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RESEARCH PAPER

Standardization of Forms in Governments

A Meta-Model for a Reference Form Modeling Language

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Abstract Forms are central interfaces for information exchange between a government and its citizens. As a way to translate laws into practice, forms are an essential part facilitating this exchange. Unfortunately, forms often require substantial development effort to ensure they comply with legal requirements, with the result that citizens often describe them as highly complex. Standardization of forms through reference modeling would help to minimize governments' effort by reusing elements and would reduce complexity for citizens by providing a unified representation of information. The article contributes a meta-model for a modeling language that can be used in representing reference models for forms. It follows a design science research approach to elicit form structure and editorial process requirements and to iteratively design the meta-model. The paper demonstrates and evaluates the meta-model using focus groups and application in three case studies. It extends research on standardization to reference modeling and government forms.

Keywords Reference modeling · Forms · Standardization · E-government · Digital government · Public administration · Meta-modeling · Graphical user interface

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1 Introduction

Forms are the central interfaces for information exchanges between the government and its citizens in the course of government service delivery (Klischewski 2006; Axelsson and Ventura 2007; Sourouni et al. 2008; Becker et al. 2012). Essential for any transactional government service delivery (Layne and Lee 2001), forms are objects containing information that are exchanged among the actors involved in a service. At the beginning of a service transaction, the citizen transmits information to the government through a form, such as an application form, that consists of fields that the citizen fills out. Based on that input, the government analyzes the information and decides whether the applicant is eligible to receive the service. If the decision is positive, the government issues a document, such as a certificate, that consists of fields the government fills out to describe its decision. Thus, forms serve two purposes in government service delivery: to start the process when a citizen wants to receive a government service and to exchange the necessary information.

Although forms have a central role in the delivery of government services, both citizens and governments are

challenged by their complexity. The convenience of electronic forms has a substantial impact on citizens' perceptions of the quality of e-government services (Papadomichelaki and Mentzas 2012; Veeramootoo et al. 2018), but citizens often indicate that governments' forms are too complex. For instance, in the United States, citizens are of the opinion that forms ask for too much information (Accenture 2015), and 60% of Germany's citizens think forms have a significant influence on their satisfaction with government services, but they complain about difficulties in filling them out (Federal Statistical Office 2015) and sometimes even have to engage lawyers to assist them with the completion (Hampel 2017).

For their part, governments, especially governments with a federal structure, struggle to manage the complexity of forms. The idea of a federal system is to share power and sovereignty across levels of government (Wheare 1946; Hueglin and Fenna 2015), so jurisdictions are distributed not only horizontally across functional departments (Layne and Lee 2001) but also vertically across federal levels (Scharpf 1988), which means that many government organizations delivering services use their own forms independent of other government bodies. For example, Germany has approximately 12,000 local governments with similar service portfolios (Algermissen et al. 2005) and 16 partly independent states with various departments, all of which deliver services to citizens. Because of the similarity of their services, these government bodies should be able to use similar forms, but currently they each develop their own forms, leading to a high degree of variation in their forms, even when they are used to request the same services (Scholta 2017). Certainly, governments can benefit from some kind of harmonization in the forms they use if only to reduce the number of requests for support from citizens who are trying to complete them (Jarrett 2015). Government bodies themselves have recognized the need for an increased level of form standardization and comprehensibility (National Regulatory Control Council 2016).

The complexity of forms has multiple causes, suggesting multiple solutions. Generally, forms that are exchanged across organizational boundaries are influenced by the organizations' laws, policies, bureaucracy, and processes (Yang and Maxwell 2011). For instance, two forms may refer to the same real-world entity but present it differently, e.g., different data attributes are used to describe the entity (Hiller and Bélanger 2001; Otjacques et al. 2007). Specifically, complexity in forms for the same service often occurs when government bodies' forms differ in terms of their content, structure, captions, and representations (Scholta 2017). Although taking into account the various sources of complexity and considering that managing such a complexity effectively would benefit both citizens and governments, academia and practice still lack an approach to address the issue.

Standardization is a feasible approach to counter complexity (Van De Ven et al. 1976; Thompson 2007; Okhuysen and Bechky 2009; Williams and Karahanna 2013). In general, a standard is "a uniform set of measures, agreements, conditions, or specifications between parties" (Spivak and Brenner 2001, p. 16). Reaching a standard requires stabilizing and solidifying its definition and boundaries (David and Greenstein 1990; Hanseth et al. 2006) for which *reference models* can be used, as they are "generic conceptual models that formalize recommended practices for a certain domain" (Rosemann 2003, p. 595). In particular, forms can be designed from reference models that constitute the required standard in order to reduce the complexity of forms across governments. Reference models take into account the established practices or best practices of government services to manage complexity by bundling and reusing elements.

To support the standardization of forms which benefits citizens and governments, this article's research goal is the *design of a meta-model for a reference form modeling language in governments*. Governments can use the language to define reference form models that serve as standards for forms and to harmonize their forms across levels of government and functional departments. Following the design science research (DSR) paradigm (Hevner et al. 2004) and applying Peffers et al.'s (2007) DSR methodology (DSRM), we propose the use of a meta-model (Strahringer 1996; Aßmann et al. 2006). Vendors of form-management systems can use this meta-model to develop a corresponding software tool for defining reference form models. With such a tool to implement the constructs introduced in the meta-model, ministry staff can develop reference form models that designers of forms in public administrations can use to define standardized forms efficiently and effectively. Public IT departments can implement these forms to provide digitized forms, and users can benefit from harmonized forms that reuse standardized elements at each service point and do not require special effort to understand and fill out. Moreover, with current prospective developments regarding the once-only principle of information exchange between users and governments (Krimmer et al. 2017), the need for reference form models is central to focusing on user needs and improving service quality.

The rest of the article is structured as follows. Section 2 presents the research background, while Sect. 3 describes our research design. We introduce the requirements for a solution to our research problem in Sect. 4, and Sect. 5 explains our meta-model. Section 6 provides an instantiation of our meta-model with a real-world example. We

report the results of our evaluation in Sect. 7, discuss our findings in Sect. 8, and conclude in Sect. 9.

2 Research Background and Idea

2.1 Service Quality and Forms in Government

Conceptualizations of government services (e.g., Lindgren and Jansson 2013; Jansen and Ølnes 2016), the management of their quality (e.g., Buckley 2003; Halaris et al. 2007; Bhattacharya et al. 2012; Papadomichelaki and Mentzas 2012; Tan et al. 2013), and the emergence of online provision (e.g., Sá et al. 2016) have seen considerable research interest. According to Jansen and Ølnes (2016), electronic government services should be studied from their users' and providers' perspectives and from that of the digital interactions, particularly the information exchanged (Lindgren and Jansson 2013) between users and providers.

Governments that seek to design high-quality services must consider the quality of both *service content* and *service delivery* (Tan et al. 2013). Service content refers to the effectiveness of the service-related functionality offered to users in fulfilling their needs. Service content comprises functions like customizing the service to the users' requirements, upgrading parts of the service content without having to rebuild the whole service transaction, and accepting user input in a manner that allows the potential service outcome to be forecast (Tan et al. 2013). Service delivery, which refers to efficient use of service content, covers the interaction between users and providers based on the service content (Papadomichelaki and Mentzas 2012) and comprises functions like interactivity (e.g., compared to using paper forms), interoperability of service content provided by multiple government departments, and adaptability to demand patterns (Tan et al. 2013). In particular, interoperability of service content, such as the exchange of a data set or handling a complete case along the service process, requires a formalized information exchange process (Lee et al. 2011; Jansen and Ølnes 2016) that can be made possible by electronic forms (Axelsson and Ventura 2007; Papadomichelaki and Mentzas 2012).

Although information exchange is a valuable part of service quality (e.g., Dawes 1996; Tambouris et al. 2009), technical challenges like heterogeneous data structures for single identifiers in tax agencies in the European Union are common (Otjacques et al. 2007), so the management of effective information exchange is challenged by issues from the organizational, technological, semantic, legal, political, and environmental perspectives (e.g., Soares and Amaral 2011; Praditya et al. 2017; Wang 2018). In particular, extant research has identified organizational culture and structures as major barriers to information exchange (Drake et al. 2004).

While governments differ in their cultural traditions, socio-economic characteristics, and value-drivers (Misuraca et al. 2011), they have to align information exchange both vertically (e.g., federal systems, supranational bodies) and horizontally (e.g., jurisdictions of business areas) (e.g., Klischewski and Scholl 2008). In government settings in which both dimensions are present and jurisdiction and functions are separated (e.g., Germany, Spain, the US, the European Union), the challenges of information exchange are even greater, especially in governments that use a federal system, where independence and equality are ensured through constitutional guarantees and influence to what extent these government bodies cooperate (Watts 1998). In a country in which one level of government passes the laws and another level executes them, the former level specifies the requirements for forms and the latter interprets them to design the forms. In such a setting, efficient cooperation is required to design forms in a way that reduces effort and misinterpretations.

We define *a form as a structured interface that provides predefined labeled spaces for manual data input and is used repeatedly to transfer data to one or more natural or legal persons.* In the case of electronic forms, we view forms as specific graphical user interfaces that are applied in their role as instruments to transfer data that the receiving person requests from the sender (Tsichritzis 1982; Papadomichelaki and Mentzas 2012). Their role in transferring data distinguishes forms from other graphical user interfaces that also allow for manual data input. For instance, the graphical user interface of an address book app is not a form, since it primarily administers and manipulates data but does not transmit data between persons. Forms also differ from data in that the data perspective comprises storing, processing, and administrating data separate from the user's view, whereas the form perspective captures data and prepares a view of a relevant subset of data for users (Yao et al. 1984; van der Aalst et al. 2005b). Despite the difference between the form perspective and the data perspective, form fields must be mapped to fields in databases since forms capture data that is finally stored in databases. Therefore, data models can serve as basis for the development of forms.

Previous work on forms has focused on interoperable data exchange between information systems and separation of concerns regarding the modelling, layout, and processing of data in forms [e.g., XML-based markup languages like XForms and Extensible Forms Description Language (XFDL)]. Recent research has emphasized the improvement of form usability in web and mobile applications and has introduced design guidelines for forms (e.g., Wroblewski 2008; Jarrett and Gaffney 2009; Bargas-Avila et al.

2010) that, for example, make recommendations for date fields (Bargas-Avila et al. 2011) or recommend how to design electronic forms for the elderly (Money et al. 2011). Concepts have been proposed that support the completion of a form, such as auto-filling (Araujo et al. 2010), which prefills fields with data that the user has entered previously.

Designing forms in a government context is a challenging task, as governments must analyze regulations at multiple levels of government that specify which data may be captured from a citizen during delivery of a government service (Axelsson and Ventura 2007) and must design forms that represent the contents adequately. A form consists of fields and groups, where groups can include fields and other groups (Lum et al. 1982). A *form designer* builds and graphically arranges a form with fields and groups, whereas a *form user* fills out fields with data. Fields have captions that indicate what data a form user is to enter.

In government service delivery, citizens use forms to exchange information and indicate their wish to receive a service (Scholta et al. 2019a). The output of government services are documents such as certificates, notifications, permits and licenses. We denote such documents as *output forms* and refer to forms that follow the definition stated above as *input forms*. In contrast to input forms, the government fills out output forms' fields in advance, so manual data input is not possible. In general, a citizen reads output forms but does not fill them out. Governments can structure output forms' layout in the same way as input forms.

2.2 Standardization and Reference Modeling

Standards play an important role in the interoperable exchange of information among actors (International Organization for Standardization 2015). Particularly in governments, standards enhance communication between agencies (European Commission 2010), so standards for managing information – and forms as interfaces to government services in particular – are a necessity in improving electronic government services (Lam 2005). As a result, standardization has gained increasing attention in research and practice in the government context (Charalabidis et al. 2009; Hellberg and Grönlund 2013; Folmer et al. 2016).

Research on standardization in organizations (Brunsson et al. 2012) and information systems management (Lyytinen and King 2006) has emphasized measures that can address complexity challenges in information management (e.g. Hanseth et al. 2006; Markus et al. 2006), but these measures' applicability in a government context is limited by the many differences between private organizations and government bodies (Rainey et al. 2010; Jurisch 2014). In particular, standardization is challenged by the complexity of government procedures (Bharosa et al. 2010; Janssen et al. 2011), the coordination of the actors involved, and their interactions (Balta and Krcmar 2018), so standardization is often ineffective in practice (Blum 2005; Scholl and Klischewski 2007). Various approaches to standardization that are tailored to the context of government services have been developed in response (Guijarro 2007; Büttner et al. 2014). For example, frameworks like SAGA (Federal Government Commissioner for Information Technology 2017), with its focus on software specifications and development methods in the context of government bodies, and the European Interoperability Framework (European Commission 2017) have been proposed to management practice.

We focus on *standardization* – that is, the process of developing standards for forms – as a means of form management in governments. According to de Vries (1999, p 155), standardization refers to "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" [emphasis added]. Based on this definition, our meta-model presents a basis for standardization because it allows governments to establish and record reference models of forms (*reference form models*) in a socio-technical process (Hanseth et al. 1996) using predefined form elements from the perspectives of both form designers and form users.

We refer to reference models as "special information models that serve to be reused in the design process of other information models" (vom Brocke 2007, p 49). In the case of governments that use a federal structure, ensuring that reference models are effective and are widely used means that all levels of government should be involved in their development (Hinkelmann et al. 2005).

Reference modelers have applied various languages to the development of reference models. For instance, conventional modeling languages like event-driven process chains (EPCs) (Keller et al. 1992; Scheer et al. 2005) and entity-relationship models (ERM) (Chen 1976) have been applied (Fettke and Loos 2003; vom Brocke 2007), although their original intent was to represent organizations' individual models. However, modeling languages that are dedicated to reference modeling, such as Configurable EPCs (Rosemann and van der Aalst 2007), have also been developed. The literature refers to modeling languages used to represent reference models as *reference modeling languages* (van der Aalst et al. 2005a; Fettke and Loos 2006, 2007; Becker and Delfmann 2007; Recker et al. 2007; Rosemann and van der Aalst 2007).

The constructs of modeling languages can be specified by *meta-models*. A meta-model contains the definition of the *abstract syntax* of a modeling language and specifies the modeling language's constructs and their syntactical relationships, whereas a *concrete syntax* is comprised of the visual representations of the constructs and their relationships that the meta-model has structurally specified (Kühne 2006).

2.3 Our Idea

Our goal is to combine forms and reference modeling by presenting the design of a meta-model for a reference form modeling language in governments. Our solution facilitates the development of reference form models that serve as templates for the design of forms, so multiple forms can result from the same reference form model, increasing standardization. Figure 1 provides an overview of our solution and its incorporation into the form-design process along four steps.

In the first step, reference modelers select a suitable modeling language for the creation of reference form models. We advocate for the use of a specific *reference form modeling language* because of the characteristics of reference form models and their development and application processes. For instance, laws can have strict requirements or allow for individual approaches to the structure of government forms; that is, they have differing degrees of obligation. Therefore, as indicated in Fig. 1, reference modelers should be able to indicate whether elements of a reference form model have to occur on forms (obligatory) or can be adapted or removed (optional). In our view, such a language is superior to a language that is dedicated to the representation of organization-specific form models, so we propose an *abstract syntax* of a reference form modeling language. *Concrete syntax* is part of future work on, for instance, the decision concerning whether to represent fields as ellipses, as suggested in Fig. 1.

In the second step, a reference modeler builds the *reference form models* using the selected reference form modeling language. In the example in Fig. 1, the reference form model suggests a form structure with three fields, where "given name" and "surname" have to occur on each form model, and "gender" is optional.

Third, form designers construct *form models* by reusing elements from the reference form model. In the example presented in Fig. 1, the language XForms is applied to describe an organization's form model that contains the fields "given name," "surname," "place of birth," and "gender," so the form model extends the reference form model by adding the field "place of birth." In contrast to the reference form model, the form model is a textual, machine-readable specification of a form structure. Form designers create such form models using graphical user interfaces in form-management systems.

Finally, the form-management system transforms the form models into actual *forms*, so forms instantiate form models and materialize an arrangement of fields and groups, such as in PDF forms or web forms. Figure 1 shows an exemplary form instance that uses a two-column structure and radio buttons to capture the gender. Other forms can instantiate the same form model by, for instance, using a linear sequence of fields and representing the gender with a drop-down list.

3 Research Design

In designing the meta-model, we used the DSRM proposed by Peffers et al. (2007) and executed three DSRM cycles: We first *defined the problem* and explained our research's relevance to it. Then, in each cycle, we *elicited requirements* for a solution, *developed* a version of our artifact, *demonstrated* its functionality, and *evaluated* it for various criteria. The demonstration and evaluation took place in Germany since Germany has a federal structure with vertical and horizontal jurisdictions and offers complex government services using many forms.

In the first cycle, we *elicited requirements* by conducting a literature study and organizing two focus groups (Morgan 1997; Krueger and Casey 2015) with practitioners and researchers. We performed a semi-structured literature study to define the initial set of requirements and synthesized the key findings as input for the initial definition of requirements that was conducted in internal discussions with five domain and method experts in the core research group. Then we used these requirements as a starting point in discussions with two focus groups.

The two focus groups comprised two kinds of participants. One focus group consisted of fifteen experts from all three levels of government in Germany. The members, who worked in various business areas and did not have a technical focus, were recruited from the middle management of their organizations and were experts for the business and legal requirements of forms. A typical role of these participants was that of functional manager of organizational departments, so most of the members of the group were responsible for their organizations' processes and organizational structures and participated in the discussion from this business perspective. The other focus group consisted of twenty experts from government IT departments and providers of form-management systems, so their jobs had a technical focus. The government experts were recruited from the middle management of all levels of government, whereas the representatives of providers of

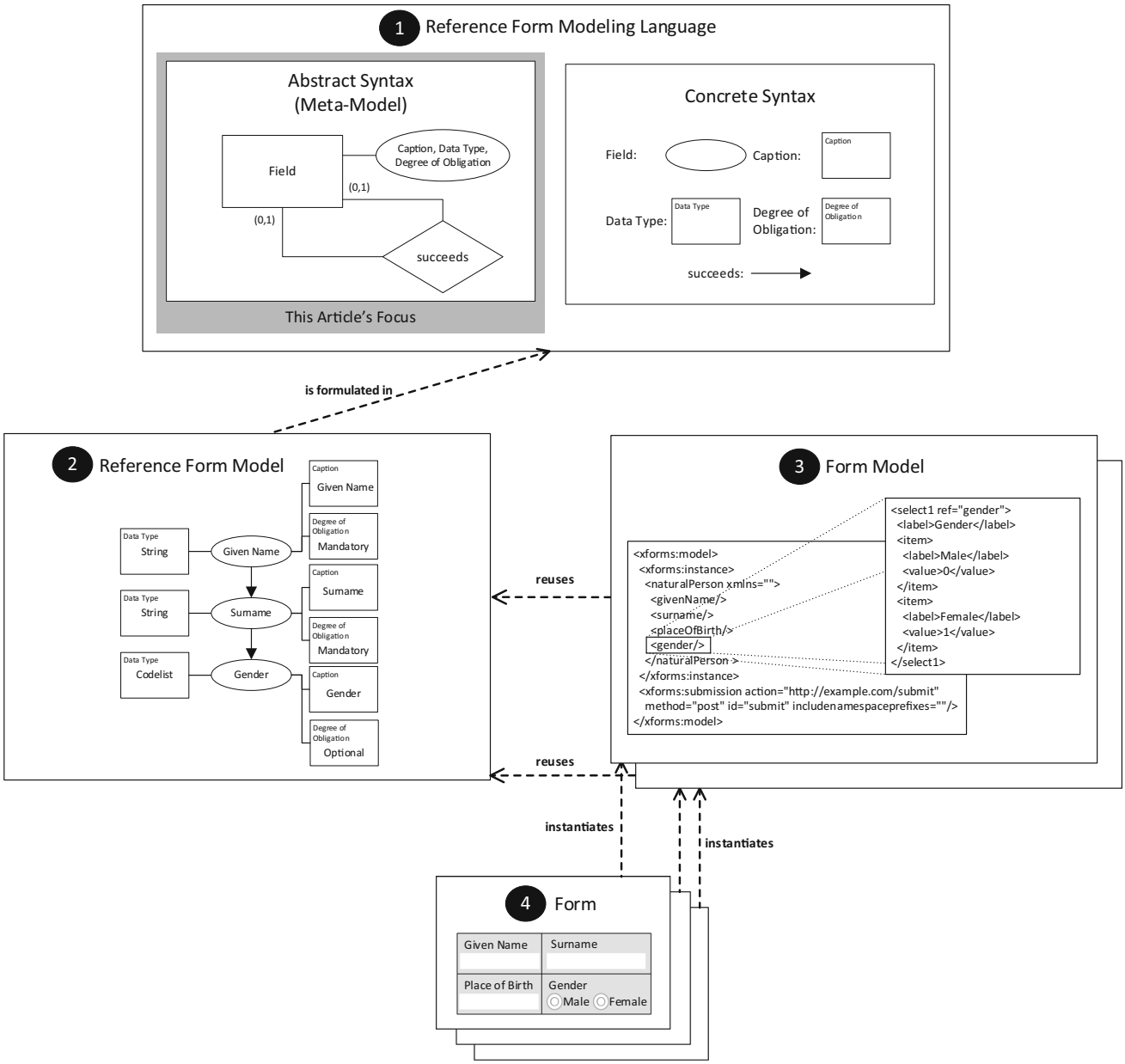

Fig. 1 Our idea

form-management systems were recruited from top management. The government representatives were responsible for their organizations' IT architectures, so they had a profound understanding of the solutions that were in use and could discuss shortcomings and problems with actual systems and formulate clear expectations for improvement from the technical perspective. Thus, the first focus group discussed the issue from a business perspective, and the second focus group did so from a technical perspective.

The government experts were selected based on our goal of including all levels of government and as many regional areas of Germany as possible, whereas the experts from form-management system providers were recruited based on their market shares. There was no overlap in people of the two focus groups. The focus groups were provided with the current set of requirements and explanations via email as preparation before the meetings.

The set of requirements was derived iteratively and updated after each focus group meeting. After two meetings with each of the focus groups, no requirements were deleted or adapted and no new requirements emerged, so we assumed a stable, complete, and relevant set of requirements. In the subsequent DSRM cycles, the set of requirements was updated after each evaluation in response to the feedback we received.

Subsequently, we *developed* and updated the meta-model in the three DSRM cycles. In each of the cycles, we sought to determine how the requirements could be met. If a solution did not emerge from discussions in our research group based on our knowledge and experience, we conducted semi-structured literature studies. Once we agreed on a solution, we proceeded with demonstration and evaluation of the existing version of the meta-model.

In all three cycles, we jointly *demonstrated* and *evaluated* the meta-model, which led to updates of the requirements and the design of the meta-model in the next cycle. At the end of the third cycle, we reached a stable version of the meta-model so did not require another DSRM cycle. The evaluation was guided by three criteria: *efficacy*, which indicated whether the requirements were adequately fulfilled; *completeness*, which indicated whether no further requirements were to be addressed; and *effectiveness*, which indicated whether the solution was valuable for use in practice. We chose the first two criteria to obtain a satisfactory solution to our research problem and the third to create a solution that is implementable in practice.

The research methods applied differed between the first cycle and the second and third cycles. In the first cycle, we conducted iterative meetings with the two focus groups about the conceptualization of our solution, while in the second and third cycles, we implemented the meta-model in a software tool that served as a proof-of-concept and performed three case studies from Germany using this tool. The software tool incorporated all constructs of our meta-model and provided a simple user interface for reference modelers. In the case studies, we created reference form models for input forms and output forms in the areas of (a) firearms licenses and (b) the business register in the second cycle, and (c) housing benefits in the third cycle.

The design of the case studies was guided by four criteria for trustworthiness in qualitative research – credibility, transferability, dependability and confirmability – and strategies to establish them (Guba 1981; Krefting 1991; Morse 2015). We addressed *transferability* using three cases, the selection of which was based on two factors: (1) the cases had to originate from different business areas to ensure that we minimize bias from laws and regulations that are specific to one area and that the results cover the facets and constructs of the meta-model, and (2) the ministries had to be willing to support us over a period of twelve to eighteen months. The firearms licenses case was in the jurisdiction of the Federal Ministry of the Interior, while the Federal Minister for Economic Affairs and Energy supported the business register case, and the housing benefits case was under the responsibility of the Federal Minister for the Environment, Nature Conservation, Building and Reactor Safety.

We addressed *credibility*, *dependability*, and *confirmability* using an investigator triangulation and member checking. People from the research group and project members from practice created and reviewed the reference form models that resulted from our cooperation with the departments from the federal ministries that were responsible for formulating the relevant laws and regulations. We constructed the reference form models iteratively until the domain experts from the ministries confirmed their appropriateness and agreed to the final version. In so doing, we ensured that the reference form models followed the syntax of our meta-model (method expertise), complied with the relevant laws, and were valuable for use in practice (domain expertise). Thus, we removed ambiguity in the interpretation of laws and evaluated the reference form models' adequacy and suitability.

We used deduction and induction to develop the reference form models using the constructs introduced in our meta-model (Becker and Schütte 2007). Deductively, we analyzed laws, regulations, interoperability frameworks, and existing reference process models. Although laws and regulations specify the data that citizens must provide, some of these regulations provide precise data requirements, while others are vague. In the latter case, we consulted applicable interoperability frameworks to shape the structures of the reference form models. If reference process models existed, they provided additional information about processed data and required data and the forms that were to be exchanged and standardized. A method triangulation for *credibility*, *dependability*, and *confirmability* was used since we not only analyzed written sources like laws and interoperability frameworks, but also consulted domain experts in the ministries for their expertise. Inductively, we recorded and compared existing forms from government practice to avoid mistakes in the deductively developed reference form models. We compared our inductively derived results to the reference form models and, after consulting with the experts from the ministries, adapted the models if necessary. We kept the minutes of the meetings and discussions to document the feedback gathered and stored the reference form models in the software tool, thus addressing *dependability* through comprehensive descriptions of research methods and results.

4 Requirements and Their Fulfillment

In the following, we present six requirements for a meta-model for a reference form modeling language. We categorize the requirements as follows:

1. Requirements that deal with the *structure and purpose* of a form, such as a field's occurrence on a form.

2. Requirements that cover the *editorial and usage process*, such as the maintenance of a reference form model.

4.1 Structure and Purpose

Three of the six requirements are in the structure and purpose category.

REQ 1 – modular structure A form's structure has to be modular so its elements can be designed independently but can be combined easily and work as an integrated whole (Baldwin and Clark 2003). Hence, by using a structure that contains separately defined and reusable modules, single modules can easily be substituted into or removed from the whole. A form comprises fields and groups that can occur on multiple forms, so a meta-model has to provide constructs for modules that can be reused on multiple reference form models to reduce the variety of fields and groups and achieve a high degree of harmonization.

REQ 2 – static properties Each form has properties like its name and purpose that are associated with and fulfilled by its structure. Separation between the form's name and purpose and its structure allows one to take into account various kinds and frequencies of changes. Governmental practice suggests that properties like a form's name and purpose change significantly less frequently than structures since the laws that affect a form might change some required fields but are unlikely to change a form's name or purpose. Such is the case for the German identification card, where the form's name and purpose have remained unchanged since 1951, but the last structural modification was performed in 2010, when date of birth and place of birth were separated into two fields. Consequently, a solution has to separate a reference form model's structure clearly from its static properties.

REQ 3 – electronic form Whereas traditional paper forms are still important artifacts in government services, electronic forms like fillable PDF documents and web forms provide enhanced functionality, with benefits for both citizens and governments. This enhanced functionality represents a major shift in handling the context-specific business logic for a form derived from law: paper forms can only explain how to fill out a form, while electronic forms allow for novel interactions with form users, such as highlighting or hiding fields and groups that are required from or irrelevant to a citizen based on his or her previous entries or performing plausibility checks on the data entered. The meta-model has to allow the enhanced functionality of electronic forms to be modeled based on domain experts' knowledge and laws.

4.2 Editorial and Usage Process

Three of the six requirements are in the editorial and usage process category.

REQ 4 – decentralized jurisdiction The legal basis for government services and corresponding forms can be defined on each level of government according to its area of responsibility. In turn, each of these levels of government contains functional departments that represent business areas. For example, most social services like housing benefits are defined by the federal government in Germany but each state can adjust the legal basis and, thus, the decision criteria and the information needs. Consequently, the requirements for the design of forms are formulated in laws, as laws define the data that is necessary to deliver a service and that must be requested from and provided by the citizen (Axelsson and Ventura 2007). Assuming a three-level structure of jurisdiction, based on its laws a functional department of the federal government can suggest reference form models that are refined on the state level, and local governments can instantiate reference form models to implement forms. For instance, because of a regulation, the German federal government specifies a template for application for a business registration that is to be used in the lower levels but can be adapted. In other cases, the federal government's specifications are binding, and no modifications are allowed in subsequent levels. For example, the identity card is an output form that is structurally equal for each German citizen. The meta-model has to incorporate mechanisms that enable specifications and modifications on various levels of government and their functional departments.

REQ 5 – precise law Form designers are encouraged or, in some cases, obliged to request from the citizen only the data that is required to deliver the service and to avoid unnecessary fields and groups (Jarrett and Gaffney 2009). When laws regarding the data requirements are vague, creators of reference form models can model a form structure in various ways by reusing one of the existing modules. However, when laws are precise in their data requirements and even contain obligatory templates with specifications for the graphic arrangement of fields and groups, the data requirements have to be represented even if they contradict existing standardized modules, as the data requirements are defined by law. For example, a law that is the basis for the identity card in Germany requires a group with "given name," "surname," "birth name," and "alias," but the existing module contains only "given name" and "surname." Although the purpose should be to omit conflicting modules, the meta-model has to support a transition to harmonized laws. It must provide a mechanism that allows for appropriate representation of legally binding forms and their elements since such elements are

required but may to be used only in restricted scenarios. Since laws work as standards from a government perspective, this requirement takes into account that standardization should allow a level of flexibility (Hanseth et al. 1996) and that particular elements in practice will not change (Hanseth et al. 2006).

REQ 6 – practical applicability Reference form modelers are encouraged to reuse modules to achieve a high degree of standardization. However, a reference modeler can be forced to create a new module if no existing module exactly meets the modeler's needs, even if the difference is only marginal. Thus, the number of modules is expected to grow to a level at which reference modelers have difficulty identifying suitable modules for their reference form models. For instance, consider the legally specified form that initiates a business registration in Germany. It contains a group for the address and contact details of the "commercial unit" and a group for the same details of the "headquarters." These groups have equal structures and are semantically similar since a headquarters is a specific commercial unit. In this case, two modules must be created, even though the groups are semantically similar and have the same structure, differing only in regard to their captions. To ensure the meta-model's practical applicability, the meta-model must achieve standardization while simultaneously providing a mechanism with which to maintain control over an increasing number of modules.

4.3 Fulfillment

As the extant research has suggested (e.g., Soares and Amaral 2011; Scholl et al. 2012; Praditya et al. 2017), the challenge of designing standardized forms that allow for an efficient information exchange eventually improve service quality for form users is not solely a technical challenge. The six requirements derived and presented above support this argument, since REQ 1–3 address technical issues, while REQ 4–6 address organizational and legal issues.

Various extant modeling languages support the definition of forms as interfaces. On one hand, markup languages like XForms [currently used in various government and non-government organizations (cf., e.g., Orbeon 2019)], Extensible Forms Description Language (XFDL, used by government organizations like the United States Army), and XML Forms Data Format (XFDF, developed by Adobe for creating forms in PDF files) focus on defining forms' data structure, layout, and functionality. On the other hand, markup languages like Extensible Application Markup Language (XAML), USer Interface eXtended Markup Language (UsiXML), Web Modeling Language (WebML), and Interaction Flow Modeling Language (IFML) focus on the definition of interfaces of web-based and other types of applications and, like the form-specific languages mentioned above, cover data structures, layout, and functionality. What extant modeling languages have in common is that they predominantly address requirements REQ 1–3.

REQ 1 is fulfilled by these languages. For instance, XForms can be applied to define a field using an element named "input." The field can be addressed later on by referring to its ID, which is defined in an attribute named "ref." Fields can be grouped together in XForms using an element named "group," which can be identified based on the value stored in its "ref" attribute. Since XForms uses namespaces, elements can be reused on multiple forms.

Extant languages meet REQ 2 to a limited extent. For instance, XFDL suggests storing a form in a file named after the form's name followed by ".xfdl" as the file extension. Although existing languages are flexible and allow custom elements and attributes to be defined in a form (e.g., by applying a custom namespace and a corresponding schema), there are no predefined properties that fit the domain-specific requirements of forms' static properties in the government domain. For instance, there are no predefined elements or attributes for the purpose of a form. Moreover, existing languages are document-centric, such that a form's structure and the static properties are merged into one document.

REQ 3 is addressed by extant languages. For instance, XForms, XFDL and XFDF allow for defining actions and functions that use an electronic form to support an enhanced user experience. In particular, XFDL defines "button" as an "item" on a form that can execute the "action" named "signature," thus allowing the application of a digital signature. XFDL seeks to ensure non-repudiation of a filled-out electronic form, which is similar to signing a paper form. Moreover, IFML allows the whole business process related to a form, including "actions" and "data flows," to be defined.

To our knowledge, none of the extant languages address REQ 4-6 in the government domain to a full extent. They address these requirements only rudimentarily. Languages like XForms and XFDF might directly or based on bindings to files defined in further XML or non-XML languages support the implementation of a form according to role and policy models that correspond to a decentralized government structure (REQ 4) and with elements of its structure that correspond to precise laws (REQ 5). For example, a group of fields to represent an "address" on a form could be bound to a namespace reserved for a particular legal body or law. In the case of XForms, this example could be implemented by defining a "group" element with an attribute named "xmlns" and an attribute value that represents to what the namespace should be linked. REQ 6 is focused on practical applicability and reuse of forms and form elements. A number

of extant languages are widely adopted in form-management practice and provide modeling language constructs that allow structure, semantics, and captions of form elements to be separated. For instance, binding XML schemes would allow the structure and semantics of general form elements to be modeled and a set of attributes that can be customized for a specific form element instance to be added. Still, the set of customizable attributes has to be determined for the domain of government forms, which extant languages have not addressed.

In summary, extant languages address the stated requirements to a limited extent and provide elements that are useful in guiding software engineers on *how* to realize form models technically. Hence, extant modeling languages can be applied to transform a reference form model into a form. Once the required constructs are defined, they can be realized with existing languages. For instance, once a static property like "description" (REQ 2) and a mechanism to account for the implications of precise laws (REQ 5) are defined as concepts, they can be implemented as attributes of an element using XForms. Further, once a link to jurisdiction in regard to levels of government (REQ 4) and a set of a form's elements recognized as supporting a manageable number of modules (REQ 6) are defined as concepts, a reference modeler can define corresponding elements in XFDL and provide an XML Schema to validate reference form models.

However, it remains unclear to reference modelers *what* constructs are necessary to address the requirements that focus beyond the technical perspective of forms in government. Although applied to conceptual models like data models and process models (e.g., Hars 1994; Schütte 1998; Fettke et al. 2005; Hinkelmann et al. 2005; Ardalani et al. 2013; Scholta 2016; Rehse et al. 2017; Sonntag et al. 2017; Scholta et al. 2019b) and service models (e.g., Palmonari et al. 2008; Loutas et al. 2011; Narducci et al. 2016), the concept of reference modeling has not yet been transferred to government forms. Consequently, we advocate for a meta-model of a modeling language that would allow reference form models for the government domain to be created, which would extend related approaches that have been focused on the technical perspective. Such a reference form model can be transformed into a form using existing languages like XForms or XFDL and a suitable XML Schema.

5 The Artifact

This section presents our meta-model for a reference form modeling language to be used by governments. For each of the six requirements that were introduced, we present the part of the meta-model that addresses the requirement. The parts are modeled using the ERM notation and are consolidated in a holistic meta-model visualized in Fig. 10 (in the Online Appendix). We choose the ERM notation since we present a conceptual model and ERM has been shown to be a suitable notation for meta-modeling (e.g., Strahringer 1996; Rosemann and zur Muehlen 1998; Becker et al. 2002; Rosemann and Green 2002; Delfmann 2006; vom Brocke 2007). To annotate cardinalities, we apply the look-here convention (Ferg 1991; Song et al. 1995). The reading direction of the model parts is first from left to right and then from top to bottom.

5.1 Meta-Model Parts for Structure and Purpose

To address REQ 1 (Fig. 2), the meta-model provides two kinds of *modules* for forms: *fields* and *groups*. A reference modeler can use a module on both input and output forms since we aim at standardization across both. Thus, a module bundles input and output information that refers to the same underlying data entity. However, the attribute values may vary depending on whether a module is used for input or output. Therefore, we have attributes that apply if a form user inputs data to a module (e.g., *caption input*) or a module outputs data to the form user (e.g., *caption output*). For example, although the caption of a field can be the same on input and output forms (e.g., "Address"), a helptext on an input form (e.g., "Please enter your address") can differ from a helptext on an output form (e.g., "This group presents address information").

If required, a reference modeler can *justify* or align a module's design with *legal foundations* or other standardization initiatives, such as interoperability frameworks. Legal foundations can be structured hierarchically; that is, they can *be superordinate to* other legal foundations. For instance, the German Weapons Act "WaffG" consists of the article "§ 14 WaffG," which contains paragraph "§ 14 (4) WaffG." Modeling legal foundations in this way facilitates a rigorous maintenance regime since the responsible reference modelers of all affected entities can be informed automatically if a law changes and requires changes to modules and forms.

To depict the structure of groups and reference form models, groups and form structures *consist of* modules. We introduce the entity types *module assignment* and *module instance* and do not link module and group/form structure via a relationship type since a relationship requires a unique combination of module and group/form structure, but a module can occur in a group/form structure more than once, which requires more than one such combination. To suggest a sequence of modules in a group or form structure, a module assignment/instance can *succeed* another module assignment/instance.

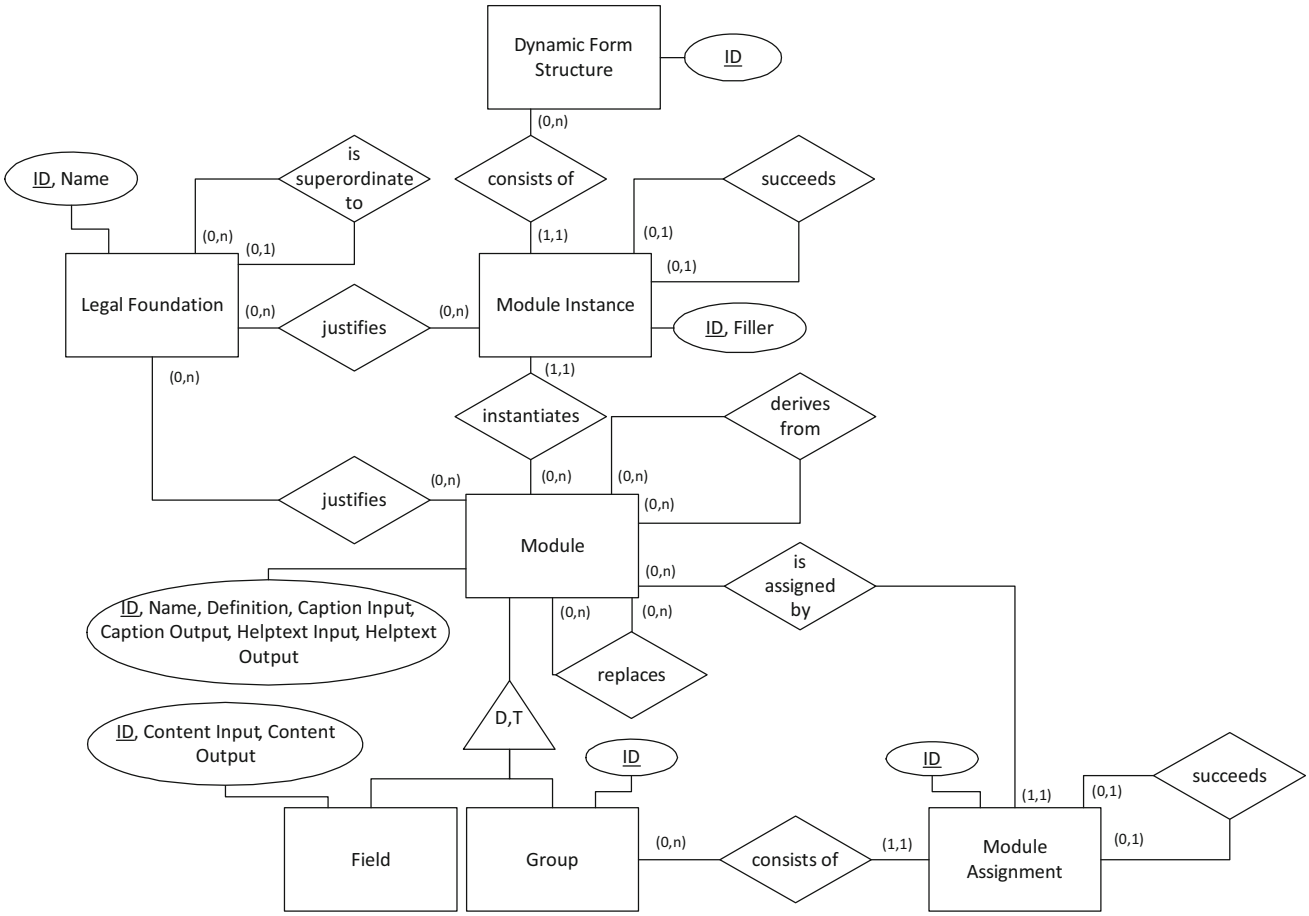

Fig. 2 Meta-model part that addresses REQ 1

A module can *replace* another module when the first module is no longer valid. Since a module can remain valid in some areas of the government, the reference modeler can decide whether to keep the old version or substitute it with the new version in a reference form model.

A module *derives from* another module to extend it or to omit some of its elements. For example, whereas an international address requires a country to be specified, this information can be omitted in a national address. This relationship type helps to illustrate what modules exist regarding a real-world entity.

To fulfill REQ 2 (Fig. 3), we introduce two constructs that constitute a reference form model: *static form properties* and *dynamic form structure*. Static form properties *describe* the structure and are comprised of *name*, *definition*, *caption*, and *helptext*. Because of the varying frequencies of change, the legal foundations may differ between the static properties and the structure, so a separate relationship type between form structure and legal foundation is required.

Forms can *have purposes*. For example, Germany's identification card, passport, and residence permit can all be used as identification documents for all services, but there are also forms whose purposes are related to specific services. Thus, forms can *serve government services* with a certain purpose. For example, a proof of need for something like a firearm-holder permit in Germany is supplementary to an input form and dedicated to a specific government service. Purposes and government services are related to the static form properties and not to the form structure since they are applicable to the form in general, regardless of its structure.

REQ 3 (Fig. 4) is addressed by the entity types *rule* and *codelist*, and the attributes *cardinality* and *data type*. For example, rules can check whether a field's value is plausible, such as whether a date of birth is that of an adult or a person's name does not contain a certain set of characters. The *content* of a rule contains information regarding the triggering conditions, the execution's logic, and the output from applying the rule. We do not aim to specify a rule formally but define it with natural language since domain

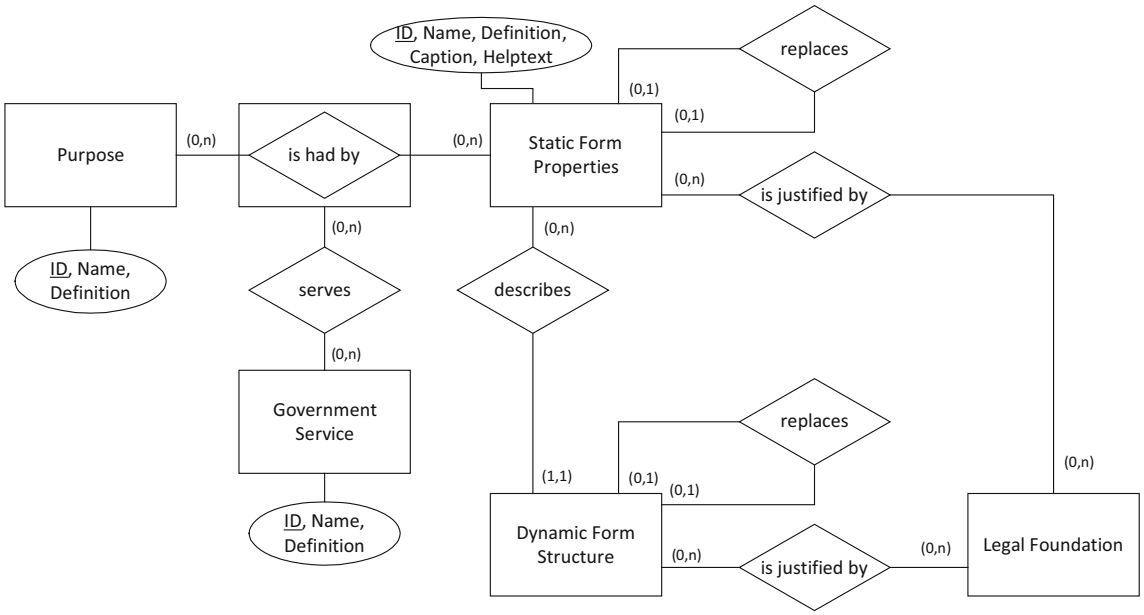

Fig. 3 Meta-model part that addresses REQ 2

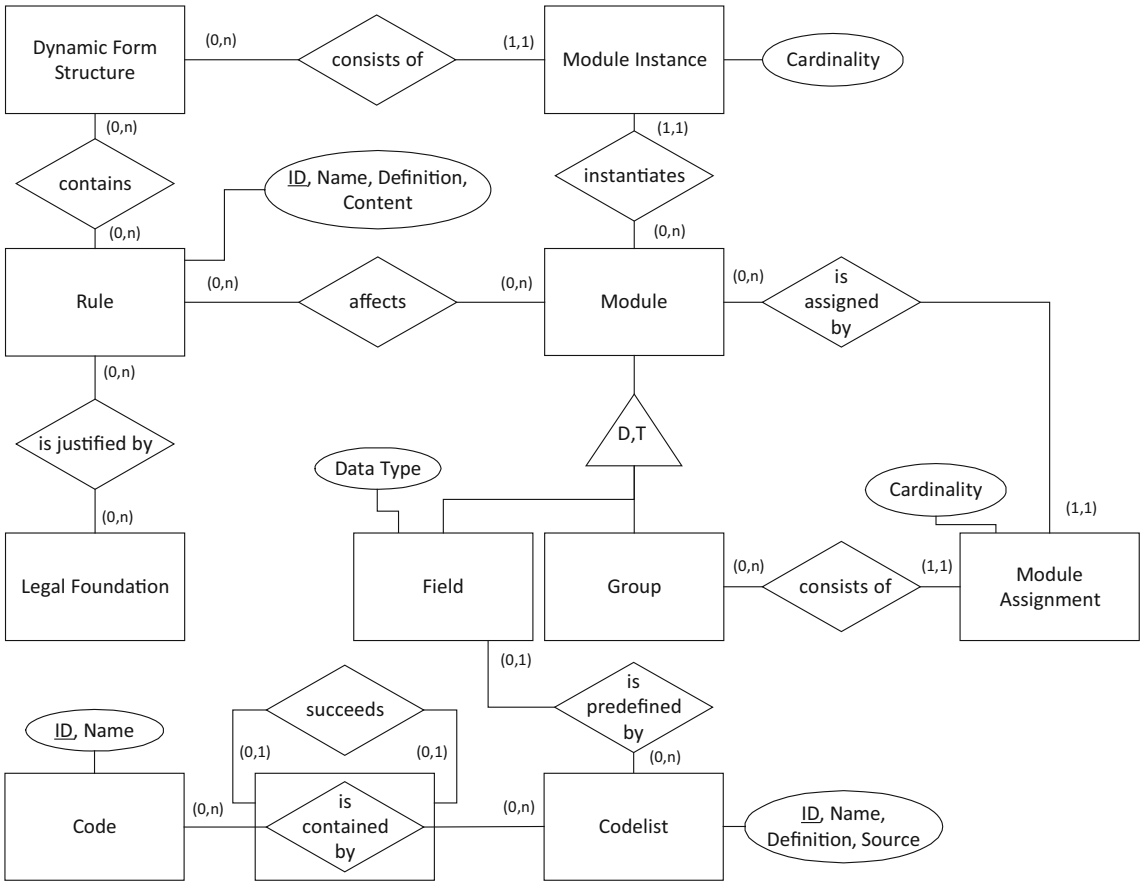

Fig. 4 Meta-model part that addresses REQ 3

experts with little implementation expertise are involved in the construction of reference form models and must be able to understand and ensure the quality of the resulting reference form models. By using data types and codelists,

electronic forms can prevent users from making entries that are in the wrong input format by restricting the entries to certain values.

A reference modeler can define lower and upper bounds for the number of instances of a module using cardinalities by assigning to a cardinality attribute typical values known from data modeling, such as "(0, 1)" or "(1, n)." For example, a module instance of a group that captures information on household members receives the cardinality "(1, n)" for a form structure if there is 1 to an unlimited number of household members. With the introduction of cardinalities, an electronic form can simplify the interaction between the user and the form by, for example, showing the exact number of modules that must be filled out or requiring at least one user input.

5.2 Meta-Model Parts for Editorial and Usage Process

Since in a government system the government can be subdivided vertically into levels and horizontally into functional departments, we structure a government such that a *level of government* (e.g., "Federal Government") *contains* several *functional departments* (e.g., "Federal Ministry of Finance") to address REQ 4 (Fig. 5). To indicate the hierarchical relationships, a level of government *is superordinate to* other levels. Since a functional department can be subdivided, it *is superordinate* to other functional departments. For example, the German Federal Ministry of Finance has divisions for the federal government's budget and financial market policy.

Since functional departments have competencies and jurisdictions in the business areas of a government, functional departments *define* modules. As in government systems, the power can be balanced among the levels; the levels of government can declare such modules relevant to their departments and reference form models so the modules become *usable* for the departments. For example, a subordinate level of government may extend the laws of a superordinate level, so an additional field is needed that does not occur in the common set of modules. Therefore, a field is created that is relevant to the subordinate level of government but is not sufficiently generic that it is aligned with the superordinate level. For instance, a module with information on a person's public transportation card, such as Queensland's *go card*, is relevant only to Queensland and is not to be used in other Australian states.

Static form properties and form structure are *defined* by governments' functional departments, which create, maintain, release, and terminate reference form models. Functional departments can *derive* static form properties and form structures from superordinate levels of government, so lower levels can copy and adapt a reference form model to their own laws and guidelines, including deletions from and insertions to the superordinate reference form model. In this way, a reference form model flows through all levels of government. A reference form model that covers the

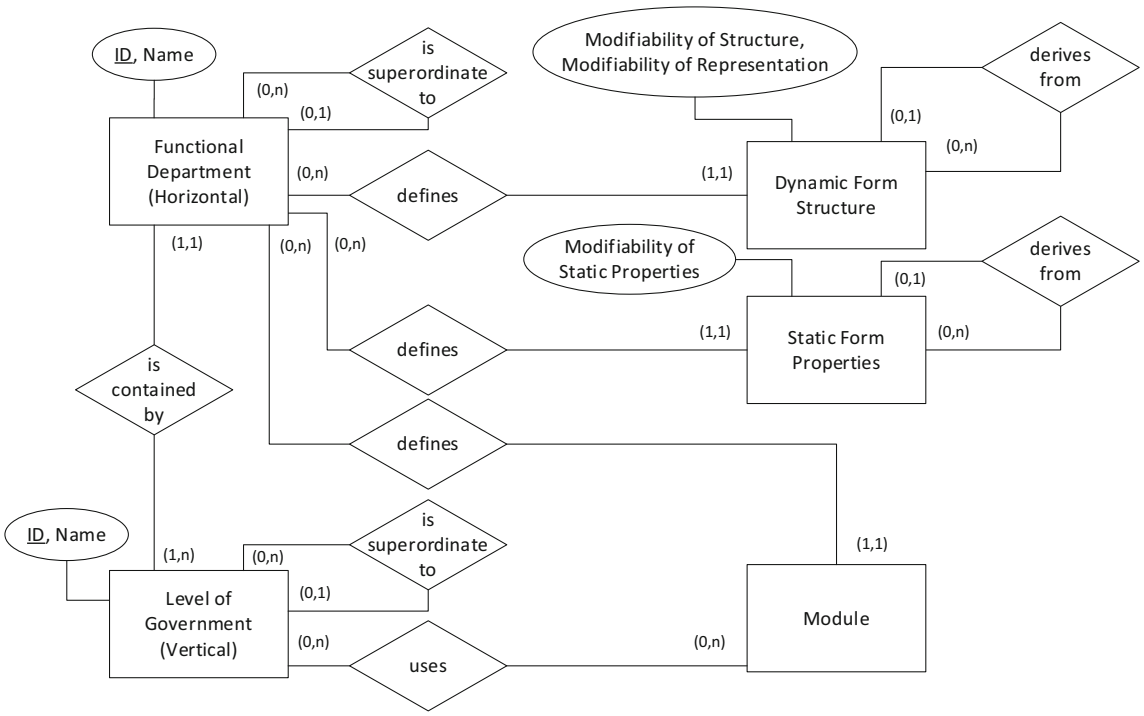

Fig. 5 Meta-model part that addresses REQ 4

regulations of all levels is provided to governmental bodies that instantiate it to forms for use in government service delivery.

Since the ability of subordinate levels of government to derive and adapt reference form models depends on laws and the distribution of jurisdictions across the levels of government, functional departments of superordinate levels can restrict subordinate levels' adaptations of their reference form models. *Modifiability of static properties* indicates the right to adapt static form properties, *modifiability of structure* provides permission to adapt a form structure, and *modifiability of representation* indicates whether the "cosmetic" aspects of a form can be modified on the module instance between a form structure and a module (REQ 6).

The modifiability attributes affect reference form models and the final forms. For example, the German federal government can specify that the structure of the reference form model for the application for housing benefits can be extended by the state level's reference form models (value "extendable" for modifiability of structure). The state level can then extend the structure and allow the local government level that uses the state level's reference form model to create a form by, for example, adding some specific information that is relevant to a municipality. However, since the form's name and purpose should be the same in all states, the static form properties remain unchanged across the levels of government (value "no" for modifiability of static properties). The law does not make mandatory specifications regarding the appearance of each field or the layout (value "yes" for modifiability of representation).

The values for the modifiability attributes are specified by the reference modeler and result from law. The modifiability attributes and their values constitute rules that determine what can be changed when one is deriving a reference form model. Whereas the values for the modifiability of static properties and representation can be "yes" or "no," the structural modifiability is on multiple levels: modifiable, extendable, restrictable, and not modifiable.

How a reference modeler uses the values depends on the scenario. For example, the "modifiable" value is assigned in cases like that of the application form for the German certificate of eligibility for public housing, where a law on the federal government level applies only if a state has not passed its own law. Another example is an output form that is given to a citizen after s/he registers at the German residents' registration office. Since the law specifies a maximum amount of data that can be presented on the form, the value is "restrictable." A reference modeler assigns the value "extendable" in cases such as the application form for the German business registration, where the law provides a template and advises – but does not oblige – governments to use it in designing their forms. However, a government cannot remove fields from this template since, according to law, the government must be able to share the data specified in the template with other organizations. Therefore, the structure can only be extended. In cases like that of the German identification card, the value "not modifiable" is applicable since it is the same for all German citizens.

To meet REQ 5 (Fig. 6), we take into account that, in the context of reference form models, some modules' possibilities for standardization are restricted. For that reason, our meta-model introduces two *module types*: standardized and non-standardized. We decided to differentiate between these two module types so reference modelers can filter the set of modules to identify the modules they can use in their scenarios. "Standardized" modules should always be used in reference form models if no legal restrictions are present, but if an existing standardized module does not meet the needs of a reference form model, a new module must be created. If the new module is prescribed by law and contradicts existing modules, and if its creator does not have standardization competence, the module's type is non-standardized. Modules of this type are used only in the restricted scenario specified by the respective law and are strictly defined in terms of their attributes and – in the case of groups – the modules they consist of.

For instance, German law proposes a template for the application form for a business registration that suggests using a single field to capture an address's street, number, zip code, city, and optionally e-mail address and homepage. Since the address usually constitutes a group subdivided into multiple fields, the template's address field is "non-standardized" whereas the address group is "standardized," although it is not usable for this template.

To fulfill REQ 6 (Fig. 7), the meta-model allows representational modifications to be made for module instances. If an existing module is semantically similar to a reference modeler's needs, then it can be reused by changing the attributes that are related to syntax on the module instance between a form structure and a module. Thus, the reuse of the existing module does not increase the number of modules since no new module must be created to make representational modifications.

We divide a module's attributes into two subsets, the first of which consists of syntax-related attributes applied

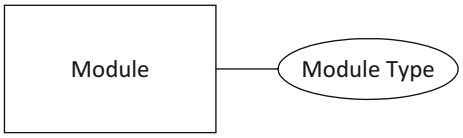

Fig. 6 Meta-model part that addresses REQ 5

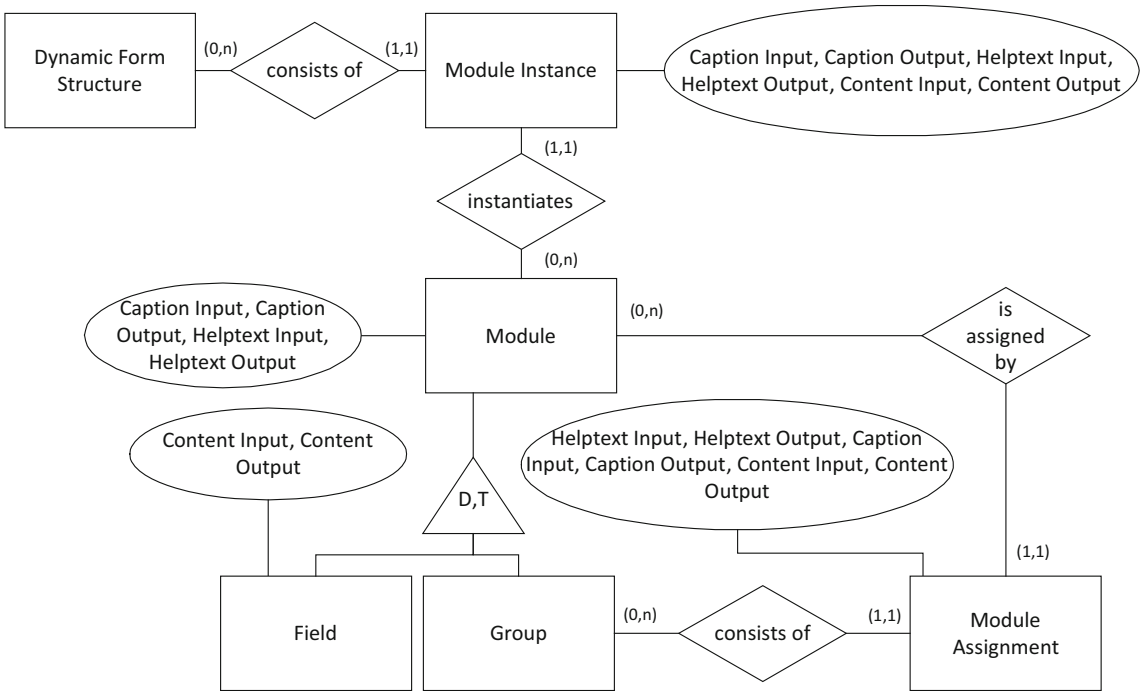

Fig. 7 Meta-model part that addresses REQ 6

in the representation of a module: *captions*, *helptexts*, and *contents*. Equivalent attributes are also assigned to a module instance, so their values that are specified for the module in general can be overridden and specialized on the module instance between a form structure and a module. Therefore, if these attributes must be changed, the need to create a new module can be avoided. Since fields and groups can belong to groups and so can be indirectly allocated to reference form models, representational attributes can also be overridden on a module assignment. The second subset comprises all other attributes that define a module's semantics, such as name and definition. Since a module should have a clear meaning, the values of these attributes are specified only in general and remain the same for all occurrences of the module. If these attributes must be changed, a reference modeler should create a new module since the semantics differ from those of existing modules.

In the example of the business registration in Germany that contains a structurally equal and semantically similar "commercial unit" group and "headquarters" group, instead of defining two structurally identical groups with different captions, we can override the caption on the module instance to create only one group. In contrast, two groups, "Birth" and "Death," both include the fields "Date" and "Place" and so have the same structure, but their definitions differ substantially. Therefore, a reference modeler has to keep them as separate modules and cannot consolidate them into a single module with different captions on module instances.

6 Demonstration

Here we provide an instantiation of our meta-model by designing a reference form model for the application for a firearm-holder permit for sports shooters in Germany (application for "WBK gelb"). The firearm-holder permit enables sports shooters to acquire certain firearms and the according munitions. The German states assign responsibility for the service's delivery differently: For example, in Saxony municipalities or district administrations deliver the service to citizens, whereas in Berlin the state criminal police office provides the service (Saxon State Ministry of the Interior 2018; The Police President in Berlin 2018).

Figure 8 presents the static form properties. If an attribute is not listed for an entity, then the attribute has a null value. The reference form model is related to the government service that issues the "WBK gelb," and its purpose is to serve as an application form for this government service. The functional department "Department KM5" (ID: FD000116) of the responsible ministry at the level "Federal Government" (ID: FL000001) defines the form properties and form structure of the reference form model and provides the model to the subordinate levels of government, such as "Bavaria" (ID: FL000005) on the state level and "Nuremberg" (ID: FL000118) on the local

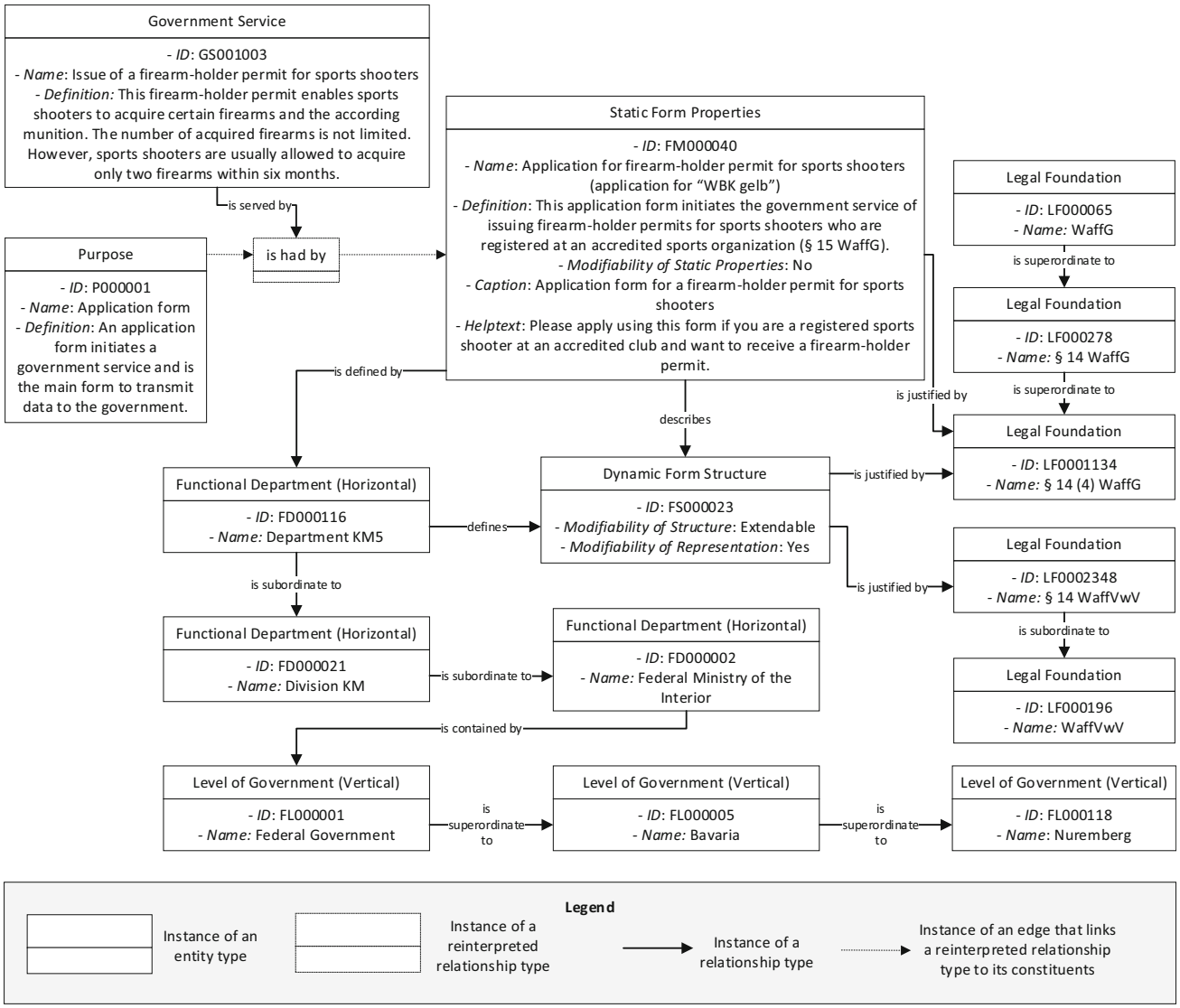

Fig. 8 Static form properties of the application for "WBK gelb"

government level. The static form properties are justified by the legal foundation "§ 14 (4) WaffG" (ID: LF0001134). We modeled the structure of legal foundations using a high level of detail. Depending on the purpose of the modeling, the reference modeler can apply a lower level of detail and, for example, relate LF0001134 directly to LF000065.

The static form properties are defined as not modifiable, so government bodies at subordinate levels cannot change them. However, the structure of the reference form model can be extended, and its representation can be modified (Fig. 8, attributes modifiability of structure and modifiability of representation), as the legal foundation defines what information must be requested from a citizen so her or his request can be processed, but it does not define how the information must be presented on a form. For instance, the structure contains the minimum required information as defined in federal government law, but at the state level additional fields might be required because of differences in firearm ledgers.

The entire form structure of the application for "WBK gelb" consists of 202 module instances, an excerpt of which is depicted in Fig. 9. The group "Firearm" (ID: G000049) occurs twice in the form structure, first to request information required for the firearm acquisition and then to describe a firearm that the applicant already owns. Since our meta-model seeks to minimize the number of modules, it allows the various purposes of the group to be distinguished based on the attribute caption input. While the caption input that is defined for the group in general ("Firearm") is overwritten on the module assignment between G000001 and G000049 ("Firearm for

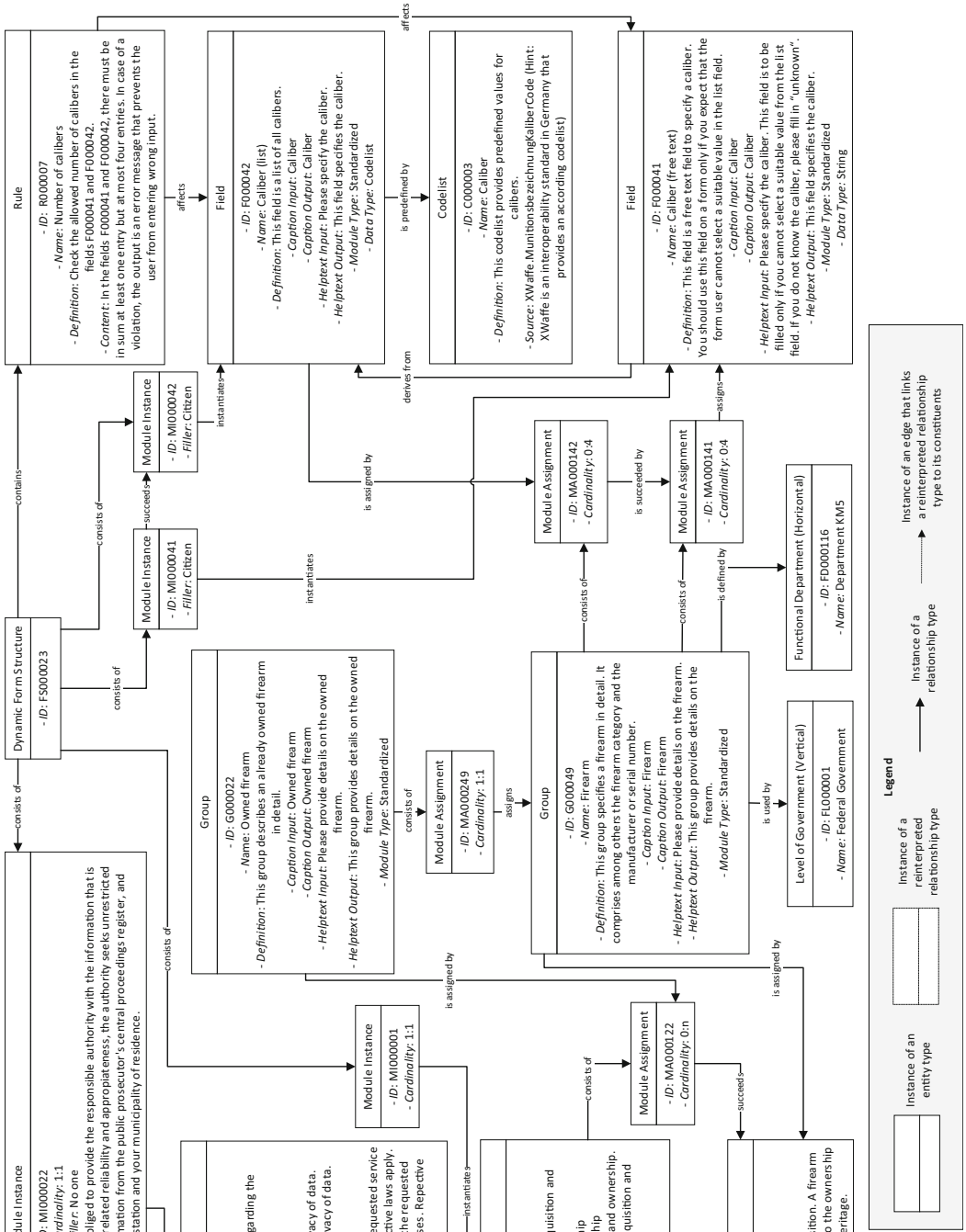

Fig. 9 Excerpt of the dynamic form structure of the application for "WBK gelb"

acquisition"), it is valid for G000049 in G000022 since a value is not defined for caption input in the module assignment. The cardinalities of the group G000049 also differ, as there may not be a new firearm to be registered if the form is used only to register a firearm the applicant already owns (cardinality 0:n in G000001), and because if a firearm is already owned, its information has to be provided exactly once (cardinality 1:1 in G000022). The group G000049 has the module type "standardized" since it is defined in accordance with the German Weapons Act "WaffG" and the responsible ministry has the jurisdiction to prescribe the representation of firearms on forms. Within the responsible "Federal Ministry of the Interior" (ID: FD000002), the "Department KM5" is dedicated to firearms, so this functional department defines module G000049. To allow "Department KM5" to build form structures with the module, G000049 can be used on the "Federal Government" level.

The field "Data privacy hint" (ID: F000022) exemplifies the application of the attribute content output on a module instance. Since the hint is specific to each reference form model, the data privacy field's content must be adapted on the module instance, so the content is set to a value based on the requirements of the reference form model to which it relates.

Another notable detail is a firearm's caliber. One of the fields – field "Caliber (list)" (ID: F000042), which can be filled out up to four times, as described by its cardinality "0:4" according to corresponding law – provides a list of known calibers that is modeled using a codelist assigned to the field. The codelist (ID: C000003) refers to an external source and is managed externally, so we do not list its codes. If the firearm the citizen wishes to register is of a caliber that has not been included in the codelist, he or she can add a free-text description of the caliber (ID: F000041). Since the numbers of entries in both caliber fields will be added, a rule (ID: R000007) requires between one and four entries. As the free-text field is an extension of the list field, F000041 derives from F000042.

7 Evaluation

We evaluated our artifact in all three DSRM cycles (cf. Table 1), guided by the criteria *efficacy* (are the requirements adequately fulfilled?), *completeness* (are there other requirements to be addressed?) and *effectiveness* (is the solution valuable for practice?). We evaluated *effectiveness* only in the third cycle since it was there that we had achieved a stable version of the meta-model that addressed all requirements satisfactorily.

In the first cycle, we discussed the meta-model in the course of the two focus groups to evaluate its *efficacy*. For this purpose, we developed an initial draft of our meta-model that addressed REQ 1, REQ 2, REQ 3, and REQ 4, as these requirements emerged from the focus groups. It was important to the focus group with experts from the business perspective that we address the decentralized and leveled structure of the German government system, so we emphasized REQ 4. The members of this group were used to consider the various levels of government and distributed responsibilities. In the version of the meta-model

Table 1 Overview of the evaluation results

DSRM cycle I	DSRM cycle II	DSRM cycle III
Efficacy		
REQ 1: Sequence of modules should be specifiable	REQ 1: 135 of 324 fields and 86 of 187 groups were reused	REQ 5: Various models with adequate differentiation between "standardized" and "non-standardized" modules
REQ 2: Developed design was suitable	REQ 2: 36 appropriate models with form properties and structures	REQ 6: For example, the field "Data privacy hint" consolidated 12 privacy statements
REQ 3: Data type, codelist, and cardinality should be added	REQ 3: Models with 1 to 23 rules, 11 simple data types, and 29 codelists	
REQ 4: Meta-model should allow for generic government structures	REQ 4: Suitable representation of relevant parts of the German federal structure	
Completeness		
The set REQ 1-4 seemed to be complete	REQ 5-6 emerged	Results indicated the completeness of REQ 1-6
Effectiveness		
–	–	Reducing a form's size from 778 to 189 fields
		Instantiation of a reference form model to a form
		Use of the meta-model's constructs by practitioners in the ministries

at that time, we modeled the federal government level and state level as relevant levels of government. The focus group members emphasized that the meta-model would be beneficial only if it also incorporated the local government level and allowed for a generic representation of a government structure with no statically predefined levels.

The focus group with experts from the technical perspective gave priority to REQ 1, REQ 2, and REQ 3. REQ 2 was especially important to this focus group, who praised our realization of the separation between static form properties and dynamic form structure. An intense discussion around REQ 1 on whether the meta-model should allow for a specification of the sequence of modules found some experts opposed to specifying the sequence of modules since it is barely legally defined. Others, however, were in favor of it since the form standardization is useful only if the order of modules is also standardized. Therefore, we incorporated optional "succeeds" relationship types into the meta-model that can, but do not have to be, specified in a model. All experts were convinced by the modular representation of a form. To address REQ 3, the meta-model at that time depicted the enhanced functionality of electronic forms by rules, but the experts promoted a more precise representation with data type, codelist, and cardinality.

As a result, we evaluated the solutions for REQ 1–4 in this DSRM cycle and used the focus groups' feedback to refine the solution in the next cycle. In contrast, the results did not require an update of the requirements in the next cycle, suggesting their *completeness*.

In the second and third cycles, we applied our meta-model to three case studies in Germany. The cases were set in the German government system, which consists three levels of government. The federal and state governments can pass laws, although in most cases, a general law is defined on the federal government level and handed over to the state level, where it is refined and tailored to the states' individual specifics and then forwarded to the local government level where a service is executed based on the law. The German legal system follows civil law instead of common law. Various councils and institutions work to align the legal regulations and policies between the states and the federal government. For example, the IT Planning Council consists of federal and state CIOs to reconcile e-government strategies and pass IT standards, and the interior ministers attend the regular Conferences of Interior Ministers for political exchange and cooperation. It was in this cooperative and interwoven setting that we performed our three case studies. For all of these cases, the federal government specifies the base law, whereas the states are responsible for its execution but forward the practicalities of this execution to local governments. This distribution of jurisdictions requires that some reference models be in place, especially on the federal government level, to support the form design on the local government level.

The results of the second cycle's evaluation with the first two case studies were twofold: First, the application to the cases revealed the *efficacy* of our meta-model's realization of the structural requirements REQ 1, REQ 2, and REQ 3 and the process requirement REQ 4. Fields and groups were suitable mechanisms with which to build a reference form model's structure and to support the forms' modularity (REQ 1). After the second cycle, the tool contained 324 fields and 187 groups, among which 135 fields and 86 groups appeared more than once in a form structure and were reused in other reference form models. Reference form models contained between 14 and 76 fields and between 2 and 47 groups. We were able to separate the forms' static properties from their structures adequately (REQ 2). The tool contained 36 reference form models that were described by both static form properties and form structures. The constructs of rule, code, codelist, cardinality, and data type captured the specifics of electronic forms (REQ 3). Reference form models had between 1 and 23 rules. In total, we used 11 simple data types and 29 codelists. We represented the relevant parts of the German federal structure and indicated the reference form models' degree of commitment through the modifiability attributes (REQ 4).

The second result of the second DSRM cycle regarded the requirements' *completeness*. In contrast to the structure-related requirements, process-related requirements had rarely been regarded, as indicated by a rapidly increasing number of modules. Despite the high reusability of some modules, 121 modules were case-specific and not useable for other scenarios, so we were confronted with many semantically similar modules and groups with only slight structural differences. For instance, twenty groups represented an address, seven of which differed in only one or even no fields. We also had privacy information for each application form that differed only in the content. These issues occurred because of laws that contradicted existing standardized modules (REQ 5) and because of structurally identical groups whose representational attribute values differed (REQ 6).

The third DSRM cycle indicated the *efficacy* and appropriateness of the meta-model's constructs. All constructs were used and tested. The new concepts that were established in the third cycle had positive effects on the issues identified in the second cycle's evaluation. Defining modules as "non-standardized" helped us to separate modules that would not be applicable to various reference form models (REQ 5). For instance, all six of the output reference form models for firearm-holder permits and all three input reference form models for business registries contained "non-standardized" modules. Adapting

representational attributes on the module instance between a module and a reference form model helped us to reduce the number of modules (REQ 6). Two modules exemplify the suitability of the mechanism we introduced. First, four fields that defined the texts that summarize the permissions for firearm holders were consolidated in one field, which was applied in four output reference form models with semantics unchanged but with different values for caption output and content output. Second, the field "Data privacy hint" consolidated twelve privacy statements and was applied in twelve reference form models with the same semantics but varying content outputs on the module instance. The feedback from the ministries and practitioners confirmed the appropriateness of our solution and the reference form models we created, so no adaptions to the meta-model were necessary after the third cycle's evaluation. The results of the third cycle did not lead to additional requirements, indicating the requirements' *completeness*.

The *effectiveness* of our meta-model for harmonization initiatives is underpinned by two results. First, in the housing benefits case, we were able to reduce the number of fields substantially. We compared the current application forms of Germany's sixteen states' capitols by mapping equal fields of the various forms to reveal commonalities and differences. Our analysis indicated that the forms contained 778 different fields. Unfortunately, the differences were manifold – different captions, helptexts, structures, or contents – and were not rooted in requirements by law or jurisdiction, which practitioners suggested as one reason for citizens' perception of forms' complexity. After creating a reference form model, we were able to implement all requirements using only 189 fields. A form that instantiates our reference form model reduces the complexity for citizens because less information is requested. Second, to indicate the feasibility of a reference form model's instantiation for creating a new form, we derived one exemplary form from our reference form model for the application for "WBK gelb." This instantiation shows that suitable forms can be derived from reference form models that are depicted with our meta-model's constructs.

8 Discussion

This article supports the management of forms' complexity by means of three major contributions to research. First, it provides requirements for a meta-model for a reference form modeling language in governments. Researchers can transfer these requirements, which cover the specifics of reference models, to other perspectives and artifacts in governments, such as process models, service descriptions for citizens, and organigrams. While the extant research has addressed the requirements of the structure and the purpose of a form–how to design a form from a technical perspective–and technical tools exist in practice, our work presents a first structured approach to summarizing these requirements (REQ 1–3). Moreover, we address a research gap related to insights into what constructs are necessary to model government forms beyond the technical perspective. We address this gap by defining requirements for the editorial and usage process (REQ 4–6) that refer to reference modeling in governments, and their transfer to other perspectives allows governmental institutions to be comprehensively harmonized.

Second, this article presents a meta-model that meets these requirements (cf. Table 2). It proposes mechanisms which are able to account for the effects of laws that constitute a government service, the separation of governments into horizontal and vertical jurisdictions, and the number of elements to be managed on standardization initiatives, and ultimately the management of the quality of service content (customizing, upgrading, accepting) and service delivery (interactivity, interoperability, adaptability) in government. The meta-model can be used for a new reference form modeling language and it, or parts of it, can be applied to extend existing languages. Since reference models can constitute theoretical contributions on their own (Schütte and Becker 1998; vom Brocke 2003), researchers can use our meta-model as the basis for developing and representing reference form models. When interoperability frameworks are absent, researchers can develop such frameworks based on the reference form models.

Third, this article suggests the application of reference modeling to addresses major challenges of inefficient domain-expertise-focused form design from the government perspective and insufficient form comprehensibility from the citizen perspective. In particular, reference models can constitute standards that should be followed in governments, as they "establish and record a limited set of solutions" (de Vries 1999, p 155) toward harmonization between laws and the data required in government services, and they represent a level of abstraction – compared to forms – that still allows for modifications and corresponds to the flexibility of standards (Hanseth et al. 1996). Governments benefit from this standardization through reduced design effort, and citizens obtain harmonized and more recognizable forms. A reference modeler can use modules to model a form's security and safety aspects, such those for as a signature field. For example, to specify whether and how verification of an identity is to be performed, a reference modeler could create a group "Verification of identity" that consists of two fields, "In person" or "Electronic," where only one of the two fields has to be filled out.

Table 2 Meta-model fit to requirements

Requirement	Fit
REQ 1 – Modular structure	The meta-model provides two kinds of modules: fields and groups. Fields can be used to enter data, whereas groups combine related fields or other groups. These constructs address the quality of service delivery since interoperability challenges between the government departments involved can be addressed efficiently by forms that have a modular structure. (For example, modules regarding personal information could be reused across services, and modules regarding a specific service could be reused at other levels of government)
REQ 2 – Static properties	In our meta-model, the form structure consists of modules, and static form properties are comprised of attributes like a form's name and purpose
REQ 3 – Electronic form	Rules, codelists, cardinalities, and data types are ways to account for electronic forms' enhanced functionalities. Rules can trigger automatic actions based on the relations between modules, data types and codelists restrict field entries to certain values, and cardinalities manage how many occurrences can be provided or are required per module. These constructs address the quality of service content and service delivery, as content is addressed in terms of improved customization and acceptance (e.g., rules for calculating the expected payment), and delivery is addressed in terms of interactivity and interoperability (e.g., reuse of rules and codelists between government departments)
REQ 4 – Decentralized jurisdiction	The meta-model provides constructs for a representation of government structures (level of government, functional department) and offers mechanisms with which to manage reference form models across levels of government (modifiability of static properties, structure, and representation). These constructs address the quality of service content and service delivery since government departments seek to customize content efficiently (e.g., customizing a form according to local circumstances at the local government level based on a reference form model at the state level) and to support the interoperability and adaptability of this content effectively during service delivery (e.g., reusing a group created by a functional department at the federal government level and extending it with additional fields derived from a state law)
REQ 5 – Precise law	Our meta-model distinguishes between "non-standardized" modules that are required by laws and "standardized" modules for a real-world entity. These constructs address the quality of service content since the differentiation between the two types of modules allows content to be updated with minimal impact to the users' experience. (For example, a government department's "non-standardized" module does not have a cascading effect on other services and forms)
REQ 6 – Practical applicability	The meta-model allows representational modifications (e.g., captions and contents) to be made to the module instances and module assignments between modules and forms/groups to limit the number of modules and keep them manageable. These constructs address the quality of service content and service delivery since they impact the upgrading of content and adaptions to delivery (e.g., changing a data privacy hint for an application that the citizen applies for at state level based on a reference form model designed at the federal government level)

The meta-model can be transferred to standardize forms in sectors like the health sector, but also in retail and industry to an extent. Companies can also use electronic forms (REQ 3) with modular structures (REQ 1). Further, separation between static form properties and dynamic form structure might be appropriate (REQ 2). However, the editorial and usage processes differ between companies and governments, as companies align their product portfolios to market demands, while the law defines governments' service portfolios (Lee and Hong 2002; Becker et al. 2012). Therefore, precise laws are not relevant to the standardization of forms in other sectors (REQ 5). In addition, whereas governments rely on constitutionally defined organizational structures with clearly assigned responsibilities, private companies can decide on their organization structure themselves (Zwicker et al. 2010). Therefore, leveled and decentralized jurisdictions have a limited impact on the standardization of forms in other sectors (REQ 4). In contrast, companies may need to pay attention to the number of modules to ensure practical applicability if they offer services like governments do and have a high number of forms like insurance companies and banks do (REQ 6).

Our research also has implications for practice. First, our meta-model enables governments to develop reference form models in cooperation across horizontal and vertical jurisdictions. Form designers can use the developed reference form models as a basis for the construction and implementation of government forms, especially when the number of laws, corresponding forms, and/or levels of government is high. Exemplary applications include approaches like that of eForms, which focuses on the standardization of procurement notices in the EU; eSENS, a pan-European project to strengthen the EU digital single market and facilitate public services across borders; and the GSA Forms Library provided by the US General Services Administration. To apply our artifact in practice, form designers who use form models in structured formats like XML can easily translate their domain-specific information based on reference form models to support reuse and more efficient form management. If reference form models are provided when a law is passed, then they constitute an

operationalization of the law in regard to forms and provide legal certainty regarding the interpretation of the law.

Second, the use of our meta-model in practice can also reveal potential for improvements in laws, such as the elimination of "non-standardized" modules and the missing alignment with interoperability frameworks for data exchange between government bodies. It can encourage the legislature to formulate laws in such a way that they request the minimum set of data from citizens.

Third, software vendors can apply the reference form models created with the constructs introduced in our meta-model to design information systems and their interfaces, which government bodies use to make decisions and to deliver services to citizens. For instance, reference form models can be transformed into forms using languages and technologies that are already common in practice: the validation of a form with predefined rules can be based on XForms or any other XML-based (non-)proprietary format, combined with XML Schema. The form's layout can be realized using a stylesheet transformation, and non-repudiation of a form modeled as a signature module in the reference form model can be implemented based on XFDL. Such efforts will reduce customization efforts since, even in the default configuration, the systems' data structures will be similar to the data attributes in practice. Ultimately, as harmonization of government service provision increases (e.g., the Single Digital Gateway in the EU), reference form models will be the basis for user-focused services that require the exchange of information across organizational and national borders.

9 Conclusion and Outlook

The quality of government service content and delivery depends on forms, since forms are central interfaces for information exchanges between the government and its citizens. Unfortunately, both citizens and governments are challenged with forms' complexity: the latter struggle to manage forms because of vertical and horizontal jurisdictions, and the former struggle with understanding and using forms when they apply for a service. To counter this complexity, we propose a standardized-forms approach based on reference modeling that benefits both citizens and governments. In particular, we present the design of a meta-model for a reference form modeling language in governments. In the course of our research, we applied the DSRM and derived six requirements for our meta-model. For each of these requirements, we introduced constructs, demonstrated their functionalities with an example from practice, and described the artifact evaluation along three DSRM cycles. Finally, we discussed the implications of our research for academia and practice.

Our research has some limitations that lead to suggestions for future work. First, we address complexity only from a standardization perspective and do not deal with the graphical layout of forms. Future research can, for example, address forms' complexity by substituting forms with chatbots that assist citizens in applying for a government service (Rubel 2017), as chatbots enable interactions that are more intuitive and dynamic than forms (Buyle et al. 2018; Androutsopoulou et al. 2019). The complexity of forms is also inherited from laws, so as long as laws remain complex, forms will be complex as well since they are an implementation of laws. Future research should focus on finding ways to formulate simpler laws or – from an information systems perspective – to transfer laws automatically or semi-automatically into operationalizations like processes and forms.

Second, using our meta-model in practice requires that it be extended by a concrete syntax to cover the representational aspect of a modeling language. When implementing our meta-model, software vendors should pay attention to mechanisms that allow for a high degree of usability. For instance, templates can be created for similar reference form models so that models can be devised easily. Knowledge structures, such as taxonomies, can be established to organize reference form models and modules. Structural comparisons of groups that refer to the same real-world entity allow modelers to select the most appropriate group for their scenarios. If desired, implementations of our meta-model could allow guidelines to be attached to reference form models that explain how to process and analyze the data that is submitted through forms.

Third, we evaluated our meta-model in three case studies in Germany, but the German government's law and regulation system's differences from those of states like the US, France, and the United Kingdom pose a limitation to the requirements derived and to the development and evaluation of our research artifact. Still, the meta-model is constructed to be beneficial in a general context, independent of a government structure, so it should be applicable to other government settings and their laws and regulations. Upcoming studies should transfer and evaluate the meta-model in other countries to demonstrate its general suitability.

The complexity of governmental forms is an important issue. We suggest the concept of reference modeling to address this complexity through standardization. Our meta-model is the first meta-model for a reference form modeling language in governments that addresses the complexity related to domain-expert design and service-focused use of forms. The results from the demonstration and evaluation of the meta-model suggest that our solution is appropriate, and its practical usefulness is indicated by

the German federal and state governments' decision to implement the meta-model in Germany's governmental practice.

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