Schulterzucken, ja, wie es halt in Ihrem Kontext am besten passt. Wir können halt nur die möglichen Werte einer totalen, vollen Automatisierung hochhalten. Ob und wie sie es genau machen? Wir kennen sie nicht. Die KoSIT ist ja in Bremen. Da unten in der kleinen Kommune in Bayern. Sorry. Natürlich sind wir da. Wir nennen es immer die Schwierigkeiten oder die Fragen der Umsetzung. Da haben wir nur, wir konkret als Koordinierungsstelle, nur recht geringen Einfluss und auch Hilfsmöglichkeiten. Rückwärts gerechnet, Herausforderungen gibt es viele. Ich habe ja diese Ebenen der Interoperabilität genannt und mal im Nebensatz erwähnt. Es geht darum, auf all diesen Ebenen gemeinsames Verständnis zu erzeugen. Ja, <u>das</u> ist die Herausforderung, das gemeinsame Verständnis zu erzeugen. Mal mehr, mal weniger, in einem Bereich stärker als in dem anderen und so weiter. Also unsere Kompetenz besteht auch da drinne, da auch sehr moderierend und sehr neutral eben dazu beizutragen, dass dieses Verständnis zu einem hohen Grad, da sind wir auch durchaus Pareto, es muss nicht 100 Prozent sein bis aufs letzte Komma, aber sozusagen mit unserer Erfahrung ausreichend für eine gute fachliche Spezifikation der Standards herstellen. Und es geht meistens erstaunlich besser als (unv.). Im XEinkauf ist die besondere Herausforderung gegenüber vielen Standards, dass wir europäische Standards für Deutschland annotieren. Und dann gibt es wirklich die gesamte Spannbreite von sehr guten europäischen Vorgaben, wie die CEN EN 16931, die Vorlage für XRechnung ist. Und dann gibt es Vorlagen, die eigentlich den Charakter erfüllen, das ist kein Standard. Und durchaus sehr viele, wo man merkt, da machen Leute Standards, die nicht annähernd so eine Standardisierungserfahrung haben, wie zum Beispiel in der KoSIT geballt über die letzten zwei Jahrzehnte gesammelt wurde. Klingt jetzt ein bisschen hochnäsig, aber das ist ja auch mit der Zweck, warum die KoSIT koordiniert wurde, um genau dieses Wissen zu bündeln, zu sammeln, zu stärken, zu verschärfen und einen Erfahrungsschatz anzusammeln, der auch was Handwerkliches hat. Häufig haben wir es mit Standards zu tun, die nicht aus so einem Kontext kommen. Manchmal sind sie trotzdem total gut und manchmal merkt man es ihnen leider an. Das ist eine Herausforderung.

I: Ja, und du hast ja jetzt auch schon so ein bisschen mit angeschnitten: Wie kann man denn jetzt solchen Herausforderungen entgegenwirken? Beispielsweise, wenn jetzt... mal ganz konkret vom CEN oder von irgendeiner anderen Organisation irgendwas als Übergabe käme oder als Zuarbeit käme, was sozusagen so nicht ganz passt. Wie könnt ihr dem entgegenwirken?

T1: Einen Versuch, hatte ich auch gesagt, was auch Teil der KoSIT ist und (unv.) auch nicht im Speziellen habe, ist natürlich, das möglichst gar nicht erst zustande kommen zu lassen. Wir nennen das natürlich auch Einfluss auf die Standardisierung auf der europäischen Ebene zu nehmen. Das ist eine wichtige Sache. Einfluss ist begrenzt, es wird viel über Mehrheitsvotum entschieden bei den Standards dort, (unv.) bei uns herrscht im Wesentlichen das Konsensprinzip. Ich habe noch an keinem Standard gearbeitet, wo es eine Abstimmung im Sinne von Mehrheitsentscheid geben musste. Und wenn es nicht kommt, versuchen wir immer möglichst konstruktiv, möglichst helfend zu Verbesserungen schlechter Vorgaben beizutragen. (.) Wirkungsgrad hängt nicht von uns ab, sondern natürlich auch von da. Das sind so die zwei wesentlichen Punkte.

I: Super, vielen lieben Dank. Dann kommen wir nun noch zu den letzten Fragen. Gibt es jetzt noch weitere Punkte, die du jetzt noch nicht genannt hast, die sonst noch für die Spezifikation von elektronischen Beschaffungsstandards relevant sind, die dir jetzt noch einfallen?

T1: Ne, so spontan nicht. Also ich glaube, durch die gut gestellten Fragen haben wir es wirklich, hoffentlich (unv.) Detail, nicht zu detailliert, eigentlich alle wesentlichen Punkte reingebracht. Also für den Prozess wichtig. Tatsächlich gibt es eine andere Definition of done, das ist nur sozusagen eine Finalheit zu erwähnen. Das hängt auch ein bisschen ab von Standard zu Standard. Also zum Beispiel XRechnung als auch eForms-DE, sind sozusagen erst dann veröffentlicht, wenn sie auch im Bundesanzeiger erscheinen. Also das sind zwei Standards, die rechtlich der Verwaltung vorgegeben werden. Insofern ist das auch ein wichtiger Teil, der den Prozess gar nicht so sehr beeinflusst, aber sozusagen Definition of done und Relevanz der Standards, ob sie denn rechtlich vorgegeben sind oder pur freiwillig. Die sind rechtlich vorgegeben, also ist unsere Definition of done (..) technisch gesprochen ein PDF zu erzeugen, das der Bundesanzeiger kriegt und dann seine notariellen Änderungen dran macht und veröffentlicht, damit es genau diese Rechtsrelevanz förmlich auch hat. XBestellung hat das zum Beispiel nicht, das wäre jetzt noch so (.) das Sahnehäubchen.

I: Super, ja, vielen Dank nochmal für die Ergänzung. Auch super interessant. Und möchtest du sonst noch irgendetwas, was sonst noch in deinem Kopf ist, jetzt zum Interview ergänzen?

T1: Danke und tschüss. Bitte (unv.).

Transcript of Interview 2 from 26.06.2024 with the Coordination Office for IT-Standards

I: So, die Aufnahme ist gestartet. Dann bist du mit der Aufnahme einverstanden?

T2: Ja, bin ich.

I: Bist du auch mit der Verarbeitung der Aufnahme bei uns über den Transkriptionsservice einverstanden, mit anschließender Löschung und dann eben nur noch dem Verbleib des Transkriptes des Interviews?

T2: Ja, auch damit bin ich einverstanden.

I: Super, ja, vielen Dank. Dann starten wir direkt rein. Und zwar dann die erste Frage, wie würdest du die Testsuite der XRechnung denn insgesamt bewerten? Eher als erfolgreich oder eher als verbesserungswürdig?

T2: Also ich würde spontan sagen, vor allem als stabil. Und also erfolgreich, finde ich, klingt so, als müsste man, als wäre das jetzt so ein Marketing, würde so ein Marketing-Gedanke dahinterstehen. Aber ja, also ich würde mal sagen, die läuft, die ist stabil, die gibt es ja auch schon lange und wird auch stetig weiterentwickelt. Also verbesserungswürdig, ich würde ich jetzt nicht sagen, dass sie irgendwelche groben Mängel hat, aber es stellt sich so im Laufe der Zeit heraus. Wir können da immer neue Bedarfe auch einbringen und die ausweiten. Und (.) genau, auch insofern würde ich sagen, dass sie (..) durchweg eigentlich sozusagen positiv zu bewerten ist. Ja, also dass sozusagen die Weiterentwicklungsanforderungen eigentlich eher ein Beweis dafür sind, dass sie gut funktioniert, weil man immer weiter aufbauen kann.

I: Ja, du hattest ja jetzt auch schon einen Punkt so ein bisschen aufgenommen mit der Zeit. Seit wann gibt es jetzt die Testsuite der XRechnung?

T2: Also ich musste es nachgucken, ich bin ja gar nicht so lange dabei. Der erste Commit war 2018. Also es gab die erste Version von XRechnung schon und dann, (unv.) so ein Jahr später, wurde dann die Test-Suite quasi (..) eingebracht, geboren.

I: Ja, und wann und wie bist du denn dann das erste Mal mit der Test-Suite in Kontakt gekommen?

T2: Das war im November 2021, als ich angefangen habe, bei der KoSIT zu arbeiten. Das gehört dann einfach zu meinen Aufgaben (.) Wartung und Pflege der technischen Komponenten. Da gehört die Testsuite natürlich dazu.

I: Ja, und dann deine konkrete Aufgabe. Was war die im Zusammenhang dann mit der Testsuite?

T2: Ja, also eben dieses übergeordnete Wartung und Pflege der technischen Komponenten. Und das lässt sich jetzt gar nicht so (…) spezifizieren. Also es ist eben (..) stetig der Auftrag zu gucken, dass alles funktioniert sozusagen. Eben zu gucken, gibt es

Weiterentwicklungsbedarfe, zu gucken, treten irgendwo Fehler auf. Da kommen wir, glaube ich, auch gleich nochmal drauf zu sprechen, wie die einzelnen Komponenten auch miteinander spielen und wie sich eben auch so Weiterentwicklungen quasi immer parallel auseinander ergeben. (..) Ich mache da sozusagen kleine technische Umsetzungen, konzeptionelle Fragen, (4) so ein Allround-Paket.

I: Okay, alles klar. Okay, und was ist denn so konkret eigentlich nochmal das Ziel der Testsuite für die XRechnung?

T2: Also das nach außen hin formulierte Ziel der Testsuite ist eben, ein Set an Referenznachrichten zur Verfügung zu stellen, die dann eben so als, naja, so Illustrationen, Orientierung dienen können, um das Verständnis auch für die Spezifikation zu schärfen. Also das klingt jetzt, das ist jetzt sehr abstrakt formuliert, aber du findest halt irgendwie ein semantisches Datenmodell und hast dann eben Beispielrechnungen, an denen du dann auch nachvollziehen kannst, wie einzelne Zusammenhänge dann am besten oder eindeutig dargestellt werden, abgebildet werden. Das wäre so das, (…) was die Test-Suite nach außen hin transportiert, also dass Leute die auch wirklich nutzen können, um ihre Implementierung zu überprüfen, beispielsweise, und (.) für uns nach innen hin ist das schon auch ein, ich würde mal sagen, ja, sowas wie ein Referenz-Rahmen vielleicht nicht, Referenz- Element-Tool, wie auch immer, also wir haben eben diese Test-Nachrichten und (…) (unv.) also wenn wir Schematron-Regeln ändern oder wenn sich an der Validator-Konfiguration was ändert, dann ist die Testsuite sozusagen der Posten, an dem uns spätestens angezeigt wird, wenn da irgendwo Fehler drinstecken. Oder andersrum, wenn jetzt, ich sag mal, sich im CEN-Schematron irgendwas geändert hat, also und das sind in (..) in den letzten Releases vor allem sozusagen Änderungen, die zur Stabilisierung beitragen, also das sind keine grundlegend neuen Regeln oder so, sondern eher Bugfixes oder nochmal irgendwie neue Regeln, wo jetzt gesagt wird, hier an der Stelle gibt es noch keine Kardinalitätsprüfung, dann wird die eingebaut oder so, dann haben wir die in den CEN-Schematron-Regeln, übernehmen die in die Validator-Konfiguration und wenn die Test-Suite dann, die Test-Suite-Fälle dann mit der Validator-Konfiguration geprüft werden, dann stellt sich da vielleicht raus, oh, wir haben in unserer Test-Suite tatsächlich auch einen Kardinalitätsfehler, der ist einfach vorher niemandem aufgefallen. Also das ist diese Gegenseitigkeit der Komponenten. Dann gibt es in der Test-Suite auch noch so ein kleines Tool, was wir mitnutzen, das ist so ein CII-to-UBL-Converter. (..) Den lassen wir quasi so parallel mitlaufen und (..) benutzen den sozusagen dann auch nochmal, um zu gucken, wenn jetzt eine CII-Rechnung positiv validiert wird, aber dann das transformierte UBL plötzlich zu Fehlermeldungen führt in der Validator-Konfiguration, dann hilft uns das auch nochmal zu gucken, entweder haben wir einen

Fehler in der Testsuite oder ist in dem CII-to-UBL-Tool ein Fehler. Das wird nicht von der KoSIT gepflegt, aber genau, wir sind da trotzdem im Austausch, wir nutzen das. (..) Jetzt bin ich vielleicht ein bisschen von der Ursprungsfrage abgewichen. Was ist das Ziel der Testsuche? (beide lachen) Oder gut, vielleicht sind wir auch schon bei Punkt 2. Naja, ja, machen wir mal erstmal einen Punkt hier.

I: Okay, alles klar. Ja, du hast ja jetzt auch schon ein bisschen was zur Funktionsweise genannt. Will ich auch gleich nochmal so ein bisschen drauf zurückkommen. Jetzt erstmal nochmal konkret. Könntest du nochmal die Bestandteile listen, die du gerade auch schon angesprochen hast, aus denen denn die Testsuite jetzt konkret besteht?

T2: Genau, also die Testsuite, du meinst, ja, also die Testsuite ist sozusagen ein Set aus Referenznachrichten und die sind gegliedert in sogenannte Geschäftsfälle, also das sind so Echtweltrechnungen die irgendwann mal eingesammelt wurden und zur Verfügung gestellt wurden. Und dann gibt es die sogenannten technischen Testfälle. Das sind aktuell, (.) ich glaube, vier, also für jede Syntax jeweils vier Testfälle, die den Anspruch haben, möglichst umfassend zu sein. Also dann auch alle BGs und BTs, die multiple vorhanden sein dürfen, dann auch abzubilden und auch alle optionalen Elemente mindestens einmal abzubilden und so weiter. Genau. Dazu gehört dann in dem ganzen Build-Prozess auch eine automatisierte Validierung anhand der Validator-Konfiguration für XRechnung und eben dieses CII-to-UBL-Tool. Das, (..) genau. Jetzt muss ich mal kurz überlegen, ob ich irgendwas vergessen habe. Naja, gut, wir haben noch eine Dokumentation. Also, wir haben sozusagen eine Markdown-Datei, die nochmal versucht, möglichst übersichtlich die Inhalte der ((Bohrgeräusche)) einzelnen Testdateien abzubühnen, sodass man sagen kann, was weiß ich, jetzt irgendwie sowas wie Extensions, Subinvoice-Lines sind dann im Testfall Nummer 501 oder was, also (…) enthalten. Also eine gute Textbeschreibung sozusagen von den Inhalten, um sich ein bisschen zurechtzufinden.

I: Okay, dann ist meine erste Frage, die sich jetzt nochmal für mich so ein bisschen stellt, bei den verschiedenen Testfällen, die ihr ausarbeitet. Du hattest ja jetzt schon erwähnt, dass vier Stück quasi pro Syntax aus technischer Sicht gemacht werden. Gibt es dann auch unabhängig davon für diese Geschäftsfälle die Testdateien? Wie viele sind das dann im Endeffekt? Wie viele Geschäftsfälle covert ihr?

T2: Also du meinst die Business...

I: Genau, die Business Cases

T2: Das sind, warte, ich muss jetzt mal kurz reingucken, sonst zeige ich dir irgendwas Falsches. Also wir haben (…) Falsches Projekt. Wir haben Business Cases für die CIUS sind es (unv.) (…) sagen wir mal, gute 30 (unv.), also 30, die dann jeweils für CII und UBL vorhanden sind. Und für die Extension haben wir fünf Testfälle in UBL und einen in CII. Die lassen sich nicht doppeln, weil die Extension gibt es, (.) die Extension lässt sich nur in bestimmten Aspekten für CII abbilden. Also die Sub-Invoice-Lines funktionieren in CII nicht, deswegen gibt es da keine Verpflegung.

I: Okay, und inwieweit unterscheidet sich das dann, wenn man jetzt so einen technischen Testfall für eine der Syntaxen formuliert und wenn man den Geschäftsfall formuliert?

T2: Also diese Business Cases, das sind halt tatsächlich, aber das liegt auch wieder vor meiner Zeit, aber das sind eben, also in meinem Kopf ist das so (..), die haben angefangen mit der, also die Testsuite wurde initialisiert. Dann gab es da, glaube ich, ein Set von, lass mich nicht lügen, vielleicht zehn Geschäftsfällen. Und ich glaube, dass (..), also der Aufbau ist, glaube ich, einfach so erfolgt, dass es eine Spezifikation gab und dann gibt es eben Rückmeldungen dazu. Wie sollen wir das denn umsetzen? Wie bildet sich denn der Fall ab? Man tauscht sich aus und dann wird sozusagen im letzten Schritt gesagt, okay, ihr habt hier irgendwie eine valide Rechnung für euren Geschäftsfall, sagen wir, ein bestimmter Rechnungstyp oder eine bestimmte Art von Rechnung, eine Gasrechnung oder irgendwas aus dem Bauwesen oder irgendwie so. Und dann werden die eben für die Test-Suite angefragt und dann zugeliefert sozusagen und dürfen dann anonymisiert verwendet werden. Also das sind wirklich ganz spezifische Fälle und die technischen Fälle sind eben, ja, wie gesagt, solche, die vielleicht jetzt fachlich, inhaltlich nicht so ganz logisch sind, also wo wir jetzt auch nicht unbedingt darauf achten, dass (…) was weiß ich, der Posten, der da jetzt in der Rechnungszeile abgehandelt wird, auch jetzt einen passenden Mehrwertsteuersatz hat oder so. Wir nehmen da einfach Werte, die valide sind und gucken aber eher, dass sozusagen eine möglichst große Bandbreite an Syntax sozusagen abgebildet ist. Ich weiß gerade nicht, wie ich das besser formulieren soll, aber das eine hat sozusagen den Anspruch, auch inhaltlich Sinn zu machen. Und das andere, wirklich den Anspruch einfach technisch möglichst umfassend zu sein. Und jetzt sind wir gerade im Gespräch darüber, oder im Gespräch darüber, wir denken jetzt an, auch nochmal einen minimalen Testfall da einzufügen für (.) bestimmte Szenarien, die jetzt so denkbar sind. Ich weiß nicht, du willst irgendwas entwickeln in der Visualisierung und dann brauchst du halt irgendwie erstmal eine kleine Testdatei, um zu gucken, ob die Basics funktionieren und willst jetzt nicht irgendwie (…) keine Ahnung, so eine Riesendatei, wo du dann schon 30 Fehlermeldungen drin hast oder so, oder wenn wir jetzt drüber nachdenken, ob es irgendwann auch, also wenn wir irgendwann sozusagen Nachrichten aus dem gesamten Beschaffungsprozess stringent miteinander abbilden wollen, ob es dann nicht auch sinnvoll ist, eine minimale Testrechnung zu haben, um die mit einer vielleicht minimalen Bestellung oder so schon mal irgendwie verbinden zu können. Das ist noch nicht total ausgereift. Da kannst du dir ja wahrscheinlich auch Szenarien dann denken, wo es einfach auch sinnvoll ist, erstmal einen Kern zur Verfügung zu haben. Das gibt es aber noch nicht. Das wird es dann halt demnächst wahrscheinlich geben. Also das ist so viel zur stetigen Weiterentwicklung.

I: Okay, alles klar. (…) Dann will ich quasi nochmal so ein bisschen darauf zurückkommen, wenn man jetzt auch quasi in diesen Test-Cases denkt, sowohl technisch als auch Business-Case-mäßig. Im Endeffekt ist es so, (.) ihr als KoSIT definiert quasi beide Test-Cases, aber für die Business-Cases kriegt ihr quasi den Kontext auf Anfrage von irgendwelchen Akteuren aus der Praxis gestellt. Habe ich das richtig verstanden?

T2: Ja, bestenfalls kriegen wir die gestellt. Also wir haben schon seit einiger Zeit Fälle, wo wir immer wieder auch nach Beispielen gefragt werden, aber keine zur Verfügung stellen können, weil (.) wir keine zugeliefert bekommen. Also das sind dann eben bestimmte Invoice, also Rechnungen mit bestimmten Invoice-Type-Codes oder so für eine bestimmte Syntax (hustet), wo wir schon häufiger in Gremien oder, naja, da wo wir eben Anbindung haben und auch mal nachfragen können, angefragt haben und bisher keine Rückmeldung bekommen. Entsprechend können wir sowas dann auch nicht zur Verfügung stellen, weil das halt eben die Geschäftsfälle eben nicht die sind, die wir uns zusammen konstruieren wollen.

I: Ja. Okay. Und wenn man jetzt quasi in so einer Art Minimal Viable Product denken würde, auch für die Bestandteile der Testsuite, was wäre denn so eine Minimalmenge an Test Cases, sowohl Business Test Cases als auch Technical Test Cases, die man jetzt wirklich am Anfang bräuchte, wenn man sowas mal pilotmäßig entwickeln würde für einen anderen Standard?

T2: Das finde ich jetzt so spezifisch schwer zu beantworten aus verschiedenen Gründen. Ich glaube, das ist einfach sehr abhängig von der Komplexität des Standards, für den du die Test-Suite zur Verfügung stellen willst. Und es ist auch etwas (..), was (…) was sich so sukzessive erarbeitet, würde ich mal sagen. Also du hast, ich würde sagen, wenn du von Anfang an eine Testsuite mitdenkst, dann steht die nicht für sich. Du wirst sie nicht sozusagen in einem Guss irgendwie (.) auf den Markt werfen, sozusagen, sondern du wirst sie parallel entwickeln, zusammen mit den Prüfregeln oder mit einer, ich denke jetzt mal in XRechnung, Validator-Konfiguration zum Beispiel. Deswegen wäre mein Ansatz, aber da müsstest du vielleicht auch nochmal Renzo fragen oder so, wie er das damals gedacht hat auch, wäre mein Ansatz zu sagen, tatsächlich, also entweder oder, oder sowohl als auch mit einem einen minimalen Testfall anzufangen, also in einem Konstrukt, wo du weißt, also du hast das semantische Datenmodell und du leitest dir diesen minimalen Anwendungsfall ab, plus, na gut, wenn du den Standard noch entwickelst, dann gibt es natürlich auch keine entsprechenden Testnachrichten, die du irgendwo anonymisiert zur Verfügung gestellt kriegen kannst, aber dann müsstest du wahrscheinlich anfangen, nach außen zu gehen und zu fragen, was sind wahrscheinliche Anwendungsfälle? Ne, weiß ich nicht genau. Also ich habe ja vorhin schon kurz beschrieben, wie ich denke, wie die Anfänge der XRechnung-Test-Suite zustande gekommen sind, weil es die ja wirklich auch nicht von Anfang an gab. Aber wenn man das jetzt wirklich von Anfang an mitentwickelt, ja, ich glaube, du musst klein anfangen und dann irgendwie nehmen, was du kriegen kannst, sozusagen, und gucken, ich weiß nicht, je nachdem, was es ist, das ist ja jetzt relativ abstrakt, ich weiß auch nicht genau, mit den Katalogen, du hast das ja schon mal kurz dargestellt, aber da bin ich jetzt auch nicht so richtig drin, aber dass du guckst, irgendwie gibt es bestimmte Konstellationen, wo du weißt, die schließen sich gegenseitig aus oder so, oder gibt es einen Standardfall und andere, die vielleicht eher sozusagen so Randphänomene sind oder so, dass du halt eben guckst, was du mit dem konventionellsten vielleicht anfängst und dich dann irgendwie in die anderen Bereiche vorarbeitest oder halt guckst, wenn es Konstellationen gibt, die gleichberechtigt nebeneinander stehen, dass du dann halt auch parallel entwickelst. Kann ich jetzt leider nicht mehr als so abstrakt darstellen. Ich hoffe, das passt.

I: Das hilft mir schon mal ordentlich weiter. Vor allem auch so die Erkenntnis, hattest du ja jetzt auch schon ein wenig angedeutet, auch noch mal eine kurze Rückfrage dazu. Also prinzipiell würde es sich dann in dem Fall einfach empfehlen, quasi auch noch mal an Akteure aus der Praxis heranzutreten, auch schon in der Entwicklung. Und nachzufragen, hey, kann man hier vielleicht schon eine Art Business Case schon mal irgendwie anhand von einem typischen Anwendungsfall irgendwie ableiten?

T2: Ja, das wäre jetzt so mein, also da fehlt mir tatsächlich die Praxiserfahrung. Also ich bin ja quasi mit XRechnung überhaupt erst in dieses Ganze ((Bohrgeräusche)), oh, jetzt wird hier gebohrt. Ich hoffe, das legt sich jetzt nicht auf der Aufnahme nieder. (..) Ich bin ja mit XRechnung überhaupt erst als Quereinsteigerin in dieses ganze Thema Standardisierung und so weiter eingestiegen. Deswegen (…) bin ich da so ein bisschen, also ich glaube, da kannst du wirklich auch gut nochmal Renzo zu Fragen zu, wie viel Sinn das tatsächlich macht. Was ich gerade auch nochmal dachte, ist, es gibt ja auch schon, na gut, also es gibt ja auch schon andere Kataloge, sage ich jetzt mal, (..) wo du jetzt natürlich, also die sind ja auch aus Gründen anders, aber wo es vielleicht trotzdem schon mal irgendwie Illustrationen von Anwendungsfällen gibt, die du vielleicht auch benutzen könntest.

I: Okay, ja, das hilft mir schon mal sehr weiter. Dann würde ich sagen, machen wir (..) hier schon mal einen groben Cut bei dem Thema und gehen dann weiter auf die nächsten Fragen ein. Da bist du jetzt eben auch schon ein bisschen detaillierter drauf eingegangen, deswegen nur noch mal eine kleine Nachfrage. Wie genau beziehungsweise in welcher Reihenfolge genau werden jetzt noch mal diese einzelnen Bestandteile irgendwie in Abhängigkeit voneinander entwickelt?

T2: Ja, also parallel tatsächlich. Also wenn wir jetzt in die XRechnungs-Test-Suite gucken, dann ist ja da vor allem die Abhängigkeit zur Validator-Konfiguration gegeben und ich glaube, das hatten wir auch schon mal in irgendeinem Treffen kurz angesprochen, dass es da dieses viel zitierte Henne-Ei-Problem gibt. Also wenn die Validator-Konfiguration sich weiterentwickelt oder sich eben an den Prüfregeln was ändert, dann ist im Zweifelsfall die Kompatibilität mit der Test-Suite nicht mehr gegeben und umgekehrt. Und dann ist das tatsächlich manchmal so ein bisschen so ein (…) Gefummel, wenn du um (..) die Testsuite zu prüfen, dann eben eine Validator-Konfiguration schon, also, ich versuche nochmal anders, du brauchst um eine Validator-Konfiguration zu (…), nee, warte, Okay, ich glaube, jetzt müssen wir mal kurz von vorne anfangen, weil ich nämlich noch eine andere Frage in meinem Kopf habe, die ich die ganze Zeit schon gehabt habe, also nämlich die Frage nach überhaupt der Abgrenzung der Testsuite und wie (..) klar eigentlich ist oder ob das überhaupt jetzt hier vielleicht in diesem Kontext eine Rolle spielt, dass wir (..) auch in den anderen Komponenten noch Tests haben. Ich weiß nicht, ob das im Kontext XRechnung so klar ist und inwiefern das für deine Überlegungen auch eine Rolle spielt, dass wir in der Validator-Konfiguration und auch in dem (.) XRechnung Schematron nochmal quasi eigene Testkonzepte integriert haben, die halt einen anderen Fokus haben, nämlich einen rein technischen. Ob ich da nochmal was zu sagen sollte oder ob wir das jetzt völlig ausklammern können?

I: Ich denke nicht völlig ausklammern. Bewusst bin ich mir dessen schon prinzipiell, aber ich glaube, es wäre nochmal ganz gut (..), also könntest du noch mal bitte so ein bisschen die Abgrenzung schaffen von so einer Validierung oder einem Testfall, den man jetzt beispielsweise direkt auch bei der XRechnung einbaut, einem technischen Anwendungsfall, den man dann irgendwie rausstellt, einen Business-Anwendungsfall, den man rausstellt und der Validator-Konfiguration? Wenn das möglich ist, das grob abzugrenzen.

T2: Also ich kann dir ja mal die Architektur der einzelnen XRechnungskomponenten und dann die jeweiligen Bezüge zum Testen darstellen. Also es gibt ja die Komponenten, die wir pflegen für XRechnung, jetzt mal abgesehen davon, vom XRechnung-Model SeMoX, (.) das hat keine dezidierte Teststruktur in sich, gibt es noch die XRechnung Schematron-

Komponente, also das sind eben die deutschen Geschäftsregeln, die da entwickelt und gepflegt werden. Da gibt es Testdateien, die darauf ausgelegt sind, dann jeweils spezifische Geschäftsregeln (.) zu testen. Und ich weiß nicht, ob Renzo dir schon mal sein XML-Mutate-Tool dargelegt hat. Das ist so eine Art (…) Wie kann ich das jetzt gut beschreiben? Ich bin ja keine studierte Informatikerin oder wirklich gelernte Software-Informatikerin.

I: Ich habe mir das schon mal so ein wenig angeguckt. Das war ja auch etwas (..) worüber er mal ein Paper geschrieben hat und ja auch auf einer Konferenz präsentiert hatte, aber ich bin da auf jeden Fall nicht im Detail drinnen.

T2: Also du kannst sozusagen, du kannst in einer XML-Datei an bestimmten Stellen diese sogenannten Mutator-Anweisungen einbauen, die dann, es gibt ein bestimmtes Set zur Auswahl, das ist eigentlich, glaube ich, auch in der Weiterentwicklung begriffen, aber also so die Basics sind, (.) entferne dieses Element oder verwende einen anderen Wert oder du kannst eine ganze Reihe von anderen Werten da einsetzen und was gibt's noch? Add, Remove, na gut, Add, also hinzufügen funktioniert, glaube ich, gerade nicht. Es gibt (..), naja, es gibt auf jeden Fall sozusagen die Möglichkeit, in einer Testdatei an verschiedenen Stellen durch diese Anweisungen dann unterschiedliche Szenarien zu erzeugen und den Anweisungen außerdem, das ist das Wichtige, hinzuzugeben, was erwarte ich davon, was erwarte ich, was hier passiert. Und da gibt es irgendwie eine Möglichkeit zu sagen, ich erwarte, dass es hier ein valides Schema oder einen Fehler bei der Schema-Validierung gibt und es gibt die Möglichkeit zu sagen, ich erwarte, dass folgende Schematron-Regeln valide sind oder invalide sind. Genau, dann kannst du halt irgendwie sagen, für die Prüfregel BR-DE-20 erwarte ich an dieser Stelle mit diesem Wert, dass die Schematron-Überprüfung fehlschlägt. Und wenn sich diese Erwartung erfüllt, (..) dann hat sich halt sozusagen die Erwartung an den Test erfüllt. Ich werde hier, glaube ich, gerade auch schon wieder ein bisschen zu ausführlich.

I: Nee, das ist gut. Ja, alles gut.

T2: (unv.) Schematron-Testen. Und in der Validator-Konfiguration XRechnung, (..) das ist die sozusagen, ja, die Konfiguration, die sozusagen zusammenstellt, also nimm den Validator, also das Prüftool von der KoSIT, und nimm die CEN-Schematron-Regeln in welcher Version auch immer, also standardmäßig natürlich in der aktuellsten Version, weil auf den Prüfregeln für die EN 16931, also auf diesen CEN-Schematron-Regeln, setzen unsere Schematron-Regeln, die XRechnungs-Schematron-Regeln auf. (…) Dann werden bestimmte Szenarien konfiguriert (.) für UBL Invoice, für UBL Credit Note, für UBL Extension, dann nochmal CII und CII-Extension und, also dann wird halt geguckt, was, welche (..), wie nennt man das? (.) Ich sage jetzt mal, was hat in welchem Szenario

Gültigkeit, worauf soll validiert werden und dann wird geguckt, für eine Rechnung wird die sozusagen all diesen Anforderungen gerecht. Also erstmal wird geguckt, ist es valides XML, ist es Schema-valide, je nachdem, welche Syntax jetzt gerade aufgerufen wird und dann wird eben geguckt. Sind die Schematron-Regeln, XRechnung, CIUS valide? Wenn es ein Extension-Szenario ist, dann werden die Regeln auch noch mit reingenommen und so weiter. Und da gibt es dann verschiedene (..) Tests, Szenarien, sage ich jetzt mal. Da gibt es einmal die CEN-Unit-Tests, wo wir gucken, ist das CEN-Schematron sozusagen so (…) wie erwartet, es gibt halt häufiger auch mal Probleme mit Prüfregeln, die dann gar nicht sozusagen in der Hand von XRechnung liegen, sondern wo wir dann feststellen, ach so, ja, das sind in letzter Zeit häufig Fälle gewesen, wo es noch keine Prüfregeln gab, in Fällen, wo es welche geben müsste, um die korrekte Abbildung einer Rechnung nach dem semantischen Datenmodell zu gewährleisten. Also häufig so Kardinalitätsprüfungsgeschichten, wo dann, wo wir dann oft, also die Reihenfolge ist dann oft, wir schreiben einen Test, den benutzen wir dann, um eine Fehlermeldung bei der CEN zu machen und sagen, hier, das ist ein Testfall, der ist semantisch nicht korrekt, weil dieses Inhaltselement mehrfach vorhanden ist, das darf es aber nicht laut semantischem Datenmodell, wir brauchen hier eine Prüfregel und dann wird das CEN-seitig implementiert und wir können dann über diese Teststruktur, das wird (..), ich versuche mich zu strukturieren, aber ich rede jetzt, glaube ich, einfach erstmal weiter. Also ein Test, der keinen Fehler wirft (unv.), also eine Testdatei, die keinen Fehler wirft, obwohl sie einen werfen sollte, ist erstmal bei uns kategorisiert als unexpected. Dann haben wir dann eine Teststruktur, die sagt, okay, an dieser Stelle müsste es einen Fehler geben, der tritt aber nicht auf. (.) Und in dem Moment, wo dann über eine neue CEN-Schematron released dann eine entsprechende Prüfregel eingebunden wird, können wir abgleichen anhand unseres Testfalls, wird dieser Fehler jetzt doch geworfen, so wie wir ihn erwarten oder nicht? Und dann trifft es zu, was eigentlich in der Regel der Fall ist, aber manchmal halt auch nicht. Also gerade beim letzten Release war es so, dass wir (..) Ticket aufgemacht hatten und dann wurde das als gelöst und in dem Release aufgenommen, im Change-Log markiert und (..) dann beim Durchlaufen unserer Testdateien haben wir festgestellt, ja, nee, der Fehler wird aber immer noch nicht geworfen, weil, ich weiß nicht was, irgendwas schon schiefgelaufen war, auf jeden Fall war diese Änderung nicht mit aufgenommen, wie eigentlich angekündigt, so und also (..) (unv.) ist das Ganze dann korrekt umgesetzt, wird dann dieser Testfall bei uns verschoben in die CEN-Unit-Tests, wo wir dann halt definieren, wir haben hier diese Testdatei, wir erwarten an der Stelle, dass die, keine Ahnung, CII-SR-431-Regel zum Überprüfen, ob BT, Schlag mich tot, jetzt wirklich auch nur einmal vorhanden ist, ob das auch richtig funktioniert. Das sind so (.)

Testfälle, die wir, (..) also da gibt es keine tiefere Systematik drin, dass wir jetzt den Anspruch haben, möglichst umfassend zu testen, sondern das ist dann wirklich so spezifisch, es gibt Fehlermeldungen zu bestimmten Themen, wir haben dann diesen Test und dann bleibt er auch erstmal drin und dann können wir gucken, ob die Implementierung sozusagen stabil ist. (.) Dann haben wir Integration-Tests, wo wir zum Beispiel gucken, ob unsere Extension-Regeln mit den CEN-Schematron-Regeln kompatibel sind oder wo geguckt wird, wenn wir für die Extension CEN-Schematron-Regeln überschreiben müssen, dass das dann auch korrekt funktioniert. Genau, das sind die Tests in der Validator-Konfiguration XRechnung und die Testsuite ist halt wirklich irgendwie die Kapsel für, wir wollen hier ausschließlich korrekte Testfälle abbilden, das ist in den anderen Komponenten halt nicht unbedingt so gewollt oder erforderlich, da muss man halt manchmal auch einen negativen Test konstruieren, um was Bestimmtes abbilden zu können. Genau, und die Test-Suite ist dann eben so, das sind unsere Beispiele, unsere positiven Beispiele.

I: Okay, ja, vielen Dank für die ausführliche Darstellung, das hilft mir wirklich sehr weiter.

T2: (unv.) (…) Ja, wenn ich kurz hier was, das wird so ein bisschen nicht so wirklich inhaltlich, aber ich dachte gerade, wie gut für dich, dass du das nicht händisch transkribieren musst.

I: Ja, genau, das ist ganz praktisch dann mit unserem Transkriptions, mit unserer KI da. Ja, cool, dann würde ich sagen, nochmal hier ein kleiner thematischer Cut. In deiner Einschätzung, wie lange dauert ungefähr die Entwicklung einer solchen Testsuite? Nur die Testsuite, nicht jetzt auch, worüber wir sonst noch geredet haben mit CEN und Co. Die Testsuite.

T2: Kann ich so nicht sagen, weil Entwicklung, also ich glaube, ich würde jetzt erstmal sagen, naja gut, wir entwickeln ja bis jetzt, also wir überlegen uns immer wieder, was brauchen wir, wie können wir das, ne, angefangen von einem, das sind die Basics, hin zu einem, wie können wir das für uns immer stabiler und (..) ich sag jetzt mal, wertschöpfender gestalten, aber wenn ich jetzt so gucke, was waren die ersten Commits, die Renzo da gemacht hat, würde ich sagen, naja, also auch abhängig davon, ob dir jemand schon fertige XML-Dateien zur Verfügung stellt oder nicht, unterschiedlich. Ich könnte mir vorstellen, dass ein Renzo sagt, ein paar Tage, ich könnte mir vorstellen, dass ich sage, ja, vielleicht ein paar Wochen. Aber es ist wirklich total schwer (…), da jetzt eine konkrete Einschätzung zuzutreffen. Es ist vielleicht ein bisschen auch die Frage, worauf genau du abzielst mit der Frage. Also wie lange brauchst du, also wie lange würdest du brauchen, um für XKatalog jetzt irgendwie einen erstes Set an Testnachrichten zu schreiben oder ein Set, was für die Zwecke deiner Masterarbeit ausreichend ist oder (4) ja, es ist wirklich schwer zu sagen, in Arbeitsstunden, in Wochen, aber ja, ich glaube, ein paar Wochen würde ich mir dafür schon geben und überlegen, wie fange ich an, wie baue ich auf? Und wie gesagt, eigentlich läuft die Entwicklung halt auch parallel mit anderen Komponenten (unv.).

I: Okay, ja, aber das ist ja schon mal eine gute Einschätzung. Das hilft mir ebenfalls schon mal weiter.

T2: Ja, ohne Gewähr.

I: Ja, natürlich, das sowieso. Ist ja nur eine Einschätzung, also alles gut. Genau. Ich denke, zum nächsten Punkt hast du jetzt auch schon relativ umfangreich Dinge gesagt. Vielleicht nochmal kurz runtergebrochen oder ergänzend, würde ich sagen, weil es war jetzt schon relativ ausführlich, ergänzend zu dem, was du eben gesagt hast. Gibt es sonst noch irgendwelche Aufgaben, die jetzt auch konkret die Pflege der Testsuite umfassen? Also jetzt auch konkret Testsuite, nicht Validator-Konfiguration beispielsweise?

T2: Ja, also ich glaube, dass es aber in diesem, der Reifegrad, den XRechnung erreicht hat, da gibt es dann wirklich so viel nicht mehr zu tun, außer wir erlegen uns selbst irgendwelche Weiterentwicklungen auf und dann gibt es hin und wieder mal (..) so Anmerkungen wie, naja, ihr habt hier in eurer Beispieldatei, hast du da irgendwie ein Textfeld und dann steht da ein Wert drin, der jetzt logisch nicht (..) abbildet, was das semantische Datenmodell sagt zum Beispiel. Oder wir stellen dann eben doch fest über neue CEN-Schematron-Regeln, oh, wir haben hier auch irgendwie ein Inhaltselement falsch drin. Also das sind aber wirklich (…) im Moment nur Kleinigkeiten.

I: Okay, genau. Und dann auch nochmal kurz runtergebrochen, hattest du eben auch schon mal kurz runtergebrochen, aber einfach, damit ich es vielleicht nochmal offiziell gelistet habe. Wie wird jetzt konkret die Testsuite der XRechnung momentan eingesetzt, im aktuellen ausgereiften Zustand?

T2: Die ist sozusagen fester Bestandteil des Gefüges an technischen Komponenten. Also die wird, das läuft ja alles über diese Ant-Build-Skripts immer sozusagen automatisiert durch. Das heißt, die Test-Suite steht jetzt nicht nur für sich, sondern die wird auch in der Validator-Konfiguration, also nicht in ((T2 verliert die Interverbindung)).

T2: Okay. Hörst du mich wieder?

I: Hi. Ja, ich höre dich wieder. Du bist kurz rausgeflogen irgendwie.

T2: Ja, also ich habe den Bildschirm noch gesehen, aber Audio und Video war irgendwie hinüber scheinbar.

I: Ja, aber ist nicht schlimm. Ich habe es auch schon für die Transkription vermerkt. Der Bereich wird dann rausgeschnitten.

T2: Okay, gut. So, kurz nochmal zurück. Ach so, genau. Wenn wir die Validator-Konfiguration entwickeln, dann wird sozusagen in dem Schritt, also ich weiß nicht, hast du dir diese Ant-Build-Skripte schon mal angeguckt (unv.)?

I: Nicht genauer, nein.

T2: Ja, das wird ja sozusagen alles, (.) da fehlt mir leider auch irgendwie die Fachterminologie so richtig für. Ja. (..) Naja. (…) Also es gibt sozusagen beim Durchlaufen dieser Validator-Konfiguration bestimmte Schritte, die automatisiert durchlaufend werden und da gehört eben das Testen immer dazu. Das heißt, wenn wir die Validator-Konfiguration entwickeln, dann lassen wir in regelmäßigen Abständen das, was wir da tun, eben gegen die XRechnung Test-Suite durchlaufen oder auch wenn ich ein neues Release mache, dann wird bei dem Erzeugen der Distribution immer vorher durchgeprüft, sind die Regeln (..) mit der Testsuite kompatibel und es gibt einen Abbruch im Buildprozess, wenn da Fehler auftreten zum Beispiel und (..) das Gleiche passiert, wenn wir in der Visualisierungskomponente entwickeln und (.) bei Schematron passiert es nicht. Naja, und die Testsuite in sich ist halt die Testsuite in sich. So, warte mal, was war jetzt nochmal die konkrete Frage?

I: Wie die Testsuite jetzt eben einfach momentan eingesetzt wird.

T2: Ach so, genau. Also die ist sozusagen wirklich fester Bestandteil und so Referenztool für alles, was wir technisch weiterentwickeln, würde ich jetzt mal so sagen. Also die läuft da halt so mit als relativ stabiles Werkzeug.

T2: Wie viel die jetzt von außen genutzt wird, ob jetzt Leute da wirklich auch regelmäßig drauf gucken, keine Ahnung. Also Leute, die irgendwie anfangen, sich neu damit auseinanderzusetzen, aber (…) ja.

I: Ja, okay. Genau, dann würde ich ja auch jetzt weiter übergehen zur nächsten Frage. Welchen konkreten Mehrwert bzw. welche konkreten Vorteile, bist du jetzt auch schon natürlich drauf eingegangen ein bisschen, schafft denn jetzt eine solche Testsuite bei der Spezifikation bzw. Profilierung von einem Standard wie der XRechnung, aber auch bei der produktiven Nutzung?

T2: Ja, also eigentlich genau das, was ich gerade gesagt habe, insbesondere bei der produktiven Nutzung, haben wir jetzt halt wirklich diesen Referenzrahmen, an dem wir immer auch abgleichen. Also natürlich gibt es da auch immer Unschärfen und (..) Nachschärfungsbedarfe, aber im Wesentlichen wissen wir, wir können (..) immer dieses Set an Referenznachrichten validieren und gucken (.), sozusagen (.), ja, (unv.), aber ob alles sozusagen wie erwartet läuft oder ob dann doch irgendwo Fehler auftreten. Und bei der Profilierung würde ich sagen, naja, also eben (.), also eigentlich genau das Gleiche, nur dass du halt vielleicht noch nicht diese Stabilität hast, sondern eher so, du hast halt immer dieses (..) also so eine Art Gegengewicht. Du bewegst dich nicht im luftleeren Raum, weder auf der einen noch auf der anderen Seite, sondern du hast irgendwie sozusagen deine Struktur und deine Erwartungen auf der einen und auf der anderen Seite und die kannst du sozusagen fortlaufend gegeneinander abgleichen. Auch ein bisschen abstrakt möglicherweise formuliert, aber ja, (.) das würde ich als Mehrwert verstehen.

I: Ja, super, top. Gibt es denn da noch wesentliche Herausforderungen, die sich in der Vergangenheit, aber vielleicht auch jetzt gegenwärtig ergeben haben, in Bezug auf die Entwicklung bzw. Anwendung der Testsuite?

T2: Also es mag sein, dass das in den Anfängen anders war, aber wesentliche Herausforderungen in Bezug auf die Testsuite sehe ich jetzt nicht, kann ich mich auch gerade nicht erinnern, dass wir die in den letzten Jahren hatten. Also ich glaube tatsächlich, im Moment ist eigentlich die größte Herausforderung, Leute dazu zu kriegen, uns Testnachrichten zu besorgen, aber das ist jetzt auch nicht mehr so gravierend, weil es gibt ja schon zumindest einige.

I: Okay, aber wenn man jetzt quasi einen neuen Standard auch profilieren würde, gleichzeitig an der Testsuite arbeitet, würde dann auch da eben diese Beschaffung von relevanten Test-Cases aus diesem Business-Kontext eine wesentliche Herausforderung darstellen? Wie schätzt du das ein? Haben wir eben auch schon mal ein bisschen drüber geredet.

T2: (4) Superschwer für mich, das einzuschätzen. Also im Zweifelsfall vielleicht erst mal für (…) die technischen Entwicklungen tatsächlich mit selbst konstruierten technischen Testfällen anfangen. Und wie offen da Leute von außen sind, das kommt, glaube ich, wirklich (..) drauf an, also ich könnte mir schon vorstellen, ja klar, am Anfang, also wenn du einen Standard entwickelst sozusagen, der noch nicht produktiv ist, dann wird es auch schwierig, was Konkretes zu bekommen, aber wenn du irgendwie Anbindung hast an, ja, nee, (unv.) also das fällt mir wirklich schwer da. Aber ich glaube, es ist halt immer irgendwie zu sehen als was, was eine stetige Weiterentwicklung bedarf. (…) Ja.

I: Okay, ja, vielen Dank. Genau, dann jetzt zum Schluss noch mal als vorletzte Frage. Gibt es jetzt außerhalb von den Punkten, die du ausgeführt hast, noch weitere Dinge, die einfach für die Arbeit an, also die Entwicklung einer solchen Test-Suite oder die Arbeit mit einer solchen Test-Suite zu bedenken sind, die wichtig sind?

T2: Nee, fällt mir auf Anhieb nichts ein, aber da kann ich auch immer nur wieder so auf Renzo verweisen, zu sagen (unv.) von meiner Seite aus jetzt erstmal keine Anmerkungen.

I: Okay, alles klar, vielen Dank. Möchtest du sonst noch etwas ergänzen zu egal was jetzt im Interview?

T2: Nö, also (…) ich habe, glaube ich, alles gesagt, was ich dazu gerade im Kopf habe.

Appendix C: German PDF-Specification of the XKatalog

XKatalog-Standard

Version 0.5.0

Publication date 2025-01-31

Universität Koblenz und Koordinierungsstelle für IT-Standards
https://xeinkauf.de/

XKatalog-Standard

Dies ist die vorläufige Spezifikation des XKatalog-Standards für das Katalogmanagement im öffentlichen Einkaufsprozess. Der Standard soll es Lieferanten ermöglichen, ihre Produktinformationen in einem XML-basierten Datenstandard katalogisiert erfassen zu können. Konkret kann der XKatalog in der ersten Prozessphase des Post-Awards, dem Katalogmanagement, zum Einsatz kommen, um einen nahtlosen Prozessübergang zwischen Pre- und Post-Award gewährleisten zu können. Die Profilierung des „XKatalogs“ als elektronischer Katalogstandard ist essenziell, um die Grundlage einer ganzheitlichen Datentransformation von der Spezifikation eines Beschaffungsbedarfs bis zum Rechnungseingang zu ermöglichen. Der Standard befindet sich in aktiver Entwicklung.

Table of Contents

Chapter 1. Semantische Datentypen

1.1. Amount

Dieses Feld enthält einen Betrag, der einen Geldwert (ohne Mehrwertsteuer) bezeichnet, und einen Währungscode aus einer Liste von Währungscodes.

Eigenschaften von Amount			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	decimal	1	10000.25
Currency Identifier	string	1	EUR
Mit dieser Eigenschaft wird die Währung des Betrags angegeben.			

1.2. Any

Der ur-Typ, grundsätzlich keine Einschränkung bei den Datenwerten. Kann als Platzhalter verwendet werden.

Eigenschaften von Any			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	-	1	

1.3. Binary

Ein primitiver Datentyp. Eine Menge binärer Ziffern mit begrenzter Länge.

Eigenschaften von Binary			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	-	1	

1.4. Binary Object

Mit diesem Datentyp wird eine die Rechnung begleitende Datei in der Form eines Binärobjekts abgebildet. Derartige Anhänge können mit dem Katalog übermittelt werden. Je Syntax muss zur Übermittlung von Anhängen genau ein Weg definiert sein. Gegebenenfalls liegen Größenbeschränkungen vor.

Eigenschaften von Binary Object			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	binary	1	
Mime Code	string	1	image/jpeg
Mit dieser Eigenschaft wird der MIME-Typ (Multipurpose Internet Mail Extensions) der Datei angegeben. Ein Rechnungsempfänger muss Anhänge der folgenden MIME-Typen annehmen und verarbeiten können. (Übliche Dateiendungen sind in Klammern angegeben.) application/pdf image/png			

Eigenschaften von Binary Object			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
    image/jpeg text/csv application/vnd.openxmlformats-officedocument.spreadsheetml.sheet application/vnd.oasis.opendocument.spreadsheet 			
Filename	string	1	drawing5.jpeg
Mit dieser Eigenschaft wird der Dateiname angegeben.			

1.5. Code

Dieses Feld enthält Werte aus einer definierten Codeliste.

Eigenschaften von Code			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	string	1	ABC123

1.6. Date

Dieses Feld enthält ein Datum und detaillierte zeitliche Informationen wie z.B. Uhrzeit und Zeitzone.

Eigenschaften von Date			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	string	1	2024-08-20
YYYY-MM-DD			

1.7. Decimal

Ein primitiver Datentyp. Eine Untergruppe der reellen Zahlen, die durch dezimale Numerale abgebildet werden kann.

Eigenschaften von Decimal			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	-	1	

1.8. Document Reference

Dieses Feld enthält Informationen, die eine eindeutige Identifizierung eines zugehörigen Geschäftsdokuments ermöglichen.

Eigenschaften von Document Reference			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	string	1	abc:123-DEF

1.9. Group

Diese Reihe ist eine Geschäftsgruppe.

Eigenschaften von Group			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	any	1	

1.10. Identifier

Dieses Feld enthält Informationen, die eine eindeutige Identifizierung ermöglichen.

Eigenschaften von Identifier			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	string	1	abc:123-DEF
Scheme identifier	string	0..1	GLN
Mit dieser Eigenschaft wird die Kennung des verwendeten Bildungsmusters angegeben. Die Kardinalität der Eigenschaft ist im Kontext eines Informationselements, das auf dem Datentyp Identifier basiert, spezifiziert.			
List identifier	string	0..1	MP
Mit dieser Eigenschaft wird die Kennung der verwendeten Liste angegeben. Die Kardinalität der Eigenschaft ist im Kontext eines Informationselements, das auf dem Datentyp Identifier basiert, spezifiziert.			
List version identifier	string	0..1	20.0601
Mit dieser Eigenschaft wird die Version der verwendeten Liste angegeben.			
List code name	string	0..1	Büromöbel
Mit dieser Eigenschaft wird das textuelle Äquivalent des Codewerts angegeben.			

1.11. Indicator

Dieses Feld enthält entweder "true" oder "false".

Eigenschaften von Indicator			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	string	1	true

1.12. Numeric

Dieses Feld enthält eine numerische Zahl.

Eigenschaften von Numeric			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	decimal	1	3

1.13. Percentage

Numerische Information, die durch Berechnung, Zählung oder Sequenzierung zugewiesen oder bestimmt wird und als Prozentsatz ausgedrückt wird.

Eigenschaften von Percentage			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	decimal	1	50.84

1.14. Quantity

Dieses Feld enthält eine Mengenangabe.

Eigenschaften von Quantity			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	decimal	1	10.4751
Eine Gleitkommazahl ohne Limitierung der Nachkommastellen.			
Standard Unit Code	string	1	C62
Mit dieser Eigenschaft wird die Standardmaßeinheit einer Quantität angegeben. Die Kardinalität der Eigenschaft ist im Kontext eines Informationselements, das auf dem Datentyp quantity basiert, spezifiziert.			

1.15. String

Ein primitiver Datentyp. Eine endliche Folge von Zeichen.

Eigenschaften von String			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	-	1	

1.16. Text

Dieses Feld enthält einen Text.

Eigenschaften von Text			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	string	1	Hallo Welt!

1.17. URL

Dieses Feld enthält eine elektronische Adresse, in der Regel einen Uniform Resource Locator (z. B. eine Webadresse).

Eigenschaften von URL			
Eigenschaft	**Grundtyp**	**Anz.**	**Beispiel**
Content	string	1	https://xeinkauf.de/

Chapter 2. Codelist Overview

ID	Name	Beschreibung	Version
untdid-5189	UNTDID 5189 Allowance or charge identification code	Die Codeliste basiert auf der Codeliste 5189 (Allowance or charge identification code) des United Trade Data Interchange Directory (UNTDID). Sie ist konform zur DIN EN16931-1:2017 und zu dem darauf basierenden Standard XRechnung. EN16931-3-2, 3-3, 3-4 Annex A definiert eine Untermenge dieser Liste. Des Weiteren enthält sie alle Einträge, die für die Nutzung im Kontext des Standards XBestellung und XKatalog benötigt werden. Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:untdid.5189_3	3
iso-3166-1	ISO 3166-1 Country codes	Country codes (kompatibel zu ISO 3166-1). Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:country-codes_8	8
iso-4217	ISO 4217 Currency codes	Currency codes (kompatibel zu ISO 4217) Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:currency-codes_3	3
header-catalogue-action-codes	openPeppol Header Catalogue action codes	Codeliste der Aktionen, die auf den Header eines Katalogs angewendet werden können. Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/ActionCode_header/	1.0
line-catalogue-action-codes	openPeppol Line Catalogue action codes	Codeliste der Aktionen, die auf einzelne Zeilen des Katalogs angewendet werden können. Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/ActionCode_line/	1.0

ID	Name	Beschreibung	Version
transaction-condition-codes	openPeppol Transaction Condition codes	Codeliste der Transaktionskonditionen für Artikel. Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/TransactionCondition/	1.0
untdid-7161	UNTDID 7161 Charge reason codes	Codeliste der Special service description codes, die im Kontext des XKatalogs als Charge reason codes verwendet werden. Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:untdid.7161_3	3
untdid-8273	UNTDID 8273 Dangerous goods regulations code	Codeliste der Gefahrencodes Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/UNCL8273/	D.17A
untdid-1001	UNTDID 1001	Document name codes Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:untdid.1001_4	4
eas	EAS	Electronic Address Scheme Code list Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:eas_5	5
icd	ISO/IEC 17 6523 ICD	Identifier scheme code (kompatibel zu ISO 6523) Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:icd_5	5
untdid-7143	UNTDID 7143	Item type identification code Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:untdid.7143_4	4
untdid-6313	UNTDID 6313 Measured attribute code	Codes für die Maßattribute eines Items, z.B. Länge, Höhe oder Breite Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/UNCL6313/	D.17A
gs1-7009	GS1 7009 Packaging level codes	Codes, durch welche die Packeinheiten bzw. Packlevel von Produk-	1.0

ID	Name	Beschreibung	Version
		ten ausgedrückt werden Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/GS17009/	
untdid-5387	UNTDID 5387 Price type codes	Diese Liste spezifiziert die verschiedenen Arten von Preisen Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/UNCL5387/	D.16B
unece-n20	Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20)	Codes für die im internationalen Handel verwendeten Maßeinheiten. Link s. https://www.xrepository.de/details/urn:xoev-de:kosit:codeliste:rec20	3
mime-codes	Mime Codes	Mime Codes, welche den Dateityp eines angehängten Binärobjekts identifizieren. Link s. https://docs.peppol.eu/poacc/upgrade-3/codelist/MimeCode/	1.0

Kapitel 3. Geschäftsregeln

3.1. Regeln des Peppol Catalogues (T019)

Geschäftsregeln, die direkt aus dem Peppol post-award Katalog übernommen wurden. Die ID-Benennung entspricht der ursprünglichen Benennung von Peppol.

ID	Beschreibung	Ziel / Kontext	Informationselement
PEPPOL-T19-R001	Das Enddatum des Gültigkeitszeitraums eines Katalogs "Catalogue validity period end date Catalogue validity period end date" (BT-12) muss größer oder gleich dem Anfangsdatum "Catalogue validity period start date Catalogue validity period start date" (BT-11) sein.	Catalogue validity period	BT-11 BT-12
PEPPOL-T19-R006	Die Preise von Artikeln "Item price amount Item price amount" (BT-88) dürfen nicht negativ sein.	Price details	BT-88
PEPPOL-T19-R008	Die Höchstmenge "Maximum order quantity Maximum order quantity" (BT-80) muss größer als Null sein.	Catalogue line	BT-80
PEPPOL-T19-R009	Die Mindestmenge "Minimum order quantity Minimum order quantity" (BT-79) muss größer als Null sein.	Catalogue line	BT-79
PEPPOL-T19-R010	Die Höchstmenge "Maximum order quantity Maximum order quantity" (BT-80) muss größer als oder gleich der Mindestmenge "Minimum order quantity Minimum order quantity" (BT-79) sein.	Catalogue line	BT-79 BT-80
PEPPOL-T19-R012	Jede Position in einer Katalogzeile "Catalogue line Catalogue line" (BG-17) muss entweder durch "Seller item identifier Seller item identifier" (BT-106) oder "Standard item identifier Standard item identifier" (BT-109) identifizierbar sein.	Catalogue Catalogue item information	BG-17 BT-106 BT-109
PEPPOL-T19-R014	Jede Steuerkategorie "Classified tax category Classified tax category" (BG-27) muss einen Steuersatz "Item tax percentage Item tax percentage" (BT-141) haben, es sei denn, die Katalogzeile "Catalogue line Catalogue line" (BG-17) ist nicht steuerpflichtig.	Catalogue item information Classified tax category	BG-27 BT-141
PEPPOL-T19-R015	Wenn "Item tax category code Item tax category code" (BT-140) „Standard rated“ (S) ist, muss der Steuersatz "Item tax percentage Item tax percentage" (BT-141) größer als Null sein.	Classified tax category	BT-140 BT-141
PEPPOL-T19-B23801	Der Wert von "Certificate type code Certificate type code" (BT-130) muss 'NA' entsprechen. Grund dafür ist eine Notwendigkeit in der von Peppol verwendeten UBL-Struktur.	Certificate	BT-130
PEPPOL-T19-B00501	Der Wert von "Catalogue action code Catalogue action code" (BT-4) muss Teil der Codeliste openPeppol Header Catalogue action codes sein.	Catalogue	BT-4
PEPPOL-T19-B01702	Der Wert von "Provider party electronic address Provider party electronic address" (BT-13) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue provider	BT-13
PEPPOL-T19-B02001	Der Wert von "Catalogue provider identifier Catalogue provider identifier" (BT-14) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue provider	BT-14

ID	Beschreibung	Ziel / Kontext	Informationselement
PEP-POL-T19-B03101	Der Wert von "Provider country code Provider country code" (BT-21) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Provider postal address	BT-21
PEP-POL-T19-B03401	Der Wert von "Provider legal registration identifier Provider legal registration identifier" (BT-23) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Provider legal entity	BT-23
PEP-POL-T19-B03901	Der Wert von "Provider legal registration country code Provider legal registration country code" (BT-25) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Provider legal entity	BT-25
PEP-POL-T19-B04102	Der Wert von "Receiver party electronic address Receiver party electronic address" (BT-26) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue receiver	BT-26
PEP-POL-T19-B04401	Der Wert von "Catalogue receiver identifier Catalogue receiver identifier" (BT-27) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue receiver	BT-27
PEP-POL-T19-B05501	Der Wert von "Receiver country code Receiver country code" (BT-34) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Receiver postal address	BT-34
PEP-POL-T19-B05801	Der Wert von "Receiver legal registration identifier Receiver legal registration identifier" (BT-36) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Receiver legal entity	BT-36
PEP-POL-T19-B06301	Der Wert von "Receiver legal registration country code Receiver legal registration country code" (BT-38) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Receiver legal entity	BT-38
PEP-POL-T19-B06602	Der Wert von "Supplier party electronic address Supplier party electronic address" (BT-39) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue supplier	BT-39
PEP-POL-T19-B06901	Der Wert von "Catalogue supplier identifier Catalogue supplier identifier" (BT-40) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue supplier	BT-40
PEP-POL-T19-B08201	Der Wert von "Supplier country code Supplier country code" (BT-48) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Supplier postal address	BT-48
PEP-POL-T19-B08902	Der Wert von "Customer party electronic address Customer party electronic address" (BT-52) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue customer	BT-52
PEP-POL-T19-B09201	Der Wert von "Catalogue customer identifier Catalogue customer identifier" (BT-53) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue customer	BT-53
PEP-POL-T19-B10501	Der Wert von "Customer country code Customer country code" (BT-61) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Customer postal address	BT-61
PEP-POL-T19-B11401	Der Wert von "Line action code Line action code" (BT-74) muss Teil der Codeliste openPeppol Line Catalogue action codes sein.	Catalogue line	BT-74
PEP-POL-T19-B11601	Der Wert von "Orderable unit Orderable unit" (BT-76) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-76

ID	Beschreibung	Ziel / Kontext	Informationselement
PEPPOL-T19-B11702	Der Wert von "Item net quantity Item net quantity" (BT-77) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-77
PEPPOL-T19-B12002	Der Wert von "Minimum order quantity Minimum order quantity" (BT-79) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-79
PEPPOL-T19-B12202	Der Wert von "Maximum order quantity Maximum order quantity" (BT-80) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-80
PEPPOL-T19-B12501	Der Wert von "Packaging level Packaging level" (BT-82) muss Teil der Codeliste GS1 7009 Packaging level codes sein.	Catalogue line	BT-82
PEPPOL-T19-B15102	Der Wert von "Price lead time Price lead time" (BT-85) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-85
PEPPOL-T19-B15302	Der Wert von "Price quantity threshold Price quantity threshold" (BT-86) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-86
PEPPOL-T19-B15502	Der Wert von "Price quantity ceiling Price quantity ceiling" (BT-87) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-87
PEPPOL-T19-B16601	Der Wert von "Price country code Price country code" (BT-105) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Price location information	BT-105
PEPPOL-T19-B16802	Der Wert von "Item price amount Item price amount" (BT-88) muss Teil der Codeliste ISO 4217 Currency codes sein.	Price details	BT-88
PEPPOL-T19-B17002	Der Wert von "Item price base quantity Item price base quantity" (BT-89) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-89
PEPPOL-T19-B17201	Der Wert von "Item price type Item price type" (BT-90) muss Teil der Codeliste UNTDID 5387 Price type codes sein.	Price details	BT-90
PEPPOL-T19-B17902	Der Wert von "Packed quantity Packed quantity" (BT-117) muss Teil der Codeliste UNTDID 5387 Price type codes sein.	Catalogue item information	BT-117
PEPPOL-T19-B19202	Der Wert von "Standard item identifier Standard item identifier" (BT-109) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue item information	BT-109
PEPPOL-T19-B19601	Der Wert von "External item specifications type External item specifications type" (BT-144) muss Teil der Codeliste UNTDID 1001 Document name codes sein.		BT-144
PEPPOL-T19-B19902	Der Wert von "Attached object Attached object" (BT-146) muss Teil der Codeliste Mime Codes sein.		BT-146

ID	Beschreibung	Ziel / Kontext	Informationselement
PEP-POL-T19-B20501	Der Wert von "Item origin country Item origin country" (BT-116) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Catalogue item information	BT-116
PEP-POL-T19-B20702	Der Wert von "Item classification code Item classification code" (BT-115) muss Teil der Codeliste UNTDID 7143 sein.	Catalogue item information	BT-115
PEP-POL-T19-B21201	Der Wert von "Contracted item indicator Contracted item indicator" (BT-119) muss Teil der Codeliste openPeppol Transaction Condition codes sein.	Catalogue item information	BT-119
PEP-POL-T19-B21401	Der Wert von "Hazardous item UNDG code Hazardous item UNDG code" (BT-120) muss Teil der Codeliste UNTDID 8273 Dangerous goods regulations code sein.	Catalogue item information	BT-120
PEP-POL-T19-B22602	Der Wert von "Item property unit of measure Item property unit of measure" (BT-127) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Additional item property	BT-127
PEP-POL-T19-B24701	Der Wert von "Dimension attribute identifier Dimension attribute identifier" (BT-135) muss Teil der Codeliste UNTDID 6313 Measured attribute code sein.	Dimension	BT-135
PEP-POL-T19-B24802	Der Wert von "Measure Measure" (BT-136) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Dimension	BT-136
PEP-POL-T19-B25102	Der Wert von "Minimum storage conditions Minimum storage conditions" (BT-138) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.		BT-138
PEP-POL-T19-B25302	Der Wert von "Maximum storage conditions Maximum storage conditions" (BT-139) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.		BT-139

ID	Beschreibung
PEP-POL-T19-B00109	Der Katalog darf keine Schema-Location enthalten.

3.2. National ergänzende Regeln

Im Folgenden sind all jene Regeln spezifiziert, die sich aus den nationalen Anforderungen an elektronische Kataloge ergeben und die fachliche Nutzung des semantischen Modells spezifizieren.

ID	Beschreibung	Ziel / Kontext	Informationselement
PEP-POL-T19-NA-rule-issuerpartyname	Der Wert von "Label issuer name Label issuer name" (BT-133) muss 'NA' entsprechen. Grund dafür ist eine Notwendigkeit in der von Peppol verwendeten UBL-Struktur.	Certificate	BT-133

ID	Beschreibung	Ziel / Kontext	Informationselement
PEP-POL-BR-CL-03	Der Wert von "Allowance or charge amount Allowance or charge amount" (BT-95) muss Teil der Codeliste ISO 4217 Currency codes sein.	Price allowances and charges	BT-95
PEP-POL-EN16931-CL002	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-98) muss Teil der Codeliste UNTDID 5189 Allowance or charge identification code sein, wenn der Wert von "Charge indicator Charge indicator" (BT-94) "falsch" entspricht.	Price allowances and charges	BT-98
PEP-POL-EN16931-CL003	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-98) muss Teil der Codeliste UNTDID 7161 Charge reason codes sein, wenn der Wert von "Charge indicator Charge indicator" (BT-94) "true" entspricht.	Price allowances and charges	BT-98
PEP-POL-EN16931-R040	Der Aufschlag-/Nachlass-Betrag von "Allowance or charge amount Allowance or charge amount" (BT-95) muss dem Basis-Betrag * Prozentsatz/100 entsprechen falls ein Betrag and ein Prozentsatz ("Allowance or charge percentage Allowance or charge percentage" (BT-96)) angegeben sind.	Price allowances and charges	BT-95
BR-2	Der Aufschlag-/Nachlass-Betrag von "Allowance or charge amount Allowance or charge amount" (BT-157) muss dem Basis-Betrag * Prozentsatz/100 entsprechen falls ein Betrag and ein Prozentsatz ("Allowance or charge percentage Allowance or charge percentage" (BT-159)) angegeben sind.	Characteristic value allowance or charge	BT-157
BR-CL-1	Der Wert von "Allowance or charge amount Allowance or charge amount" (BT-157) muss Teil der Codeliste ISO 4217 Currency codes sein.	Characteristic value allowance or charge	BT-157
BR-CL-2	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-161) muss Teil der Codeliste UNTDID 5189 Allowance or charge identification code sein, wenn der Wert von "Charge indicator Charge indicator" (BT-156) "falsch" entspricht.	Characteristic value allowance or charge	BT-161
BR-CL-3	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-161) muss Teil der Codeliste UNTDID 7161 Charge reason codes sein, wenn der Wert von "Charge indicator Charge indicator" (BT-156) "true" entspricht.	Characteristic value allowance or charge	BT-161

ID	Beschreibung
BR-1	Alle XML-Elemente, die nicht im XML-Modell definiert sind, werden ignoriert.

3.3. Codelisten-Regeln

AlTl jene Regeln, die Aussagen über die Verwendung von Codelisten im Katalog treffen.

ID	Beschreibung	Ziel / Kontext	Informationselement
PEP-POL-T19-B00501	Der Wert von "Catalogue action code Catalogue action code" (BT-4) muss Teil der Codeliste openPeppol Header Catalogue action codes sein.	Catalogue	BT-4

ID	Beschreibung	Ziel / Kontext	Informa-tionsele-ment
PEP-POL-T19-B01702	Der Wert von "Provider party electronic address Provider party electronic address" (BT-13) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue provider	BT-13
PEP-POL-T19-B02001	Der Wert von "Catalogue provider identifier Catalogue provider identifier" (BT-14) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue provider	BT-14
PEP-POL-T19-B03101	Der Wert von "Provider country code Provider country code" (B-T-21) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Provider postal address	BT-21
PEP-POL-T19-B03401	Der Wert von "Provider legal registration identifier Provider legal registration identifier" (BT-23) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Provider legal entity	BT-23
PEP-POL-T19-B03901	Der Wert von "Provider legal registration country code Provider legal registration country code" (BT-25) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Provider legal entity	BT-25
PEP-POL-T19-B04102	Der Wert von "Receiver party electronic address Receiver party electronic address" (BT-26) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue receiver	BT-26
PEP-POL-T19-B04401	Der Wert von "Catalogue receiver identifier Catalogue receiver identifier" (BT-27) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue receiver	BT-27
PEP-POL-T19-B05501	Der Wert von "Receiver country code Receiver country code" (B-T-34) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Receiver postal address	BT-34
PEP-POL-T19-B05801	Der Wert von "Receiver legal registration identifier Receiver legal registration identifier" (BT-36) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Receiver legal entity	BT-36
PEP-POL-T19-B06301	Der Wert von "Receiver legal registration country code Receiver legal registration country code" (BT-38) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Receiver legal entity	BT-38
PEP-POL-T19-B06602	Der Wert von "Supplier party electronic address Supplier party electronic address" (BT-39) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue supplier	BT-39
PEP-POL-T19-B06901	Der Wert von "Catalogue supplier identifier Catalogue supplier identifier" (BT-40) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue supplier	BT-40
PEP-POL-T19-B08201	Der Wert von "Supplier country code Supplier country code" (B-T-48) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Supplier postal address	BT-48
PEP-POL-T19-B08902	Der Wert von "Customer party electronic address Customer party electronic address" (BT-52) muss Teil der Codeliste Electronic Address Scheme Code list sein.	Catalogue customer	BT-52
PEP-POL-T19-B09201	Der Wert von "Catalogue customer identifier Catalogue customer identifier" (BT-53) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue customer	BT-53
PEP-POL-T19-B10501	Der Wert von "Customer country code Customer country code" (BT-61) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Customer postal address	BT-61

ID	Beschreibung	Ziel / Kontext	Informationselement
PEP-POL-T19-B11401	Der Wert von "Line action code Line action code" (BT-74) muss Teil der Codeliste openPeppol Line Catalogue action codes sein.	Catalogue line	BT-74
PEP-POL-T19-B11601	Der Wert von "Orderable unit Orderable unit" (BT-76) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-76
PEP-POL-T19-B11702	Der Wert von "Item net quantity Item net quantity" (BT-77) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-77
PEP-POL-T19-B12002	Der Wert von "Minimum order quantity Minimum order quantity" (BT-79) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-79
PEP-POL-T19-B12202	Der Wert von "Maximum order quantity Maximum order quantity" (BT-80) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Catalogue line	BT-80
PEP-POL-T19-B12501	Der Wert von "Packaging level Packaging level" (BT-82) muss Teil der Codeliste GS1 7009 Packaging level codes sein.	Catalogue line	BT-82
PEP-POL-T19-B15102	Der Wert von "Price lead time Price lead time" (BT-85) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-85
PEP-POL-T19-B15302	Der Wert von "Price quantity threshold Price quantity threshold" (BT-86) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-86
PEP-POL-T19-B15502	Der Wert von "Price quantity ceiling Price quantity ceiling" (BT-87) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-87
PEP-POL-T19-B16601	Der Wert von "Price country code Price country code" (BT-105) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Price location information	BT-105
PEP-POL-T19-B16802	Der Wert von "Item price amount Item price amount" (BT-88) muss Teil der Codeliste ISO 4217 Currency codes sein.	Price details	BT-88
PEP-POL-T19-B17002	Der Wert von "Item price base quantity Item price base quantity" (BT-89) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Price details	BT-89
PEP-POL-T19-B17201	Der Wert von "Item price type Item price type" (BT-90) muss Teil der Codeliste UNTDID 5387 Price type codes sein.	Price details	BT-90
PEP-POL-T19-B17902	Der Wert von "Packed quantity Packed quantity" (BT-117) muss Teil der Codeliste UNTDID 5387 Price type codes sein.	Catalogue item information	BT-117
PEP-POL-T19-B19202	Der Wert von "Standard item identifier Standard item identifier" (BT-109) muss Teil der Codeliste ISO/IEC 17 6523 ICD sein.	Catalogue item information	BT-109

ID	Beschreibung	Ziel / Kontext	Informationselement
PEP-POL-T19-B19601	Der Wert von "External item specifications type External item specifications type" (BT-144) muss Teil der Codeliste UNTDID 1001 Document name codes sein.		BT-144
PEP-POL-T19-B19902	Der Wert von "Attached object Attached object" (BT-146) muss Teil der Codeliste Mime Codes sein.		BT-146
PEP-POL-T19-B20501	Der Wert von "Item origin country Item origin country" (BT-116) muss Teil der Codeliste ISO 3166-1 Country codes sein.	Catalogue item information	BT-116
PEP-POL-T19-B20702	Der Wert von "Item classification code Item classification code" (BT-115) muss Teil der Codeliste UNTDID 7143 sein.	Catalogue item information	BT-115
PEP-POL-T19-B21201	Der Wert von "Contracted item indicator Contracted item indicator" (BT-119) muss Teil der Codeliste openPeppol Transaction Condition codes sein.	Catalogue item information	BT-119
PEP-POL-T19-B21401	Der Wert von "Hazardous item UNDG code Hazardous item UNDG code" (BT-120) muss Teil der Codeliste UNTDID 8273 Dangerous goods regulations code sein.	Catalogue item information	BT-120
PEP-POL-T19-B22602	Der Wert von "Item property unit of measure Item property unit of measure" (BT-127) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Additional item property	BT-127
PEP-POL-T19-B24701	Der Wert von "Dimension attribute identifier Dimension attribute identifier" (BT-135) muss Teil der Codeliste UNTDID 6313 Measured attribute code sein.	Dimension	BT-135
PEP-POL-T19-B24802	Der Wert von "Measure Measure" (BT-136) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.	Dimension	BT-136
PEP-POL-T19-B25102	Der Wert von "Minimum storage conditions Minimum storage conditions" (BT-138) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.		BT-138
PEP-POL-T19-B25302	Der Wert von "Maximum storage conditions Maximum storage conditions" (BT-139) muss Teil der Codeliste Codes for Units of Measure Used in International Trade (UN/ECE Recommendation N°20) sein.		BT-139
PEP-POL-BR-CL-03	Der Wert von "Allowance or charge amount Allowance or charge amount" (BT-95) muss Teil der Codeliste ISO 4217 Currency codes sein.	Price allowances and charges	BT-95
PEP-POL-EN16931-CL002	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-98) muss Teil der Codeliste UNTDID 5189 Allowance or charge identification code sein, wenn der Wert von "Charge indicator Charge indicator" (BT-94) "falsch" entspricht.	Price allowances and charges	BT-98
PEP-POL-EN16931-CL003	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-98) muss Teil der Codeliste UNTDID 7161 Charge reason codes sein, wenn der Wert von "Charge indicator Charge indicator" (BT-94) "true" entspricht.	Price allowances and charges	BT-98

ID	Beschreibung	Ziel / Kontext	Informationselement
BR-CL-1	Der Wert von "Allowance or charge amount Allowance or charge amount" (BT-157) muss Teil der Codeliste ISO 4217 Currency codes sein.	Characteristic value allowance or charge	BT-157
BR-CL-2	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-161) muss Teil der Codeliste UNTDID 5189 Allowance or charge identification code sein, wenn der Wert von "Charge indicator Charge indicator" (BT-156) "falsch" entspricht.	Characteristic value allowance or charge	BT-161
BR-CL-3	Der Wert von "Allowance or charge reason code Allowance or charge reason code" (BT-161) muss Teil der Codeliste UNTDID 7161 Charge reason codes sein, wenn der Wert von "Charge indicator Charge indicator" (BT-156) "true" entspricht.	Characteristic value allowance or charge	BT-161

Chapter 4. Semantische Strukturen

4.1. XKatalog

Full semantic structure of the XKatalog.

Informationselemente von XKatalog				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Catalogue	BG-1		1	17
Grundlegende Informationen über den Katalog.				

4.1.1. Additional item property

Eine Gruppe von Geschäftsbegriffen, die Informationen über die Eigenschaften der in der Katalogzeile aufgeführten Artikel liefern.

Diese Gruppe von Informationselementen (ID: BG-24, Anz. $0.._\infty$) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue item information (ID: BG-23), siehe Abschnitt 4.1.6, „Catalogue item information“.

Informationselemente von Additional item property				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Item property name	BT-124	Text	1	4
Der Name der Eigenschaft muss ausreichend beschreibend sein, um den Wert zu definieren. Die Definition kann gegebenenfalls um die Maßeinheit der Eigenschaft ergänzt werden.				
Item property code	BT-125	Code	0..1	2
Code für die Artikeleigenschaft gemäß einem Eigenschaftscodesystem.				
List identifier			1	
Mit dieser Eigenschaft wird die Kennung der vom Element verwendeten Liste angegeben. This property is used to specify the identifier of the list used by the element.				
Item property value	BT-126	Text	1	4
Der Wert der Artikeleigenschaft.				
Item property unit of measure	BT-127	Quantity	0..1	4
Die Maßeinheit, in der der Eigenschaftswert angegeben ist, sofern relevant. Kann nicht relevant sein, wenn Eigenschaften beschreibend sind.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben. This property is used to specify the default unit of measurement for the quantity used by the element.				
Property classification	BT-128	Text	0..1	4
Standardisierte und vordefinierte Klassifizierung der Eigenschaften des Artikels.				

4.1.2. Catalogue

Grundlegende Informationen über den Katalog.

Diese Gruppe von Informationselementen (ID: BG-1, Anz. 1) ist ein direkter Bestandteil des Wurzelelements XKatalog, siehe Abschnitt 4.1, „XKatalog“.

Informationselemente von Catalogue				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Specification identification	BT-1	Identifier	1	3
Gibt die Spezifikation des Inhalts und der Regeln an, die für die Transaktion gelten.				
Business process type identifier	BT-2	Identifier	1	3
Gibt das BII-Profil oder den Geschäftsprozesskontext an, in dem die Transaktion angezeigt wird.				
Catalogue identifier	BT-3	Identifier	1	3
Eine Kataloginstanz muss einen Identifier enthalten, der es ermöglicht, die Dokumentinstanz für verschiedene Zwecke eindeutig zu referenzieren, einschließlich der Referenzierung zwischen Transaktionen, die Teil desselben Prozesses sind.				
Catalogue action code	BT-4	Code	0..1	2
Legt fest, wie ein empfangener Katalog mit den in früheren Katalogen übermittelten Katalogzeilen abzugleichen ist, sodass keine Diskrepanzen zwischen den Informationen des Lieferanten und des Kunden auftreten. Beschreibt, wie vorhandene Artikel, die nicht Teil des empfangenen Katalogs sind, und solche, die enthalten sind (unverändert, geändert oder gelöscht), behandelt werden sollen. Die Standardmaßnahme ist die vollständige Ersetzung des Quellkatalogs.				
Catalogue name	BT-5	Text	0..1	4
Ein Name des Katalogs als allgemeine Referenz.				
Catalogue issue date	BT-6	Date	1	2
Das Datum, an dem die Kataloginstanz ausgestellt wurde.				
Catalogue version	BT-7	Text	0..1	4
Die Version des Katalogs.				
Source catalogue identifier	BT-8	Document Reference	0..1	2
Identifiziert den vorhandenen, bereits erhaltenen Katalog, auf den sich diese Nachricht beziehen soll, damit keine Diskrepanzen zwischen den Lieferanten- und Kundeninformationen entstehen.				
Contract identifier	BT-9	Document Reference	0..1	2
Eine Referenz, die einen Vertrag, der sich auf diese Transaktion bezieht, eindeutig identifiziert.				
Pre-award catalogue reference	BT-158	Document Reference	0..1	2
Ein eindeutiger Verweis auf den Pre-Award-Katalog, der parallel zum bezuschlagten Angebot versendet wurde.				
General payment conditions	BT-10	Text	0..1	4
Informationen zu den allgemeinen Zahlungsbedingungen				
Catalogue validity period	BG-2		1	26
Der Zeitraum, in dem der Inhalt des Katalogs gültig ist und für den Handel verwendet werden kann.				
Catalogue provider	BG-3		1	24
Die Geschäftspartei, die den Katalog bereitstellt. Ein Verkäufer oder ein Katalog-Repository.				
Catalogue receiver	BG-6		1	24
Die Geschäftspartei, an die der Katalog gesendet wird. Ein Käufer oder ein in seinem Auftrag agierendes Katalog-Repository.				
Catalogue supplier	BG-9		0..1	25
Die Geschäftspartei, welche die im Katalog aufgeführten Artikel anbietet.				
Catalogue customer	BG-12		0..1	19

Informationselemente von Catalogue				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Diejenige Geschäftspartei, die aus dem Katalog bestellen darf.				
Catalogue group system	BG-15		0..1	20
Eine Gruppe von Geschäftsbegriffen, die Informationen über das Gruppensystem des Katalogs zum Aufbau hierarchischer Produktbäume liefern.				
Catalogue line	BG-17		1..∞	22
Eine Gruppe von Geschäftsbegriffen, die Informationen über den Inhalt der Katalogzeile liefern.				

4.1.3. Catalogue customer

Diejenige Geschäftspartei, die aus dem Katalog bestellen darf.

Diese Gruppe von Informationselementen (ID: BG-12, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue (ID: BG-1), siehe Abschnitt 4.1.2, „Catalogue“.

Informationselemente von Catalogue customer				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Customer party electronic address	BT-52	Identifier	0..1	3
Identifiziert die elektronische Adresse des Kunden.				
Scheme identifier			1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Catalogue customer identifier	BT-53	Identifier	0..1	3
Verwendung in Abwesenheit des Namens oder zusätzlich zu diesem. Es sollte ein Identifikator verwendet werden, der dem Empfänger des Dokuments bekannt ist.				
Scheme identifier			0..1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Catalogue customer trading name	BT-54	Text	0..1	4
Verwendung in Abwesenheit oder zusätzlich zur Parteikennung.				
Customer postal address	BG-13		1	27
Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Katalogkunden liefern.				
Catalogue customer contact	BG-14		1	19
Eine Gruppe von Geschäftsbegriffen, die Informationen über den Kundenkontakt im Katalog liefern.				

4.1.4. Catalogue customer contact

Eine Gruppe von Geschäftsbegriffen, die Informationen über den Kundenkontakt im Katalog liefern.

Diese Gruppe von Informationselementen (ID: BG-14, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue customer (ID: BG-12), siehe Abschnitt 4.1.3, „Catalogue customer“.

Informationselemente von Catalogue customer contact				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Customer contact person name	BT-62	Text	0..1	4
Der Name der Kontaktperson.				

Informationselemente von Catalogue customer contact				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Customer contact telephone number	BT-63	Text	0..1	4
Eine Telefonnummer für die Kontaktperson. Wenn die Person eine direkte Nummer hat, ist dies diese Nummer.				
Customer contact email address	BT-64	Text	0..1	4
Die E-Mail-Adresse der Kontaktperson. Wenn die Person eine direkte E-Mail hat, ist dies diese E-Mail.				

4.1.5. Catalogue group system

Eine Gruppe von Geschäftsbegriffen, die Informationen über das Gruppensystem des Katalogs zum Aufbau hierarchischer Produktbäume liefern.

Diese Gruppe von Informationselementen (ID: BG-15, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue (ID: BG-1), siehe Abschnitt 4.1.2, „Catalogue“.

Informationselemente von Catalogue group system				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Catalogue group identifier	BT-65	Identifier	1	3
Dient zur Identifizierung der Kataloggruppe.				
Catalogue group name	BT-66	Text	1	4
Der Name der Kataloggruppe.				
Catalogue group description	BT-67	Text	0..1	4
Eine Beschreibung mit Informationen über die Kataloggruppe.				
Product group structure	BG-16		1..∞	32
Eine Gruppe von Geschäftsbegriffen, die Informationen über eine konkrete Produktgruppenstruktur der Kataloggruppe liefern.				

4.1.6. Catalogue item information

Eine Gruppe von Geschäftsbegriffen, die Informationen über die Artikel des Katalogs liefern.

Diese Gruppe von Informationselementen (ID: BG-23, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue line (ID: BG-17), siehe Abschnitt 4.1.7, „Catalogue line“.

Informationselemente von Catalogue item information				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Seller item identifier	BT-106	Identifier	0..1	3
Eine vom Verkäufer zugewiesene Kennung für den Artikel. Verknüpft den Artikel mit seiner Kennung gemäß dem System des Verkäufers.				
Buyer item identifier	BT-107	Identifier	0..1	3
Ein vom Käufer zugewiesener Identifikator für den Artikel. Verknüpft den Artikel mit seiner Kennung gemäß dem System des Käufers.				
Manufacturer item identifier	BT-108	Identifier	0..1	3
Die Kennung des Herstellers für den Artikel.				
Standard item identifier	BT-109	Identifier	0..1	3
Ein Artikelidentifikator, der auf einem registrierten Schema basiert. Verknüpft den Artikel mit seiner Identifikation nach einem Standardsystem.				
Scheme identifier			1	

Informationselemente von Catalogue item information				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben.				
Item name	BT-111	Text	1	4
Ein kurzer Name für einen Artikel.				
Item description	BT-112	Text	$0..\infty$	4
Freiformfeld, das für eine Textbeschreibung des Artikels verwendet werden kann. Eine detaillierte Beschreibung des Artikels.				
Item keywords	BT-113	Text	$0..\infty$	4
Wird verwendet, um durchsuchbare Schlüsselwörter und/oder Synonyme für den Artikel anzugeben.				
Item brand name	BT-114	Text	$0..\infty$	4
Ein Markenname für den Artikel.				
Item classification code	BT-115	Code	$0..\infty$	2
Ein Klassifizierungscode, der verwendet wird, um die Art oder Beschaffenheit des Artikels zu klassifizieren. Es können mehrere Klassifizierungen verwendet werden, einschließlich UNSPSC-Code und CPV-Code.				
List identifier			1	
Mit dieser Eigenschaft wird die Kennung der vom Element verwendeten Liste angegeben. This property is used to specify the identifier of the list used by the element.				
List version identifier			0..1	
Mit dieser Eigenschaft wird die Version der vom Element verwendeten Liste angegeben. This property is used to specify the version of the list used by the element.				
List code name			0..1	
Mit dieser Eigenschaft wird das textuelle Äquivalent des vom Element verwendeten Codewerts angegeben. This property is used to specify the textual equivalent of the code value used by the element.				
Item origin country	BT-116	Code	0..1	2
Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				
Packed quantity	BT-117	Quantity	0..1	4
Die Anzahl der verpackten Einheiten, die in der bestellbaren Einheit enthalten sind. Wenn die bestellbare Einheit z.B. eine Palette ist, die 30 Kartons enthält, dann sind die verpackten Einheiten BOX und die verpackte Menge ist 30.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben. This property is used to specify the default unit of measurement for the quantity used by the element.				
Consumable unit quantity	BT-118	Quantity	0..1	4
Gibt die Anzahl der Verbrauchseinheiten an, die in jeder bestellbaren Einheit enthalten sind.				
Contracted item indicator	BT-119	Code	0..1	2
Der Code CT zeigt an, dass der Artikel gemäß dem referenzierten Vertrag angeboten wird.				
Hazardous item UNDG code	BT-120	Code	$0..\infty$	2
Die von den Vereinten Nationen zugewiesene Kennung für transportable gefährliche Güter, ausgedrückt als Code.				

Informationselemente von Catalogue item information				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Hazardous item hazard class identifier	BT-121	Identifier	$0..\infty$	3
Kennzeichnet eine Gefahrenklasse für gefährliche Güter, wie sie von der zuständigen Regulierungsbehörde festgelegt wurde, wie z. B. die IMDG-Klassennummer des SOLAS-Übereinkommens der IMO und die ADR/RID-Klassennummer für den Straßen-/Schienenverkehr.				
Item best before date	BT-122	Date	$0..\infty$	2
Dient zur Angabe des Mindesthaltbarkeitsdatums des Artikels oder der Artikel in der Katalogzeile.				
Item batch identifier	BT-123	Identifier	$0..\infty$	3
Gibt die Produktionscharge an, zu der der/die in der Katalogzeile aufgeführten Artikel gehörten.				
Additional item property	BG-24		$0..\infty$	17
Eine Gruppe von Geschäftsbegriffen, die Informationen über die Eigenschaften der in der Katalogzeile aufgeführten Artikel liefern.				
Certificate	BG-25		$0..\infty$	26
Informationen zur Umwelt-, Sozial-, Ethik- und Qualitätskennzeichnung des Artikels (bspw. in Form von Labels).				
Dimension	BG-26		$0..\infty$	28
Eine Gruppe von Geschäftsbegriffen, die Informationen über die Abmessungen des Artikels liefern.				
Classified tax category	BG-27		0..1	27
Eine Gruppe von Geschäftsbegriffen, die steuerbezogene Informationen liefern.				
Item product group reference	BG-30		$0..\infty$	29
Eine Gruppe von Geschäftsbegriffen, welche einen Artikel auf eine Produktgruppe referenzieren.				
Item attribute configuration	BG-31		$0..\infty$	29
Informationen zu den anpassbaren Attributen eines Artikels wie Design, Form und Modelle.				

4.1.7. Catalogue line

Eine Gruppe von Geschäftsbegriffen, die Informationen über den Inhalt der Katalogzeile liefern.

Diese Gruppe von Informationselementen (ID: BG-17, Anz. $1..\infty$) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue (ID: BG-1), siehe Abschnitt 4.1.2, „Catalogue“.

Informationselemente von Catalogue line				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Line identifier	BT-73	Identifier	1	3
Jede Zeile muss einen Bezeichner haben, der innerhalb des Dokuments eindeutig ist, um eine eindeutige Referenzierung der Zeile zu ermöglichen. Zum Beispiel aus anderen Dokumenten.				
Line action code	BT-74	Code	0..1	2
Wird verwendet, um dem Katalogempfänger mitzuteilen, welche Maßnahmen bei der Überarbeitung eines Katalogs in der identifizierten Zeile zu ergreifen sind. Siehe Regel zur Katalogversions-ID. Bei Verwendung von Aktualisierungs- oder Löschcodes wird die gesamte Katalogzeile aktualisiert oder gelöscht.				
Orderable indicator	BT-75	Indicator	0..1	3
Der Standardwert ist True, d.h. der Artikel in der Katalogzeile kann bestellt werden. Kann verwendet werden, um anzuzeigen, dass ein Artikel vorübergehend nicht auf Lager ist (über eine Katalogaktualisierung).				
Orderable unit	BT-76	Code	0..1	2

Informationselemente von Catalogue line				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Die Einheit, in der der in dieser Katalogzeile beschriebene Artikel bestellt werden kann. Ein und derselbe Artikel kann in mehreren Katalogzeilen mit unterschiedlichen bestellbaren Einheiten beschrieben werden (z.B. Kartons und Paletten).				
Item net quantity	BT-77	Quantity	0..1	4
Die Nettomenge des Artikels, die in jeder Verbrauchseinheit enthalten ist, ohne Verpackungsmaterial.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben. This property is used to specify the default unit of measurement for the quantity used by the element.				
Order quantity increment	BT-78	Numeric	0..1	3
Die Erhöhung der bestellbaren Einheiten, die bestellt werden können.				
Minimum order quantity	BT-79	Quantity	0..1	4
Die Mindestanzahl bestellbarer Einheiten, die gemäß den Angaben in der Katalogzeile, z. B. dem Preis, bestellt werden können.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben. This property is used to specify the default unit of measurement for the quantity used by the element.				
Maximum order quantity	BT-80	Quantity	0..1	4
Die maximale Anzahl bestellbarer Einheiten, die gemäß den Angaben in der Katalogzeile, z. B. dem Preis, bestellt werden können.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben. This property is used to specify the default unit of measurement for the quantity used by the element.				
Line warranty information	BT-81	Text	0..1	4
Die Verpackungsstufe der Katalogzeile.				
Packaging level	BT-82	Code	0..1	2
Die Verpackungsstufe der Katalogzeile.				
Catalogue line validity period	BG-18		0..1	23
Der Zeitraum, in dem die Informationen in der Katalogzeile gültig sind. Ein bestellbarer Katalogartikel ist nach Ablauf der Gültigkeitsdauer nicht mehr bestellbar. Wird zum Beispiel für Werbeartikel oder Preise verwendet.				
Price details	BG-19		1..∞	30
Eine Gruppe von Geschäftsbegriffen, die Informationen über Preise liefern.				
Catalogue item information	BG-23		1	20
Eine Gruppe von Geschäftsbegriffen, die Informationen über die Artikel des Katalogs liefern.				

4.1.8. Catalogue line validity period

Der Zeitraum, in dem die Informationen in der Katalogzeile gültig sind. Ein bestellbarer Katalogartikel ist nach Ablauf der Gültigkeitsdauer nicht mehr bestellbar. Wird zum Beispiel für Werbeartikel oder Preise verwendet.

Diese Gruppe von Informationselementen (ID: BG-18, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue line (ID: BG-17), siehe Abschnitt 4.1.7, „Catalogue line“.

Informationselemente von Catalogue line validity period				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Catalogue line validity period start date	BT-83	Date	0..1	2
Das Datum, an dem der Zeitraum beginnt. Das Startdatum zählt als Teil des Zeitraums.				
Catalogue line validity period end date	BT-84	Date	0..1	2
Das Datum, an dem der Zeitraum endet. Das Enddatum zählt als Teil des Zeitraums.				

4.1.9. Catalogue provider

Die Geschäftspartei, die den Katalog bereitstellt. Ein Verkäufer oder ein Katalog-Repository.

Diese Gruppe von Informationselementen (ID: BG-3, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue (ID: BG-1), siehe Abschnitt 4.1.2, „Catalogue“.

Informationselemente von Catalogue provider				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Provider party electronic address	BT-13	Identifier	1	3
Gibt die elektronische Adresse des Kataloganbieters an.				
Scheme identifier			1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Catalogue provider identifier	BT-14	Identifier	0..1	3
Verwendung in Abwesenheit des Namens oder zusätzlich zu diesem. Es sollte ein Identifikator verwendet werden, der dem Empfänger des Dokuments bekannt ist.				
Scheme identifier			0..1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Provider postal address	BG-4		0..1	33
Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Kataloganbieters liefern.				
Provider legal entity	BG-5		1	33
Eine Gruppe von Geschäftsbegriffen mit rechtlichen Informationen über den Kataloganbieter.				

4.1.10. Catalogue receiver

Die Geschäftspartei, an die der Katalog gesendet wird. Ein Käufer oder ein in seinem Auftrag agierendes Katalog-Repository.

Diese Gruppe von Informationselementen (ID: BG-6, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue (ID: BG-1), siehe Abschnitt 4.1.2, „Catalogue“.

Informationselemente von Catalogue receiver				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Receiver party electronic address	BT-26	Identifier	1	3
Identifiziert die elektronische Adresse des Empfängers.				
Scheme identifier			1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				

Informationselemente von Catalogue receiver				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Catalogue receiver identifier	BT-27	Identifier	0..1	3
Verwendung in Abwesenheit des Namens oder zusätzlich zu diesem. Es sollte ein Identifikator verwendet werden, der dem Empfänger des Dokuments bekannt ist.				
Scheme identifier			0..1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Receiver postal address	BG-7		0..1	34
Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Katalogempfängers liefern.				
Receiver legal entity	BG-8		1	34
Eine Gruppe von Geschäftsbegriffen, die rechtliche Informationen über den Empfänger des Katalogs liefern.				

4.1.11. Catalogue supplier

Die Geschäftspartei, welche die im Katalog aufgeführten Artikel anbietet.

Diese Gruppe von Informationselementen (ID: BG-9, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue (ID: BG-1), siehe Abschnitt 4.1.2, „Catalogue“.

Informationselemente von Catalogue supplier				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Supplier party electronic address	BT-39	Identifier	0..1	3
Gibt die elektronische Adresse der Lieferpartei an.				
Scheme identifier			1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Catalogue supplier identifier	BT-40	Identifier	0..1	3
Verwendung in Abwesenheit des Namens oder zusätzlich zu diesem. Es sollte ein Identifikator verwendet werden, der dem Empfänger des Dokuments bekannt ist.				
Scheme identifier			0..1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Catalogue supplier trading name	BT-41	Text	0..1	4
Verwendung in Abwesenheit oder zusätzlich zur Parteikennung.				
Supplier postal address	BG-10		0..1	35
Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Kataloglieferanten liefern.				
Catalogue supplier contact	BG-11		0..1	25
Eine Gruppe von Geschäftsbegriffen, die Informationen über den Kontakt mit dem Kataloganbieter liefern.				

4.1.12. Catalogue supplier contact

Eine Gruppe von Geschäftsbegriffen, die Informationen über den Kontakt mit dem Kataloganbieter liefern.

Diese Gruppe von Informationselementen (ID: BG-11, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue supplier (ID: BG-9), siehe Abschnitt 4.1.11, „Catalogue supplier“.

Informationselemente von Catalogue supplier contact				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Supplier contact person name	BT-49	Text	0..1	4
Der Name der Kontaktperson.				
Supplier contact telephone number	BT-50	Text	0..1	4
Eine Telefonnummer für die Kontaktperson. Wenn die Person eine direkte Nummer hat, ist dies diese Nummer.				
Supplier contact email address	BT-51	Text	0..1	4
Die E-Mail-Adresse der Kontaktperson. Wenn die Person eine direkte E-Mail hat, ist dies diese E-Mail.				

4.1.13. Catalogue validity period

Der Zeitraum, in dem der Inhalt des Katalogs gültig ist und für den Handel verwendet werden kann.

Diese Gruppe von Informationselementen (ID: BG-2, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue (ID: BG-1), siehe Abschnitt 4.1.2, „Catalogue“.

Informationselemente von Catalogue validity period				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Catalogue validity period start date	BT-11	Date	0..1	2
Das Datum, an dem der Zeitraum beginnt. Das Startdatum zählt als Teil der Periode.				
Catalogue validity period end date	BT-12	Date	0..1	2
Das Datum, an dem der Zeitraum endet. Das Enddatum zählt als Teil der Periode.				

4.1.14. Certificate

Informationen zur Umwelt-, Sozial-, Ethik- und Qualitätskennzeichnung des Artikels (bspw. in Form von Labels).

Diese Gruppe von Informationselementen (ID: BG-25, Anz. $0.._{\infty}$) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue item information (ID: BG-23), siehe Abschnitt 4.1.6, „Catalogue item information“.

Informationselemente von Certificate				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Item label name	BT-129	Text	1	4
Der Name des Produktlabels.				
Certificate type code	BT-130	Code	1	2
Die für die Artikelkennzeichnung verwendete UBL-Struktur von Peppol erfordert dieses Element. Es muss der Wert NA eingetragen werden.				
Item label type	BT-131	Text	1	4
Die Art des Labels, z. B. Umwelt, Qualität, Soziales usw.				
Item label value	BT-132	Text	$0.._{\infty}$	4
Der Wert des Labels, das für den Artikel gilt.				
Label issuer name	BT-133	Text	1	4
Die für die Artikelkennzeichnung verwendete UBL-Struktur von Peppol erfordert dieses Element. Es muss der Wert NA eingetragen werden.				
Item label reference	BT-134	Document Reference	$0.._{\infty}$	2
Ein Verweis darauf, wo die Label-Spezifikation gefunden werden kann, z. B. ein URI.				

4.1.15. Characteristic value allowance or charge

Eine Gruppe von Geschäftsbegriffen, die Informationen über Preisnachlässe und Preisaufschläge (ohne Mehrwertsteuer) auf der Grundlage des charakteristischen Werts eines Artikels enthalten.

Diese Gruppe von Informationselementen (ID: BG-33, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Item attribute characteristics (ID: BG-32), siehe Abschnitt 4.1.19, „Item attribute characteristics“.

Informationselemente von Characteristic value allowance or charge				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Charge indicator	BT-156	Indicator	1	3
Kann verwendet werden, um Preisnachlässe oder Preisaufschläge für Preise anzugeben. Der Wert „true“ wird für Preisaufschläge verwendet, der Wert „false“ für Preisnachlässe.				
Allowance or charge amount	BT-157	Amount	1	1
Der Betrag eines Preisnachlasses oder Preisaufschlags, ohne Mehrwertsteuer.				
Currency Identifier			1	
Mit dieser Eigenschaft wird die Währung des vom Element verwendeten Betrags angegeben. This property is used to specify the currency of the amount used by the element.				
Allowance or charge percentage	BT-159	Percentage	0..1	4
Der prozentuale Wert eines Preisnachlasses oder Preisaufschlags, der auf den Grundpreis anwendbar ist, ohne Mehrwertsteuer.				
Allowance or charge reason	BT-160	Text	1	4
Der Grund für den Preisnachlass oder Preisaufschlag, ausgedrückt als Text.				
Allowance or charge reason code	BT-161	Code	0..1	2
Der Grund für den Preisnachlass oder Preisaufschlag, ausgedrückt als Code. Für Rabatte ist eine Teilmenge der Codeliste UNCL5189 zu verwenden, und für Aufschläge gilt die Codeliste UNCL7161.				

4.1.16. Classified tax category

Eine Gruppe von Geschäftsbegriffen, die steuerbezogene Informationen liefern.

Diese Gruppe von Informationselementen (ID: BG-27, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue item information (ID: BG-23), siehe Abschnitt 4.1.6, „Catalogue item information“.

Informationselemente von Classified tax category				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Item tax category code	BT-140	Code	1	2
Das Steuerkennzeichen, das angibt, welche Steuerdetails für den Artikel gelten.				
Item tax percentage	BT-141	Percentage	0..1	4
Der prozentuale Steuersatz, der für den Artikel gilt, es sei denn, es gelten besondere handelspolitische Gründe, wie z. B. Steuerbefreiungen.				
Item tax scheme	BT-142	Identifier	1	3
Steuerregelung. Z.B. „MwSt“ oder „GST“.				

4.1.17. Customer postal address

Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Katalogkunden liefern.

Diese Gruppe von Informationselementen (ID: BG-13, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue customer (ID: BG-12), siehe Abschnitt 4.1.3, „Catalogue customer“.

Informationselemente von Customer postal address				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Customer address line 1	BT-55	Text	0..1	4
Die Hauptadresszeile in einer Postanschrift. In der Regel der Straßenname und die Hausnummer.				
Customer address line 2	BT-56	Text	0..1	4
Eine zusätzliche Adresszeile in einer Postanschrift, die dazu verwendet werden kann, neben der Hauptzeile weitere Angaben zu machen. Übliche Verwendung ist eine zweite Hausnummer in einem Gebäudekomplex oder in einem Gebäude.				
Customer address line 3	BT-57	Text	0..1	4
Eine zusätzliche Adresszeile in einer Adresse, die dazu verwendet werden kann, zusätzlich zu den Hauptadresszeilen weitere Angaben zu machen.				
Customer city	BT-58	Text	0..1	4
Der allgemeine Name der Stadt, in der sich die Postanschrift befindet. Der Name wird vollständig und nicht als Code geschrieben.				
Customer post code	BT-59	Text	0..1	4
Der Identifikator für eine adressierbare Gruppe von Immobilien gemäß dem jeweiligen nationalen Postdienst, wie z. B. eine Postleitzahl oder ein Postcode.				
Customer country subdivision	BT-60	Text	0..1	4
Zur Angabe einer Region, eines Landkreises, eines Bundeslandes, einer Provinz usw. innerhalb eines Landes mit Hilfe von Text.				
Customer country code	BT-61	Code	1	2
Ein Code, der das Land des Kunden identifiziert. Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				

4.1.18. Dimension

Eine Gruppe von Geschäftsbegriffen, die Informationen über die Abmessungen des Artikels liefern.

Diese Gruppe von Informationselementen (ID: BG-26, Anz. $0.._{\infty}$) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue item information (ID: BG-23), siehe Abschnitt 4.1.6, „Catalogue item information“.

Informationselemente von Dimension				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Dimension attribute identifier	BT-135	Identifier	1	3
Identifiziert das Dimensionsattribut. Höhe - Die vertikale Höhe der bestellbaren Einheit. Länge - Das horizontale Maß der längeren Seite der bestellbaren Einheit. Breite - Das horizontale Maß der kürzeren Seite der bestellbaren Einheit. Gewicht - Das Gewicht der bestellbaren Einheit einschließlich ihrer Verpackung. Volumen - das Volumen des Pakets.				
Measure	BT-136	Text	0..1	4
Das Maß für das Attribut der Dimension.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben. This property is used to specify the default unit of measurement for the quantity used by the element.				

Informationselemente von Dimension				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Dimension description	BT-137	Text	0..∞	4
Dient zur Unterscheidung zwischen Maßnahmen mit derselben attributeID.				

4.1.19. Item attribute characteristics

Informationen über die Merkmalsvarianten des Artikelattributs.

Diese Gruppe von Informationselementen (ID: BG-32, Anz. 1..∞) ist ein direkter Bestandteil der Gruppe von Informationselementen Item attribute configuration (ID: BG-31), siehe Abschnitt 4.1.20, „Item attribute configuration".

Informationselemente von Item attribute characteristics				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Characteristic value identifier	BT-153	Identifier	1	3
Wird verwendet, um den Merkmalswert eines Attributs eindeutig zu identifizieren.				
Characteristic value name	BT-154	Text	1	4
Name des Merkmalswerts.				
Characteristic value description	BT-155	Text	0..1	4
Beschreibung des Merkmalswerts.				
Characteristic value allowance or charge	BG-33		0..1	27
Eine Gruppe von Geschäftsbegriffen, die Informationen über Preisnachlässe und Preisaufschläge (ohne Mehrwertsteuer) auf der Grundlage des charakteristischen Werts eines Artikels enthalten.				

4.1.20. Item attribute configuration

Informationen zu den anpassbaren Attributen eines Artikels wie Design, Form und Modelle.

Diese Gruppe von Informationselementen (ID: BG-31, Anz. 0..∞) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue item information (ID: BG-23), siehe Abschnitt 4.1.6, „Catalogue item information".

Informationselemente von Item attribute configuration				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Attribute identifier	BT-150	Identifier	1	3
Ein Bezeichner, der zur eindeutigen Identifizierung eines konfigurierbaren Attributs eines Elements verwendet wird.				
Attribute type name	BT-151	Text	1	4
Kurzer Name für das konfigurierbare Attribut.				
Attribute type description	BT-152	Text	0..1	4
Beschreibung des konfigurierbaren Attributs.				
Item attribute characteristics	BG-32		1..∞	29
Informationen über die Merkmalsvarianten des Artikelattributs.				

4.1.21. Item product group reference

Eine Gruppe von Geschäftsbegriffen, welche einen Artikel auf eine Produktgruppe referenzieren.

Diese Gruppe von Informationselementen (ID: BG-30, Anz. 0..$_\infty$) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue item information (ID: BG-23), siehe Abschnitt 4.1.6, „Catalogue item information“.

Informationselemente von Item product group reference				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Product group identifier reference	BT-148	Identifier	1	3
Ein Verweis auf die dem Artikel zugeordnete Produktgruppe.				
Placement order	BT-149	Identifier	0..1	3
Die Platzierungsreihenfolge des Artikels innerhalb seiner zugehörigen Produktgruppe.				

4.1.22. Price allowances and charges

Eine Gruppe von Geschäftsbegriffen, die Informationen über Preisnachlässe und Preisaufschläge (ohne Mehrwertsteuer) enthalten.

Diese Gruppe von Informationselementen (ID: BG-21, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Price details (ID: BG-19), siehe Abschnitt 4.1.23, „Price details“.

Informationselemente von Price allowances and charges				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Charge indicator	BT-94	Indicator	1	3
Kann verwendet werden, um Preisnachlässe oder Preisaufschläge für Preise anzugeben. Der Wert „true“ wird für Preisaufschläge verwendet, der Begriff „false“ für Preisnachlässe.				
Allowance or charge amount	BT-95	Amount	1	1
Der Betrag eines Preisnachlasses oder Preisaufschlags, ohne Mehrwertsteuer.				
Currency Identifier			1	
Mit dieser Eigenschaft wird die Währung des vom Element verwendeten Betrags angegeben. This property is used to specify the currency of the amount used by the element.				
Allowance or charge percentage	BT-96	Percentage	0..1	4
Der prozentuale Wert eines Preisnachlasses oder Preisaufschlags, der auf den Grundpreis anwendbar ist, ohne Mehrwertsteuer.				
Allowance or charge reason	BT-97	Text	1	4
Der Grund für den Preisnachlass oder Preisaufschlag auf Dokumentebene, ausgedrückt als Text.				
Allowance or charge reason code	BT-98	Code	0..1	2
Der Grund für den Preisnachlass oder Preisaufschlag auf Dokumentebene, ausgedrückt als Code. Für Rabatte ist eine Teilmenge der Codeliste UNCL5189 zu verwenden, und für Aufschläge gilt die Codeliste UNCL7161.				

4.1.23. Price details

Eine Gruppe von Geschäftsbegriffen, die Informationen über Preise liefern.

Diese Gruppe von Informationselementen (ID: BG-19, Anz. 1..$_\infty$) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue line (ID: BG-17), siehe Abschnitt 4.1.7, „Catalogue line“.

Informationselemente von Price details				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Price lead time	BT-85	Text	0..1	4

Informationselemente von Price details				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Die Zeit vom Zeitpunkt der Bestellung bis zur Bereitstellung des Artikels in den Geschäftsräumen des Verkäufers oder an der für den Preis angegebenen Adresse.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben. Der Wert sollte ein gültiger UOM-Code wie DAY für Tage sein.				
Price quantity threshold	BT-86	Quantity	0..1	4
Dient zur Angabe der Schwellenmenge für den angegebenen Preis.				
Price quantity ceiling	BT-87	Quantity	0..1	4
Dient zur Angabe der Höchstmenge für den angegebenen Preis.				
Item price amount	BT-88	Amount	1	1
Der für jede bestellbare Einheit angegebene Artikelpreis.				
Currency Identifier			1	
Mit dieser Eigenschaft wird die Währung des vom Element verwendeten Betrags angegeben. This property is used to specify the currency of the amount used by the element.				
Item price base quantity	BT-89	Quantity	0..1	4
Die Anzahl der Artikeleinheiten, für die der Preis gilt.				
Unit Code			1	
Mit dieser Eigenschaft wird die Standardmaßeinheit der vom Element verwendeten Quantität angegeben.				
Item price type	BT-90	Text	0..1	4
Die Art des Artikelpreises. Der Typ kann mit Codes aus der UN/CEFACT-Codeliste 5387 angegeben werden. Bei zeitlich begrenzten Preisen sollte die Gültigkeitsdauer des Preises durch Angabe der Gültigkeitsdauer des Preises definiert werden.				
Orderable unit factor rate	BT-91	Text	0..1	4
Der Faktor, der zur Umrechnung der Basismenge in eine bestellbare Einheit verwendet wird. Muss angegeben werden, wenn die bestellbare Einheit von der Basismenge abweicht. Wenn nicht vorhanden, wird der Wert 1 angenommen.				
Price validity period	BG-20		0..1	32
Der Zeitraum, in dem der Preis gültig ist.				
Price allowances and charges	BG-21		0..1	30
Eine Gruppe von Geschäftsbegriffen, die Informationen über Preisnachlässe und Preisaufschläge (ohne Mehrwertsteuer) enthalten.				
Price location information	BG-22		$0..\infty$	31
Eine Gruppe von Geschäftsbegriffen, die ortsbezogene Informationen über den Preis liefern.				

4.1.24. Price location information

Eine Gruppe von Geschäftsbegriffen, die ortsbezogene Informationen über den Preis liefern.

Diese Gruppe von Informationselementen (ID: BG-22, Anz. $0..\infty$) ist ein direkter Bestandteil der Gruppe von Informationselementen Price details (ID: BG-19), siehe Abschnitt 4.1.23, „Price details“.

Informationselemente von Price location information				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Price address line 1	BT-99	Text	0..1	4

Informationselemente von Price location information				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Die Hauptadresszeile in einer Postanschrift. In der Regel der Straßenname und die Hausnummer.				
Price address line 2	BT-100	Text	0..1	4
Eine zusätzliche Adresszeile in einer Postanschrift, die dazu verwendet werden kann, neben der Hauptzeile weitere Angaben zu machen. Übliche Verwendung ist eine zweite Hausnummer in einem Gebäudekomplex oder in einem Gebäude.				
Price address line 3	BT-101	Text	0..1	4
Eine zusätzliche Adresszeile in einer Adresse, die dazu verwendet werden kann, zusätzlich zu den Hauptadresszeilen weitere Angaben zu machen.				
Price city	BT-102	Text	0..1	4
Der allgemeine Name der Stadt, in der sich die Postanschrift befindet. Der Name wird vollständig und nicht als Code geschrieben.				
Price post code	BT-103	Text	0..1	4
Der Identifikator für eine adressierbare Gruppe von Immobilien gemäß dem jeweiligen nationalen Postdienst, wie z. B. eine Postleitzahl oder ein Postcode.				
Price country subdivision	BT-104	Text	0..1	4
Zur Angabe einer Region, eines Landkreises, eines Bundeslandes, einer Provinz usw. innerhalb eines Landes mit Hilfe von Text.				
Price country code	BT-105	Code	0..1	2
Ein Code, der das Land des Preisortes identifiziert. Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				

4.1.25. Price validity period

Der Zeitraum, in dem der Preis gültig ist.

Diese Gruppe von Informationselementen (ID: BG-20, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Price details (ID: BG-19), siehe Abschnitt 4.1.23, „Price details“.

Informationselemente von Price validity period				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Price validity period start date	BT-92	Date	0..1	2
Das Datum, an dem der Zeitraum beginnt. Das Startdatum zählt als Teil des Zeitraums.				
Price validity period end date	BT-93	Date	0..1	2
Das Datum, an dem der Zeitraum endet. Das Enddatum zählt als Teil des Zeitraums.				

4.1.26. Product group structure

Eine Gruppe von Geschäftsbegriffen, die Informationen über eine konkrete Produktgruppenstruktur der Kataloggruppe liefern.

Diese Gruppe von Informationselementen (ID: BG-16, Anz. $1..\infty$) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue group system (ID: BG-15), siehe Abschnitt 4.1.5, „Catalogue group system“.

Informationselemente von Product group structure				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Product group identifier	BT-68	Identifier	1	3

Informationselemente von Product group structure				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Dient zur Identifizierung der Produktgruppe.				
Product group name	BT-69	Text	1	4
Der Name der Produktgruppe.				
Product group description	BT-70	Text	0..1	4
Eine Beschreibung mit Informationen über die Produktgruppe.				
Product group parent identifier	BT-71	Identifier	1	3
Dient zur Identifizierung der übergeordneten Gruppe der Produktgruppe.				
Product group order	BT-72	Identifier	0..1	3
Wird verwendet, um die Reihenfolge der Produktgruppe in der hierarchischen Baumstruktur zu bestimmen.				

4.1.27. Provider legal entity

Eine Gruppe von Geschäftsbegriffen mit rechtlichen Informationen über den Kataloganbieter.

Diese Gruppe von Informationselementen (ID: BG-5, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue provider (ID: BG-3), siehe Abschnitt 4.1.9, „Catalogue provider“.

Informationselemente von Provider legal entity				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Provider legal registration name	BT-22	Text	1	4
Der Name, unter dem der Kataloganbieter gesetzlich registriert ist.				
Provider legal registration identifier	BT-23	Identifier	0..1	3
Eine Kennung, die der Geschäftspartei vom nationalen Unternehmensregister zugewiesen wird.				
Scheme identifier			0..1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Provider legal registration city	BT-24	Text	0..1	4
Der Name der Stadt, in der der Kataloganbieter rechtlich registriert ist.				
Provider legal registration country code	BT-25	Code	0..1	2
Ein Code, der das gesetzliche Registrierungsland des Kataloganbieters angibt. Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				

4.1.28. Provider postal address

Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Kataloganbieters liefern.

Diese Gruppe von Informationselementen (ID: BG-4, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue provider (ID: BG-3), siehe Abschnitt 4.1.9, „Catalogue provider“.

Informationselemente von Provider postal address				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Provider address line 1	BT-15	Text	0..1	4
Die Hauptadresszeile in einer Postanschrift. In der Regel der Straßenname und die Hausnummer.				
Provider address line 2	BT-16	Text	0..1	4

Informationselemente von Provider postal address				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Eine zusätzliche Adresszeile in einer Postanschrift, die dazu verwendet werden kann, neben der Hauptzeile weitere Angaben zu machen. Übliche Verwendung ist eine zweite Hausnummer in einem Gebäudekomplex oder in einem Gebäude.				
Provider address line 3	BT-17	Text	0..1	4
Eine zusätzliche Adresszeile in einer Adresse, die dazu verwendet werden kann, zusätzlich zu den Hauptadresszeilen weitere Angaben zu machen.				
Provider city	BT-18	Text	0..1	4
Der allgemeine Name der Stadt, in der sich die Postanschrift befindet. Der Name wird vollständig und nicht als Code geschrieben.				
Provider post code	BT-19	Text	0..1	4
Der Identifikator für eine adressierbare Gruppe von Immobilien gemäß dem jeweiligen nationalen Postdienst, wie z. B. eine Postleitzahl oder ein Postcode.				
Provider country subdivision	BT-20	Text	0..1	4
Zur Angabe einer Region, eines Landkreises, eines Bundeslandes, einer Provinz usw. innerhalb eines Landes mit Hilfe von Text.				
Provider country code	BT-21	Code	1	2
Ein Code, der das Land des Kataloganbieters identifiziert. Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				

4.1.29. Receiver legal entity

Eine Gruppe von Geschäftsbegriffen, die rechtliche Informationen über den Empfänger des Katalogs liefern.

Diese Gruppe von Informationselementen (ID: BG-8, Anz. 1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue receiver (ID: BG-6), siehe Abschnitt 4.1.10, „Catalogue receiver“.

Informationselemente von Receiver legal entity				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Receiver legal registration name	BT-35	Text	1	4
Der Name, unter dem der Empfänger rechtlich registriert ist.				
Receiver legal registration identifier	BT-36	Identifier	0..1	3
Eine Kennung, die der Geschäftspartei vom nationalen Unternehmensregister zugewiesen wird.				
Scheme identifier			0..1	
Mit dieser Eigenschaft wird die Kennung des vom Element verwendeten Bildungsmusters angegeben. This property is used to specify the identifier of the pattern used by the element.				
Receiver legal registration city	BT-37	Text	0..1	4
Der Name der Stadt, in der der Empfänger rechtmäßig registriert ist.				
Receiver legal registration country code	BT-38	Code	0..1	2
Ein Code, der das gesetzliche Registrierungsland des Empfängers identifiziert. Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				

4.1.30. Receiver postal address

Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Katalogempfängers liefern.

Diese Gruppe von Informationselementen (ID: BG-7, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue receiver (ID: BG-6), siehe Abschnitt 4.1.10, „Catalogue receiver“.

Informationselemente von Receiver postal address				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Receiver address line 1	BT-28	Text	0..1	4
Die Hauptadresszeile in einer Postanschrift. In der Regel der Straßenname und die Hausnummer.				
Receiver address line 2	BT-29	Text	0..1	4
Eine zusätzliche Adresszeile in einer Postanschrift, die dazu verwendet werden kann, neben der Hauptzeile weitere Angaben zu machen. Übliche Verwendung ist eine zweite Hausnummer in einem Gebäudekomplex oder in einem Gebäude.				
Receiver address line 3	BT-30	Text	0..1	4
Eine zusätzliche Adresszeile in einer Adresse, die dazu verwendet werden kann, zusätzlich zu den Hauptadresszeilen weitere Angaben zu machen.				
Receiver city	BT-31	Text	0..1	4
Der allgemeine Name der Stadt, in der sich die Postanschrift befindet. Der Name wird vollständig und nicht als Code geschrieben.				
Receiver post code	BT-32	Text	0..1	4
Der Identifikator für eine adressierbare Gruppe von Immobilien gemäß dem jeweiligen nationalen Postdienst, wie z. B. eine Postleitzahl oder ein Postcode.				
Receiver country subdivision	BT-33	Text	0..1	4
Zur Angabe einer Region, eines Landkreises, eines Bundeslandes, einer Provinz usw. innerhalb eines Landes mit Hilfe von Text.				
Receiver country code	BT-34	Code	1	2
Ein Code, der das Land des Empfängers identifiziert. Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				

4.1.31. Supplier postal address

Eine Gruppe von Geschäftsbegriffen, die Informationen über die Adresse des Kataloglieferanten liefern.

Diese Gruppe von Informationselementen (ID: BG-10, Anz. 0..1) ist ein direkter Bestandteil der Gruppe von Informationselementen Catalogue supplier (ID: BG-9), siehe Abschnitt 4.1.11, „Catalogue supplier“.

Informationselemente von Supplier postal address				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Supplier address line 1	BT-42	Text	0..1	4
Die Hauptadresszeile in einer Postanschrift. In der Regel der Straßenname und die Hausnummer.				
Supplier address line 2	BT-43	Text	0..1	4
Eine zusätzliche Adresszeile in einer Postanschrift, die dazu verwendet werden kann, neben der Hauptzeile weitere Angaben zu machen. Übliche Verwendung ist eine zweite Hausnummer in einem Gebäudekomplex oder in einem Gebäude.				
Supplier address line 3	BT-44	Text	0..1	4
Eine zusätzliche Adresszeile in einer Adresse, die dazu verwendet werden kann, zusätzlich zu den Hauptadresszeilen weitere Angaben zu machen.				
Supplier city	BT-45	Text	0..1	4
Der allgemeine Name der Stadt, in der sich die Postanschrift befindet. Der Name wird vollständig und nicht als Code geschrieben.				

Informationselemente von Supplier postal address				
Name	**ID**	**Semantischer Datentyp**	**Anz.**	**Seite**
Supplier post code	BT-46	Text	0..1	4
Der Identifikator für eine adressierbare Gruppe von Immobilien gemäß dem jeweiligen nationalen Postdienst, wie z. B. eine Postleitzahl oder ein Postcode.				
Supplier country subdivision	BT-47	Text	0..1	4
Zur Angabe einer Region, eines Landkreises, eines Bundeslandes, einer Provinz usw. innerhalb eines Landes mit Hilfe von Text.				
Supplier country code	BT-48	Code	1	2
Ein Code, der das Land der Lieferpartei identifiziert. Die Listen der gültigen Länder sind bei der ISO 3166-1 Maintenance agency, „Codes for the representation of names of countries and their subdivisions“, registriert. Die Codes müssen der Alpha-2-Darstellung entsprechen.				

Kapitel 5. Syntax-Bindings

5.1. XKatalog

Full semantic structure of the XKatalog.

ID	Name	Pfad	Bemerkung
BG-1	Catalogue	/Catalogue	
BT-1	Specification identification	/Catalogue/cbc:CustomizationID	
BT-2	Business process type identifier	/Catalogue/cbc:ProfileID	
BT-3	Catalogue identifier	/Catalogue/cbc:ID	
BT-4	Catalogue action code	/Catalogue/cbc:ActionCode	
BT-5	Catalogue name	/Catalogue/cbc:Name	
BT-6	Catalogue issue date	/Catalogue/cbc:IssueDate	
BT-7	Catalogue version	/Catalogue/cbc:VersionID	
BT-8	Source catalogue identifier	/Catalogue/cac:SourceCatalogueReference/cbc:ID	
BT-9	Contract identifier	/Catalogue/cac:ReferencedContract/cbc:ID	
BT-10	General payment conditions	/Catalogue/cac:TradingTerms/cbc:Information	
BG-2	Catalogue validity period	/Catalogue/cac:ValidityPeriod	
BT-11	Catalogue validity period start date	/Catalogue/cac:ValidityPeriod/cbc:StartDate	
BT-12	Catalogue validity period end date	/Catalogue/cac:ValidityPeriod/cbc:EndDate	
BG-3	Catalogue provider	/Catalogue/cac:ProviderParty	
BT-13	Provider party electronic address	/Catalogue/cac:ProviderParty/cbc:EndpointID/@schemeID	Pfad zur Komponente schemeID von BT-13.
BT-13	Provider party electronic address	/Catalogue/cac:ProviderParty/cbc:EndpointID	
BT-14	Catalogue provider identifier	/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID/@schemeID	Pfad zur Komponente schemeID von BT-14.
BT-14	Catalogue provider identifier	/Catalogue/cac:ProviderParty/cac:PartyIdentification/cbc:ID	

ID	Name	Pfad	Bemerkung
BG-4	Provider postal address	/Catalogue/cac:ProviderParty/cac:PostalAddress	
BT-15	Provider address line 1	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:StreetName	
BT-16	Provider address line 2	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:AdditionalStreetName	
BT-17	Provider address line 3	/Catalogue/cac:ProviderParty/cac:PostalAddress/cac:AddressLine/cbc:Line	
BT-18	Provider city	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:CityName	
BT-19	Provider post code	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:PostalZone	
BT-20	Provider country subdivision	/Catalogue/cac:ProviderParty/cac:PostalAddress/cbc:CountrySubentity	
BT-21	Provider country code	/Catalogue/cac:ProviderParty/cac:PostalAddress/cac:Country/cbc:IdentificationCode	
BG-5	Provider legal entity	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity	
BT-22	Provider legal registration name	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity/cbc:RegistrationName	
BT-23	Provider legal registration identifier	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity/cbc:CompanyID/@schemeID	Pfad zur Komponente schemeID von BT-23.
BT-23	Provider legal registration identifier	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity/cbc:CompanyID	
BT-24	Provider legal registration city	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity/cac:RegistrationAddress/cbc:CityName	
BT-25	Provider legal registration country code	/Catalogue/cac:ProviderParty/cac:PartyLegalEntity/cac:RegistrationAddress/cac:Country/cbc:IdentificationCode	
BG-6	Catalogue receiver	/Catalogue/cac:ReceiverParty	
BT-26	Receiver party electronic address	/Catalogue/cac:ReceiverParty/cbc:EndpointID/@schemeID	Pfad zur Komponente schemeID von BT-26.
BT-26	Receiver party electronic address	/Catalogue/cac:ReceiverParty/cbc:EndpointID	
BT-27	Catalogue receiver identifier	/Catalogue/cac:ReceiverParty/cac:PartyIdentification/cbc:ID/@schemeID	Pfad zur Komponente schemeID von BT-27.
BT-27	Catalogue receiver identifier	/Catalogue/cac:ReceiverParty/cac:PartyIdentification/cbc:ID	
BG-7	Receiver postal address	/Catalogue/cac:ReceiverParty/cac:PostalAddress	

ID	Name	Pfad	Bemerkung
BT-28	Receiver address line 1	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:StreetName	
BT-29	Receiver address line 2	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:AdditionalStreetName	
BT-30	Receiver address line 3	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cac:AddressLine/cbc:Line	
BT-31	Receiver city	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:CityName	
BT-32	Receiver post code	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:PostalZone	
BT-33	Receiver country subdivision	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cbc:CountrySubentity	
BT-34	Receiver country code	/Catalogue/cac:ReceiverParty/cac:PostalAddress/cac:Country/cbc:IdentificationCode	
BG-8	Receiver legal entity	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity	
BT-35	Receiver legal registration name	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity/cbc:RegistrationName	
BT-36	Receiver legal registration identifier	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity/cbc:CompanyID/@schemeID	Pfad zur Komponente schemeID von BT-36.
BT-36	Receiver legal registration identifier	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity/cbc:CompanyID	
BT-37	Receiver legal registration city	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity/cac:RegistrationAddress/cbc:CityName	
BT-38	Receiver legal registration country code	/Catalogue/cac:ReceiverParty/cac:PartyLegalEntity/cac:RegistrationAddress/cac:Country/cbc:IdentificationCode	
BG-9	Catalogue supplier	/Catalogue/cac:SellerSupplierParty/cac:Party	
BT-39	Supplier party electronic address	/Catalogue/cac:SellerSupplierParty/cac:Party/cbc:EndpointID/@schemeID	Pfad zur Komponente schemeID von BT-39.
BT-39	Supplier party electronic address	/Catalogue/cac:SellerSupplierParty/cac:Party/cbc:EndpointID	
BT-40	Catalogue supplier identifier	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyIdentification/cbc:ID/@schemeID	Pfad zur Komponente schemeID von BT-40
BT-40	Catalogue supplier identifier	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyIdentification/cbc:ID	
BT-41	Catalogue supplier trading name	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PartyName/cbc:Name	
BG-10	Supplier postal address	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress	

ID	Name	Pfad	Bemerkung
BT-42	Supplier address line 1	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:StreetName	
BT-43	Supplier address line 2	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:AdditionalStreetName	
BT-44	Supplier address line 3	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cac:AddressLine/cbc:Line	
BT-45	Supplier city	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:CityName	
BT-46	Supplier post code	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:PostalZone	
BT-47	Supplier country subdivision	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cbc:CountrySubEntity	
BT-48	Supplier country code	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:PostalAddress/cac:Country/cbc:IdentificationCode	
BG-11	Catalogue supplier contact	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact	
BT-49	Supplier contact person name	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact/cbc:Name	
BT-50	Supplier contact telephone number	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact/cbc:Telephone	
BT-51	Supplier contact email address	/Catalogue/cac:SellerSupplierParty/cac:Party/cac:Contact/cbc:ElectronicMail	
BG-12	Catalogue customer	/Catalogue/cac:ContractorCustomerParty/cac:Party	
BT-52	Customer party electronic address	/Catalogue/cac:ContractorCustomerParty/cac:Party/cbc:EndpointID/@schemeID	Pfad zur Komponente schemeID von BT-52.
BT-52	Customer party electronic address	/Catalogue/cac:ContractorCustomerParty/cac:Party/cbc:EndpointID	
BT-53	Catalogue customer identifier	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyIdentification/cbc:ID/@schemeID	Pfad zur Komponente schemeID von BT-53.
BT-53	Catalogue customer identifier	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyIdentification/cbc:ID	
BT-54	Catalogue customer trading name	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PartyName/cbc:Name	
BG-13	Customer postal address	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress	
BT-55	Customer address line 1	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress/cbc:StreetName	
BT-56	Customer address line 2	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress/cbc:AdditionalStreetName	

ID	Name	Pfad	Bemerkung
BT-57	Customer address line 3	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress/cac:AddressLine/cbc:Line	
BT-58	Customer city	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress/cbc:CityName	
BT-59	Customer post code	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress/cbc:PostalZone	
BT-60	Customer country subdivision	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress/cbc:CountrySubEntity	
BT-61	Customer country code	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:PostalAddress/cac:Country/cbc:IdentificationCode	
BG-14	Catalogue customer contact	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact	
BT-62	Customer contact person name	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact/cbc:Name	
BT-63	Customer contact telephone number	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact/cbc:Telephone	
BT-64	Customer contact email address	/Catalogue/cac:ContractorCustomerParty/cac:Party/cac:Contact/cbc:ElectronicMail	
BG-17	Catalogue line	/Catalogue/cac:CatalogueLine	
BT-73	Line identifier	/Catalogue/cac:CatalogueLine/cbc:ID	
BT-74	Line action code	/Catalogue/cac:CatalogueLine/cbc:LineActionCode	
BT-75	Orderable indicator	/Catalogue/cac:CatalogueLine/cbc:OrderableIndicator	
BT-76	Orderable unit	/Catalogue/cac:CatalogueLine/cbc:OrderableUnit	
BT-77	Item net quantity	/Catalogue/cac:CatalogueLine/cbc:ContentUnitQuantity/@unitCode	Pfad zur Komponente unitCode von BT-77.
BT-77	Item net quantity	/Catalogue/cac:CatalogueLine/cbc:ContentUnitQuantity	
BT-78	Order quantity increment	/Catalogue/cac:CatalogueLine/cbc:OrderQuantityIncrementNumeric	
BT-79	Minimum order quantity	/Catalogue/cac:CatalogueLine/cbc:MinimumOrderQuantity/@unitCode	Pfad zur Komponente unitCode von BT-79.
BT-79	Minimum order quantity	/Catalogue/cac:CatalogueLine/cbc:MinimumOrderQuantity	
BT-80	Maximum order quantity	/Catalogue/cac:CatalogueLine/cbc:MaximumOrderQuantity/@unitCode	Pfad zur Komponente unitCode von BT-80.
BT-80	Maximum order quantity	/Catalogue/cac:CatalogueLine/cbc:MaximumOrderQuantity	
BT-81	Line warranty information	/Catalogue/cac:CatalogueLine/cbc:WarrantyInformation	
BT-82	Packaging level	/Catalogue/cac:CatalogueLine/cbc:PackLevelCode	

ID	Name	Pfad	Bemerkung
BG-18	Catalogue line validity period	/Catalogue/cac:CatalogueLine/cac:LineValidity-Period	
BT-83	Catalogue line validity period start date	/Catalogue/cac:CatalogueLine/cac:LineValidity-Period/cbc:StartDate	
BT-84	Catalogue line validity period end date	/Catalogue/cac:CatalogueLine/cac:LineValidity-Period/cbc:EndDate	
BG-19	Price details	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity	
BT-85	Price lead time	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cbc:LeadTimeMeasure/@unit-Code	Pfad zur Komponente unitCode von BT-85.
BT-85	Price lead time	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cbc:LeadTimeMeasure	
BT-86	Price quantity threshold	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cbc:MinimumQuantity/@unit-Code	Pfad zur Komponente unitCode von BT-86
BT-86	Price quantity threshold	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cbc:MinimumQuantity	
BT-87	Price quantity ceiling	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cbc:MaximumQuantity/@unit-Code	Pfad zur Komponente unitCode von BT-87
BT-87	Price quantity ceiling	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cbc:MaximumQuantity	
BT-88	Item price amount	/Catalogue/cac:CatalogueLine/cac:RequiredI-temLocationQuantity/cac:Price/cbc:PriceAm-ount/@currencyID	Pfad zur Komponente curren-cyID von BT-88.
BT-88	Item price amount	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:Price/cbc:PriceAmount	
BT-89	Item price base quantity	/Catalogue/cac:CatalogueLine/cac:RequiredI-temLocationQuantity/cac:Price/cbc:BaseQuanti-ty/@unitCode	Pfad zur Komponente unitCode von BT-89.
BT-89	Item price base quantity	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:Price/cbc:BaseQuantity	
BT-90	Item price type	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:Price/cbc:PriceType	
BT-91	Orderable unit factor rate	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:Price/cbc:OrderableUnit-FactorRate	
BG-20	Price validity period	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:Price/cac:ValidityPeriod	
BT-92	Price validity period start date	/Catalogue/cac:CatalogueLine/cac:RequiredI-temLocationQuantity/cac:Price/cac:ValidityPeri-od/cbc:StartDate	
BT-93	Price validity period end date	/Catalogue/cac:CatalogueLine/cac:RequiredI-temLocationQuantity/cac:Price/cac:ValidityPeri-od/cbc:EndeDate	

ID	Name	Pfad	Bemerkung
BG-22	Price location information	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAddress	
BT-99	Price address line 1	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAd-dress/cbc:StreetName	
BT-100	Price address line 2	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAd-dress/cbc:AdditionalStreetName	
BT-101	Price address line 3	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAd-dress/cac:AddressLine/cbc:Line	
BT-102	Price city	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAd-dress/cbc:CityName	
BT-103	Price post code	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAd-dress/cbc:PostalZone	
BT-104	Price country subdivision	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAd-dress/cbc:CountrySubentity	
BT-105	Price country code	/Catalogue/cac:CatalogueLine/cac:RequiredItem-LocationQuantity/cac:ApplicableTerritoryAd-dress/cac:Country/cbc:IdentificationCode	
BG-23	Catalogue item information	/Catalogue/cac:CatalogueLine/cac:Item	
BT-106	Seller item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:Sel-lersItemIdentification/cbc:ID	
BT-107	Buyer item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:Buy-ersItemIdentification/cbc:ID	
BT-108	Manufacturer item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:Ma-nufacturersItemIdentification/cbc:ID	
BT-109	Standard item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:Stan-dardItemIdentification/cbc:ID/@schemeID	Pfad zur Komponente schemeID von BT-109.
BT-109	Standard item identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:Stan-dardItemIdentification/cbc:ID	
BT-110	Manufacturer party name	/Catalogue/cac:CatalogueLine/cac:Item/cac:Ma-nufacturerParty/cbc:Name	
BT-111	Item name	/Catalogue/cac:CatalogueLine/cac:Item/cbc:Name	
BT-112	Item descripti-on	/Catalogue/cac:CatalogueLine/cac:Item/cbc:De-scription	
BT-113	Item keywords	/Catalogue/cac:CatalogueLine/cac:Item/cbc:Key-word	
BT-114	Item brand name	/Catalogue/cac:CatalogueLine/cac:I-tem/cbc:BrandName	
BT-115	Item classifica-tion code	/Catalogue/cac:CatalogueLine/cac:Item/cac:Com-modityClassification/cbc:ItemClassification-Code/@listID	Pfad zur Komponente listID von BT-115.

ID	Name	Pfad	Bemerkung
BT-115	Item classification code	/Catalogue/cac:CatalogueLine/cac:Item/cac:CommodityClassification/cbc:ItemClassificationCode/@listVersionID	Pfad zur Komponente listVersionID von BT-115.
BT-115	Item classification code	/Catalogue/cac:CatalogueLine/cac:Item/cac:CommodityClassification/cbc:ItemClassificationCode/@name	Pfad zur Komponente name von BT-115.
BT-115	Item classification code	/Catalogue/cac:CatalogueLine/cac:Item/cac:CommodityClassification/cbc:ItemClassificationCode	
BT-116	Item origin country	/Catalogue/cac:CatalogueLine/cac:Item/cac:OriginCountry/cbc:IdentificationCode	
BT-117	Packed quantity	/Catalogue/cac:CatalogueLine/cac:Item/cbc:PackQuantity/@unitCode	Pfad zur Komponente unitCode von BT-117.
BT-117	Packed quantity	/Catalogue/cac:CatalogueLine/cac:Item/cbc:PackQuantity	
BT-118	Consumable unit quantity	/Catalogue/cac:CatalogueLine/cac:Item/cbc:PackSizeNumeric	
BT-119	Contracted item indicator	/Catalogue/cac:CatalogueLine/cac:Item/cac:TransactionConditions/cbc:ActionCode	
BT-120	Hazardous item UNDG code	/Catalogue/cac:CatalogueLine/cac:Item/cac:HazardousItem/cbc:UNDGCode	
BT-121	Hazardous item hazard class identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:HazardousItem/cbc:HazardClassID	
BT-122	Item best before date	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cbc:BestBeforeDate	
BT-123	Item batch identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemInstance/cac:LotIdentification/cbc:LotNumberID	
BG-24	Additional item property	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty	
BT-124	Item property name	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty/cbc:Name	
BT-125	Item property code	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty/cbc:NameCode/@listID	Pfad zur Komponente listID von BT-125.
BT-125	Item property code	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty/cbc:NameCode	
BT-126	Item property value	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty/cbc:Value	
BT-127	Item property unit of measure	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty/cbc:ValueQuantity/@unitCode	Pfad zur Komponente unitCode von BT-127.
BT-127	Item property unit of measure	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty/cbc:ValueQuantity	
BT-128	Property classification	/Catalogue/cac:CatalogueLine/cac:Item/cac:AdditionalItemProperty/cbc:ValueQualifier	
BG-25	Certificate	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate	
BT-129	Item label name	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:ID	

ID	Name	Pfad	Bemerkung
BT-130	Certificate type code	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:CertificateTypeCode	
BT-131	Item label type	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:CertificateType	
BT-132	Item label value	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cbc:Remarks	
BT-133	Label issuer name	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cac:IssuerParty/cac:PartyName/cbc:Name	
BT-134	Item label reference	/Catalogue/cac:CatalogueLine/cac:Item/cac:Certificate/cac:DocumentReference/cbc:ID	
BG-26	Dimension	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension	
BT-135	Dimension attribute identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:AttributeID	
BT-136	Measure	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:Measure/@unitCode	Pfad zur Komponente unitCode von BT-136.
BT-136	Measure	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:Measure	
BT-137	Dimension description	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:Description	
BT-138	Minimum storage conditions	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MinimumMeasure/@unitCode	Pfad zur Komponente unitCode von BT-138.
BT-138	Minimum storage conditions	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MinimumMeasure	
BT-139	Maximum storage conditions	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MaximumMeasure/@unitCode	Pfad zur Komponente unitCode von BT-139.
BT-139	Maximum storage conditions	/Catalogue/cac:CatalogueLine/cac:Item/cac:Dimension/cbc:MaximumMeasure	
BG-27	Classified tax category	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory	
BT-140	Item tax category code	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory/cbc:ID	
BT-141	Item tax percentage	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory/cbc:Percent	
BT-142	Item tax scheme	/Catalogue/cac:CatalogueLine/cac:Item/cac:ClassifiedTaxCategory/cac:TaxScheme/cbc:ID	
BG-28	Item attachment specification	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference	
BT-143	Attachment identifier	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cbc:ID	
BT-144	External item specifications type	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cbc:DocumentTypeCode	
BT-145	Attached item description	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cbc:DocumentDescription	

ID	Name	Pfad	Bemerkung
BG-29	Attachment	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment	
BT-146	Attached object	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment/cbc:EmbeddedDocumentBinaryObject/@mimeCode	Pfad zur Komponente mimeCode von BT-146.
BT-146	Attached object	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment/cbc:EmbeddedDocumentBinaryObject/@filename	Pfad zur Komponente filename von BT-146.
BT-146	Attached object	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment/cbc:EmbeddedDocumentBinaryObject	
BT-147	External item specifications	/Catalogue/cac:CatalogueLine/cac:Item/cac:ItemSpecificationDocumentReference/cac:Attachment/cac:ExternalReference/cbc:URI	