Model-based governance of digitalisation in a public administration in Luxembourg: an experience report

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Abstract. *Although public administrations do not share the same goals with the private sector, digital transformation is also key to their evolution. Like other European states, Luxembourg is, as of recently, framing digital transformation of its administration through a national digital governance strategy. This paper reports on the development and operation of a customized EA framework to govern the digitalisation of a divisionally structured public administration. The results of the reported modelling project are discussed from the perspective of Return on Modelling Effort concept, sharing insights into main decisions taken in this context. We underline the value generated by domain-specific information structuring. A domain-specific model of regulatory policy was designed to adapt and specialise both the viewpoints and generic concepts of architecture modelling language, but also exploited to present and communicate information to multiple stakeholders involved. Most importantly, using a domain-specific EA framework has unexpectedly led to breaking the business silos, providing a platform for sharing business practices and facilitating answers to key managerial operational questions. Reflecting on our experience, we suggest dimensions for further elaboration of the concept of Return on Modelling Effort.*

Keywords. Public administration • Regulatory Delivery • Governance of digital transformation • Enterprise modelling • Return on Modelling Effort

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1 Introduction

In the private sector, digital transformation may be vital in preserving markets or for enabling innovation in a highly competitive economic world. Digital transformation within public administration has slightly different drivers: it is mainly concerned with the modernisation of public services, administrative simplification of interactions with public service beneficiaries, as well as increased transparency (Janssen and Hjort-Madsen 2007).

In the context of digital transformation of businesses, the discipline of enterprise architecture (EA) is recognised for its potential to support informed governance (Greefhorst and Proper 2011; Harmsen et al. 2009; Op't Land et al. 2008; Proper 2021). EA focuses on essential requirements for the design of an enterprise, and is intended to support decision-making typically by models which enable coherent high-level view of enterprise in its many facets. To this end, different architecture frameworks, modelling techniques and tools are developed and used in practice with varying degrees of success (Frank 2014; Sandkuhl et al. 2018). The development of technological support is typically steered towards the standardisation of modelling techniques and frameworks with the aim to improve the efficiency of modelling and facilitate wider use of models.

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While using models to help manage complex phenomena such as enterprises is indisputable, creating a 'good' model remains an art to be better understood. Without this understanding, modelling technologies, languages and standards are also less likely to effectively support modelling (Bjeković 2018; Bjeković et al. 2014; Proper and Guizzardi 2020). More often than not, the effort required to produce models is perceived as unjustified, modelling technologies hamper effective use and wider adoption of models, while it is also not rare for analysts to drift off to analytic peculiarities and lose sight of model objectives.

While it is obvious that trade-offs regarding costs and benefits of models need to be made in model creation, its factors are rarely explicitly considered in practice, or well understood in theoretical work. To explicitly discuss the alignment of modelling effort with its intended return, the concept of Return on Modelling Effort (RoME) is forwarded in (Proper and Guizzardi 2022). This ongoing work aims to provide theoretical understanding of factors involved in trade-offs in model creation, and to ultimately offer some practical guidance to this end.

This paper aims to contribute to the discussion on RoME with the reflection on our direct practical experience. We report and reflect on the creation and use of models in a stream of activities aimed at establishing EA methodological and technological support for steering digital transformation of a public administration in Luxembourg. Having in mind the concept of RoME, we will reflect on the exercise and strategies adopted to cost-effectively use available resources, maximise the value of models created, and offer our insights to this end.

The paper is organised as follows. Sect. 2 situates the project of in its wider organisational and political context, discussing public administration in question, the national strategy of digital administration, as well as other organisational factors pertaining to the project of modelling we report on. Sect. 3 discusses the details of the modelling project, while Sect. 4 expresses the results. Sect. 5 reflects on the materialised RoME of models created, and on the possibilities for its improvement. Prior to concluding the paper, we suggest some dimensions of rethinking the very concept of RoME.

2 Context

To situate properly the experience we report on, we will first present the organisational context of the luxembourgish public administration (Sect. 2.1) and its digitalisation challenges (Sect. 2.2). The approach to model-based governance in such an organisational context is discussed in sect. 2.3, addressing also the choice of methodological and technological support.

2.1 Department of Mobility and Transport

The Department of Mobility and Transport (DMT) is part of the Ministry of Mobility and Public Works of Luxembourg. It is in charge of the design of public policies for regulating transport of goods and passengers, as well as of the elaboration of the national mobility strategy. Besides being a regulatory policy maker, DMT also acts as a regulatory agency and is responsible of operationally achieving the intended outcomes of regulation. DMT's responsibilities cover the complete regulatory policy cycle (OECD 2017), from policy strategy to policy design and regulatory delivery, regardless of the transport mode (road, rail, air and inland navigation). DMT therefore deploys business operations concerned with the delivery of licences (access to transport markets), technical certificates (technical prescriptions of means of transport), professional certificates (qualification of transport operators), and any other regulatory instrument introduced to regulate transport.

DMT is organised according to the divisional (or product) structure model: each division of the structure manages its own regulatory products, from the regulatory policy design to the regulatory delivery processes. The products of the divisions are aligned on transport modes, as represented in Fig. 1. Such an organisational structure allows each mode of transport to be managed quite independently of each other. It does make perfect sense as the legal instruments (international, European and national laws and regulations) are developed by mode of transport. The international standardisation and collaboration institutions in transport are also concerned by specific mode. Although the divisional structure model seems pretty well adapted to the wide competence area of the DMT, there is a risk of siloed mentality, especially when it comes to the transformation of the divisions. A specific division (General transport policy) however acts as the coordinator of work and the controller of resource allocation. The use of the term "regulatory delivery" rather than "regulatory implementation" acknowledges that the relationship between regulatory authorities and regulated entities is moving away from "sanctions-oriented" inspections and enforcement (OECD 2021). It typically focuses inspections and enforcement on the regulated entities presenting the highest risk. Although each transport mode has its own business actors and rules, there is a need for common frameworks, processes and tools to support regulatory delivery across the business lines. The divisional organisation however does not help to identify them. The transformation to smarter regulatory delivery requires to enable the design and sharing of best practices and tools across the DMT.

2.2 Digitalisation of public administrations in Luxembourg

The strategic commitment to digital transformation of public services in Luxembourg is quite recent. Before the creation of Ministry for Digitalisation, in December 2018, the effort towards digitalisation was focused on operating technological platforms and products (e. g. public services one-stop-shop[1]), without real guidance on digital transformation. The strategy of digital governance adopted in 2020 indicates a strategic shift, as it consolidates different initiatives into a national strategy aiming at *more efficient, user-centric and 100 percent digital public administration*(Ministy for Digitalisation 2024). Its implementation affects all ministries and administrations of the State in a cross-divisional manner.

[1] www.guichet.lu

The national strategy identifies six principal pillars of digitalisation (so-called *digitalisation principles*), as well as more concrete recommendations for each of the following:

- Digital-by-default
- Once-only
- Inclusion and accessibility
- Openness and transparency
- Reliability and security
- Interoperability and standardisation

For instance, the *once-only* pillar underlines the consistent reuse of data already requested once from a citizen or a business in order to offer straightforward, efficient procedures. The recommendations to its achievement include implementing appropriate technological solutions for data sharing across administrations (such as base registries), but also the revision and potential redesign of relevant legal framework, to provide the legal basis for data sharing and comply with personal data protection regulations. It is important to underline that these recommendations do not solely have technological impact, *but also* affect business capabilities and inter-administrative collaboration practices. In other words, the scope and complexity of expected change in public administrations is not restricted to introducing more IT, but is associated with (digital) enterprise transformation.

The national strategy for digital government also reinforces the position of the Government IT Center (Centre des Technologies de l'Information de l'Etat - CTIE) as the main provider of technological infrastructure and solutions. Besides the operation of one-stop shop for administrative procedures and other public services, CTIE is in charge of providing standardised technological platforms dedicated to digitalisation of ministries and administrations, and of guaranteeing a transversal digitalisation of public administrations.

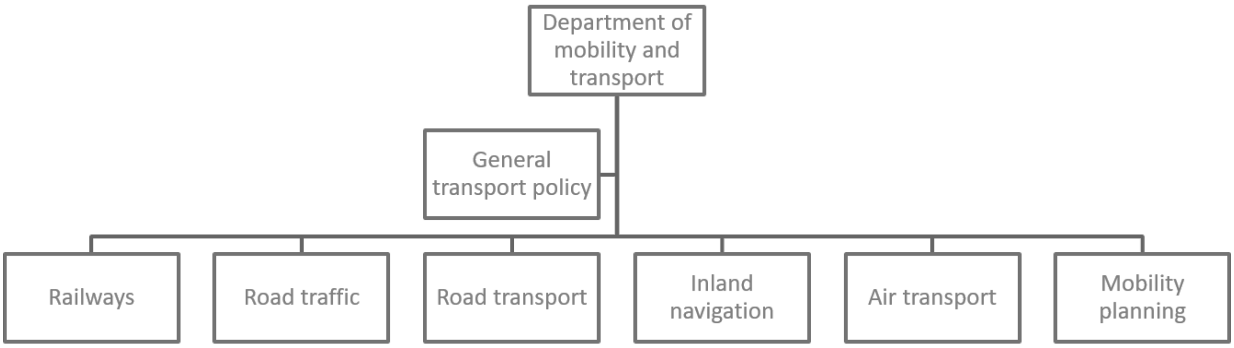

Figure 1: Divisional structure of the DMT

2.3 Governance of digitalisation based on EA models in DMT

The structured effort towards digitalisation in DMT started in 2018, with the creation of a dedicated unit - the Information Systems Service (Service des Systèmes d'Information, SSI) - with the mission to govern the digital transformation of the entire department. In order to identify its own operational objectives, the new unit launched a study aimed at objectively establishing the state of digitalisation and at collecting corresponding business lines' requirements. In response, a plethora of digitalisation requests by business lines was collected in a short period of time. The study revealed that the digital maturity of DMT's business lines was not homogeneous: a great deal of business processes were still performed manually, relying on paper documents and basic technological support, while few business lines have made considerable effort to digitalise most of their operations. However, although the digital maturity was higher in these units, technological solutions adopted were negotiated between these business lines' owners and CTIE directly, and were at best locally optimised.

National digitalisation strategy, with its six pillars, structures digital transformation efforts in DMT, acting also as the frame for its assessment. Although SSI is in charge of governing digital transformation of the entire department, it has very limited capacity for carrying out such a mission: the unit counts only four people, in charge of also providing operational IT support. Both low digital maturity of DMT and limited capacity of SSI drive the requirements towards governance system to systematically implement the *evaluation of digitalisation levels* of business lines, as well as *prioritisation* and *decision-making*.

Furthermore, current practices regarding introduction of technological support for core business processes force SSI to negotiate its position as technology governance body in DMT, both internally towards business lines, and externally towards CTIE, while simultaneously collaborating with the latter, as it is standard technology provider for administrations. The siloed thinking embedded in the organisation of DMT increases the risk of technological solutions' fragmentation across business lines. For successful digital transformation, SSI has to address this risk and to ensure that diverging solutions to recurring business needs are not applied. There is thus a strong need to scale vertically: the *integration (by design) of standardisation* (both in problem and solution definition) is also a means to overcome the capacity issue.

In order to break business silos and meet its standardisation principle across the divisions, SSI strategically decided to adopt a common EA framework and rely on EA methods to ensure informed governance of digitalisation. The overall approach, illustrated in Fig. 2, also relies on Model-Driven Engineering (MDE) and viewpoint management. The model of architecture, focusing on essential requirements to functioning of the system (i. e. DMT), plays the role of pivotal model in the whole cartography (of models) of DMT.

In the context of digital transformation, each digitalisation objective implies a specific perspective on the system (in our example DMT), with different related principles and indicators. Technically, this perspective is made explicit in a specific metamodel (i. e. viewpoint). The architecture is a specific view on the system (defined in its own metamodel), and all other views on the system need to rely on and be coherent with the model of architecture. The other views on the system can manage additional characteristics of the system, which are irrelevant at the architecture level, but necessary for the more specific considerations. The views and viewpoints are not predetermined, but are allowed to evolve with the application and evolution of knowledge of DMT and the needs at hand. The observation of a system through a specific perspective requires to define the transformation between the model of architecture and specific (model of a) view. This mechanism allows for the generation of multiple and potentially complex views on the system based on a relatively simple architecture model.

While in line with the luxembourgish enterprise modeling framework (Prometa), the chosen approach introduces additional requirements in terms of modeling infrastructure. The modeling support which is standard and in use (ARIS) in governmental bodies does not provide the capabilities needed to support and manage the integration of various viewpoints around a common backbone. Importantly, it actually lacks the extensibility both at conceptual level and at tooling level. The ARIS environment is indeed far from offering the expected capabilities of a more open modelling environment: disseminating the model repository via representations dedicated to the various stakeholders is typically not supported.

The decision to invest in a flexible modelling infrastructure became obvious in order to get the full benefit of the modelling approach chosen. An internally developed methodological and technological framework for EA labelled TREE acts as a basis for informed governance of transformation. The TREE framework allows for EA modelling of public administration through legal, strategic, organisational, technological perspectives. This model is labeled ***the information system architecture*** (in the most general sense) of the Department. More precisely, according to the standard ISO/IEC/IEEE 42010, it is a description of the architecture of the Department. More specific models developed outside of the architectural models use other kinds of supports, as required, while ensuring the integration and coherence with TREE models.

The initial version of TREE framework was conceived as a kernel of ArchiMate concepts (TheOpenGroup 2019), covering operational business with business processes, business services, business functions and applications. It additionally established their relationships with legal acts through which regulatory policy is defined. The first project where TREE has been applied is reported in the following.

3 Scaling TREE framework and evaluation of digitalisation levels of administrative procedures

The reported project fits in the wider stream of projects that introduce architecture-centered approach to the governance of digital transformation in DMT.

3.1 Project objectives

The project's primary objective was to use, validate and evolve TREE framework to support the assessment of digital maturity of administrative procedures at the department level. The initial focus on administrative procedures is chosen as they are principal interaction points between the administration and the beneficiaries of public services. Indirectly, the project was also aimed at

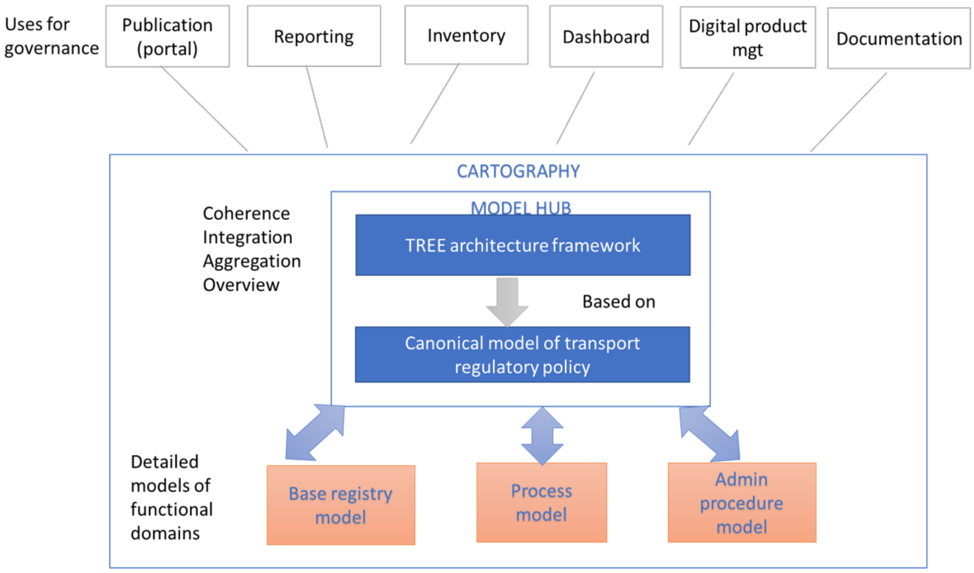

Figure 2: Overview of the EA-based approach to governance in DMT

demonstrating the value of the approach based on architecture and models.

In terms of modelling, the objectives in the project were defined as follows:

- Extend the TREE framework in order to capture the essential characteristics of transport regulation through administrative procedures,
- Apply the TREE framework to capture the essential characteristics of several business lines of DMT, concerned with administrative procedures,
- Develop the detailed model of a specific functional domain of administrative procedures, coherent with EA models,
- Operationalise indicators of digitalisation for specific functional model of administrative procedures in order to allow the necessary assessment.

Due to the awareness of a wider organisational context, there was no hard-coded rule as to the required level of formalisation of models. Instead, the priority was to demonstrate a long-term interest and value of model-based approach for the assessment of digitalisation. In other words, a solid conceptual basis and coverage of the most relevant aspects in EA framework, as well as in produced models was the primary concern in the reported project's frame.

3.2 Project team and duration

The project was realised by the authors of the present paper, whereby the first author had a twofold role of modelling expert and of project manager, while the other two authors (in role of external collaborators) participated as modelling experts. The external resource investment was approximately sixty man days on the project, with similar effort reciprocated by the first author. All authors share educational background in software engineering, with rich experience in conceptual and enterprise modelling. This common background allowed for enough flexibility in project management to account for learning, change of prioritisation, slight reorientation and scope adaptations, compared to the initial project objectives.

3.3 Modelling process and emergence of insights

The process of modelling was highly iterative and incremental. Using relatively short iterations, model increments were validated and formalised only to the extent necessary to proceed further and generate impact. It is to be noted that the primary audience of created EA and other models were modelling experts themselves. Nevertheless, the ambition to exploit created models via different more stakeholder-friendly modes of visualisation was present from the start. Although this was not a direct result of the modelling process, these modes of presentation (i. e. models) allowed for the results of modelling to be communicated and valued by the relevant operational and decision-making stakeholders in DMT.

The initial assumption was that the existing EA framework would not need to evolve a lot to cater for administrative procedures, therefore project activities were initially directed at modelling administrative procedure as a concept, and at analysing how to represent it in TREE framework. However, with this analysis and modelling of business lines and corresponding administrative procedures, the following insights surfaced:

- Administrative procedure each refers to a specific regulatory policy instrument (e. g. technical certification of a transport means, market access licence for an economic operator, qualification certification for transport operators). The administrative procedure treats a number of predictable events in the life-cycle of the instrument (e. g. delivery, modification, duplicata, renewal, suspension), or in the life-cycle of the holder of the instrument (e. g. change of address, change of the owner of transport means). From the regulation point of view, there is a generalisable similarity in life-cycle of instruments of the same type across all regulated transport modes, regardless of the existing variety of how each transport mode is operated. Each instrument type is concerned with a type of regulated entity (e. g. transport means, economic operator, professional operator), and this across different transport modes. The regulation of the same entity types is again very similar across transport modes.
- The basic schema of regulatory policy delivery cycle relative to a transport mode is to a great extent predictable based on the knowledge we gathered via analysis of several transport modes/business lines. Even more, the entire setup of a regulatory ecosystem of participants, their roles and responsibilities, is also quite similar across transport modes.

These conclusions emerged bottom-up, based on data collection, domain analysis, and consultation of regulations and regulatory policy literature. While it was clear that such generalised perspective could be valuable in terms of commonalities across business lines, the value for the concrete project or EA framework was not, so these reflections were left aside to mature in the background, in order not to impede immediate project priorities.

4 Major project results

This section presents the most important modelling decisions and the major results of the project.

4.1 Extension of TREE framework with regulatory architecture layer

As each public administration's mission is defined by the public value it creates towards citizens and businesses, we adopted a value network perspective to consider the integration of administrative procedures to TREE framework. This perspective was also called for, to position public administration in its collaboration with other (public or private) institutions in creating value for beneficiaries of administrative procedures. The need for this level of abstraction surfaced across various parallel projects in DMT, where these collaborations were discussed and designed, both in the context of regulatory delivery and beyond.

To model regulatory ecosystem of participants and their exchange in creating public value, a conceptual core of value modelling concepts (and their relationships) is introduced, namely: **actors**, **roles**, **responsibilities** assigned to a role, as well as **value objects** provided by the role within the network. This metamodel is labeled ***ecosystem viewpoint***.

Addressing these concerns with the concept of service is not appropriate, as services are too granular to actually represent value exchange and responsibilities around it. Namely, and based on the insights discussed in sect. 3.3, administrative procedures can be regarded as (public) services addressing different life-cycle events of a regulatory instrument, while instrument itself is a value object delivered by the regulatory body to the regulated entities. Other roles in the ecosystem offer value objects of different type (sometimes also instruments of regulation), in support of the main mission of the regulatory body.

The chosen ecosystem-level modelling conceptual core does resemble the core of e3value (Gordijn and Akkermans 2003) approach, with an important difference. Namely, the nature of exchange in the regulatory system is not always bi-directional (hence this was not imposed in the metamodel), and financial expression and reciprocity of value exchanges is not relevant for the analysis we needed, hence there was no rationale to opt for the metamodel outside of TREE framework. One can also wonder why we did not opt for extensions based on current Archimate specification (TheOpenGroup 2019) to this end. The initial TREE framework was on purpose designed as a minimal subset of Archimate core concepts with restricted interpretations and allowed relationships, and preserving such compactness was not revisited. This would not be possible if we opted for the current Archimate specification.

The extension of TREE framework, initially only an additional viewpoint, was finally turned into a full-fledged ***regulatory architecture layer.*** The concepts and viewpoints covered reflect decisions that need to be taken in the design of regulatory ecosystem (and corresponding regulations), and are not restricted to administrative procedures only. Therefore, this metamodel has multiple values, which materialised also outside of the scope of the reported project, i. e. beyond the integration of administrative procedures.

At the same time, modelling the setup of a regulatory ecosystem at a more strategic level frames the organisation of public administration in question, as well as its operations. Separating *regulatory architecture* from *business architecture* level of consideration allows isolating strategic from operational considerations, which is also important for the governance.

The key conceptual clusters of the regulatory architecture metamodel of TREE framework, as well as their relationships to business architecture are depicted in Fig. 5. Its relevant viewpoints (and partially covering the relationship to business architecture layer) are:

- *Ecosystem viewpoint* (setup of actors and roles participating in a regulatory ecosystem, per transport mode),
- *Service offering viewpoint* (list of DMTs administrative procedures per regulatory instrument and business line or transport mode),
- *Attributions viewpoint* (roles and responsibilities of DMT as an actor in the mode-specific regulatory ecosystem).

The use of viewpoints for ecosystem modelling and service offering is illustrated in Fig. 4 and 3, respectively. The ecosystem-level models, such as the one in Fig. 4 were used to communicate with operational agents in charge of regulatory policy delivery in different business lines. This way of structuring and visualising information was captured and valued by these stakeholders.

4.2 Domain-specific EA framework for transport regulation

The progressive maturation of the above-mentioned TREE framework *regulatory architecture metamodel* and its validation across the modelling of different transport modes led us to start to explicitly model our emerging insights with regards to transport policy (as discussed in Sect. 3.3). It progressively became clear that using this domain-specific knowledge of transport-specific regulation is a focal point for meaningful integration of administrative procedures into the architecture. We opted to model this as a separate artefact which, later on, we came

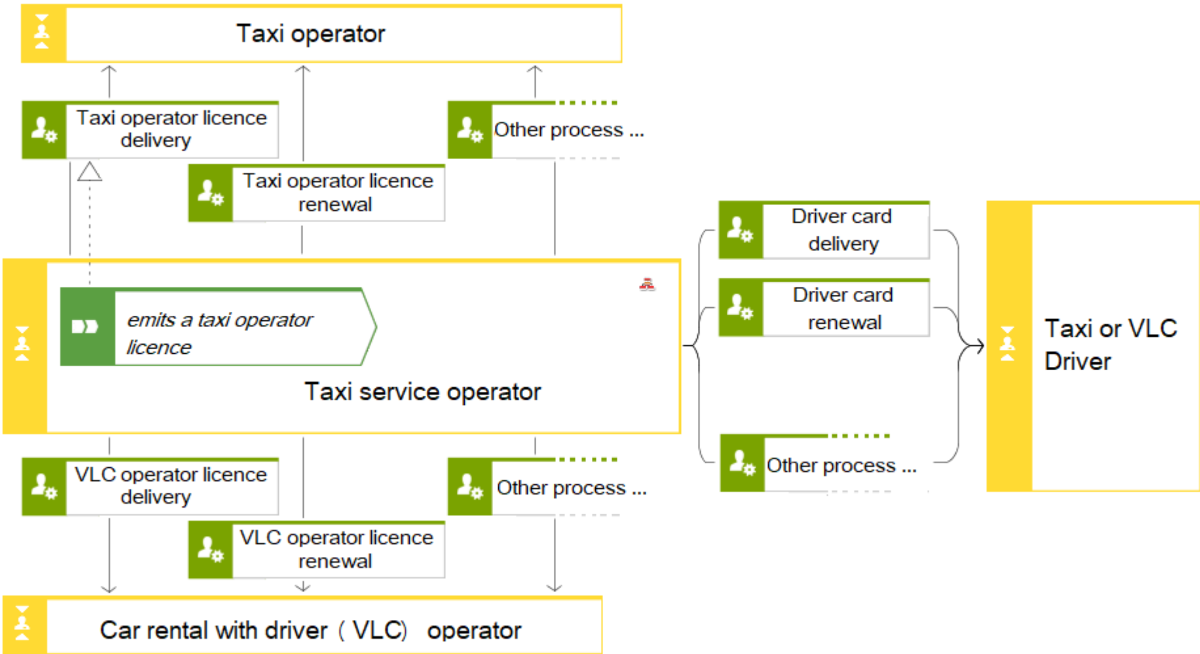

Figure 3: Service offering view per instrument for transport regulation

to label ***canonical model of transport-specific regulatory policy***. While it is not elaborated to the smallest detail, it does cover the essential concepts or transport domain regulation, which are sufficient to provide for meaningful integration of administrative procedures in the architecture.

Furthermore, it was also emerging that this knowledge could be coupled with EA framework, whereby the domain-specific semantics could be mapped to generic concepts of EA framework (e. g. business service, business process), allowing for more refined exploitation of architecture models. Thus some of the core administrative business services are administrative procedures. Each procedure covers a regulatory instrument. According to the regulatory instrument type, there is a pattern (i. e. rules) for the "complete" coverage of a regulatory instrument in the architecture: an instrument of a certain type is expected to be handled in the regulatory system through its instrument type's life-cycle, so that administrative procedures cover all the relevant events in the life-cycle of the instrument; according to the transport mode covered, the business line responsible for the instrument and related business processes can be "discovered", etc. The "system" also can understand that, for each new entity being regulated, there is a global ecosystem's pattern of instruments to be setup (together with its administrative procedures) amongst the actors of the regulatory ecosystem. For instance, when a new transport professional is introduced as regulated entity, the network of professional training, as well as certification bodies needs to be established and appointed by the regulator.

Establishing these mappings, the specialisation of a rather generic EA modelling language in TREE framework for application in regulatory policy in transport was progressively achieved in the project. The overview of the resulting TREE framework is given in Fig. 5. These developments were evaluated and improved through their application for modelling of architecture of several business lines in DMT in the reported project, as well as beyond this project's scope in parallel internal projects.

Such a specialisation of the initial framework brings a systematic approach to model business

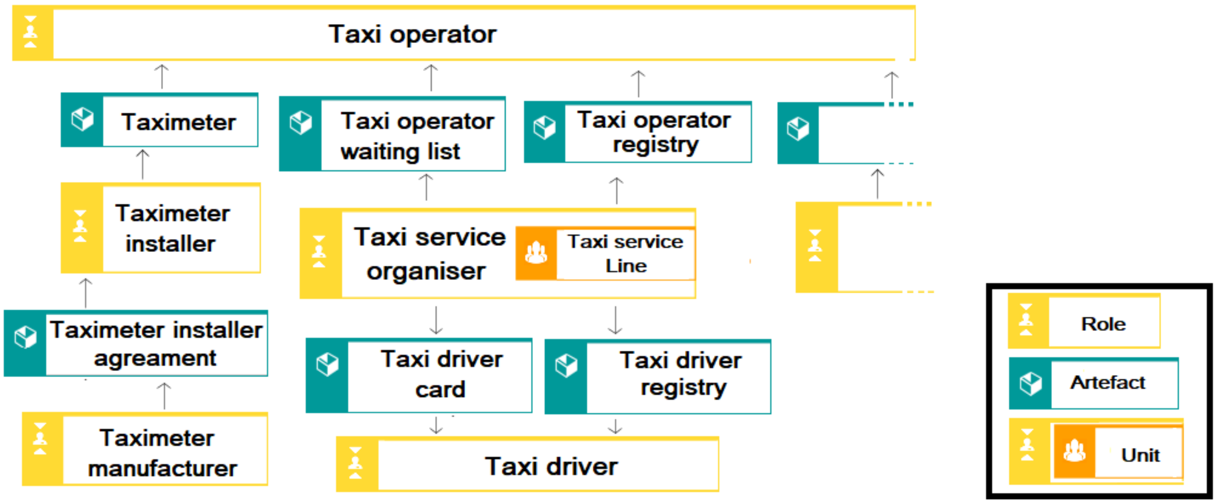

Figure 4: Regulatory ecosystem view, focus on creating public value

lines in DMT in a uniform manner, while capitalising on domain-specific knowledge and terminology. This is a major added value for stakeholders and for the development of method accompanying the use of the framework.

The achieved unification across the operational business lines also sets the ground for their transversal consideration in EA models, in terms of both their operations and of technological solutions. From the governance perspective, it facilitates the analysis and planning for standardising technological solutions across similar business functions, responding to the requirement for the governance in our organisational context (Sect. 2.3). At the same time, it also facilitates a systematic and unifying lens for the evaluation of digitalisation of business lines and their administrative procedures.

The knowledge formalised in the model of transport-specific regulatory policy can be further exploited in the TREE framework to maximise its value. For the moment, we also rely on domain-specific logic within TREE modelling framework in an implicit manner to define the rules of transition between different architecture models or layers. To fully harness the benefits of such domain-specificity, a method-like guidance would need to be formalised and incorporated in a flexible tooling support.

4.3 Specific functional domain models and digitalisation indicators

Besides its regulatory perspective, addressed in the regulatory architecture viewpoint, the administrative procedure can also be viewed from its operational perspective. It is especially valuable to be captured in order to assess the digitalisation level of the operational system. According to our framework illustrated in Fig. 2, we therefore designed a so-called functional model of the administrative procedure, independent of, although connected to the overall TREE architecture framework.

Administrative procedure model. The model is designed according to the national legal act defining the procedure to be followed by state and municipal administrations (LegiLux 1978). The administrative procedure abstracts the way for any administrative authority to receive, from a citizen, a request for a decision regarding the granting of a right. The legal act specifies that the administrative decision must be motivated and communicated to the requester. The request can be supported with required evidence. In our context

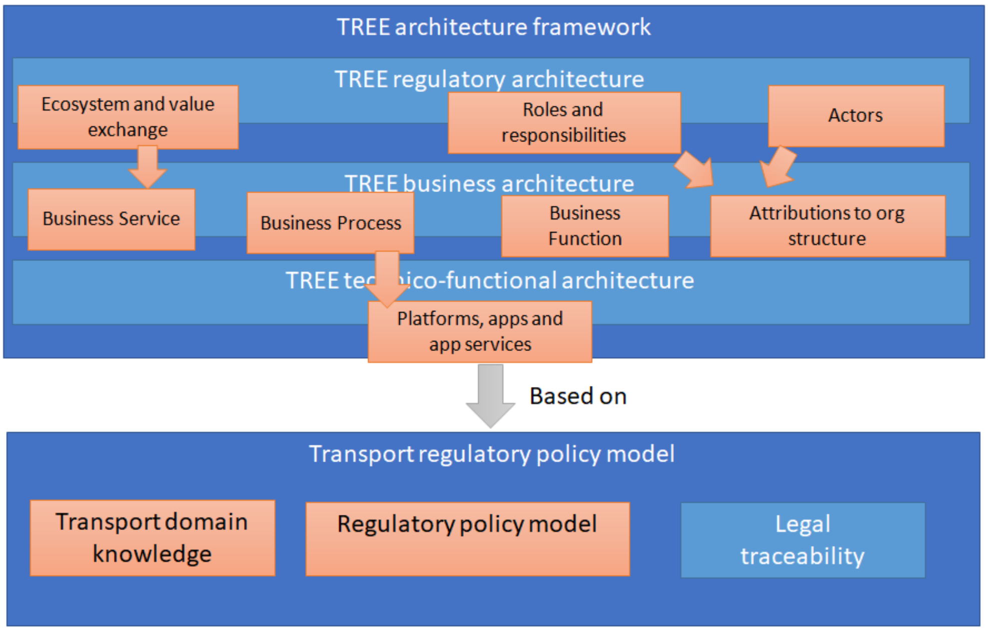

Figure 5: Overview of specialised TREE modelling framework

of regulatory delivery, the right is actually granted through the emission and delivery of the requested Regulatory Instrument. The concepts of the legal act are illustrated in Fig. 6. We have enriched the legal perspective with additional operational aspects, such as communication (and notification) channels as well as formats of supporting evidence documents and of administrative decisions. Those elements are specifically relevant in addressing the digitalisation assessment of administrative procedures.

This model of administrative procedure is managed as a specific functional domain in our EA-based approach, and the coherence with our TREE architecture framework is ensured through conceptual mapping: from the architecture point of view, the administrative procedure is seen as a business service (of type administrative service), realised by internal business function in charge of applying the rules to treat the request. This integration in the TREE architecture framework also brings the semantics of the transport-specific regulatory model, and associates the administrative procedure with the relevant regulatory instrument and concerned regulated entities. At this stage, the coherence is implicitly maintained. However, the inventory of procedures, discussed later, explicitly incorporates the relationships.

Digitalisation indicators. The assessment of digital maturity of administrative procedures initially focused on the following pillars: *digital-by-default*, *once-only* and *openness and transparency*. In a binary manner, these would be understood as: *an administrative procedure **is** digital-by-default or **is not***. As this does not bring real value in terms of assessment, we designed the following indicators:

- the digitalisation level (to provide a fine-grained metric for digital-by-default)
- the validation level (referring to transparency)
- the notification level (referring to transparency)

Most of the indicators are automatically calculated, or initialised (for future manual update). Initialisation and calculation rules were part of the indicator model, illustrated in Fig. 7.

Inventory of administrative procedures and digitalisation assessment. The domain-specific

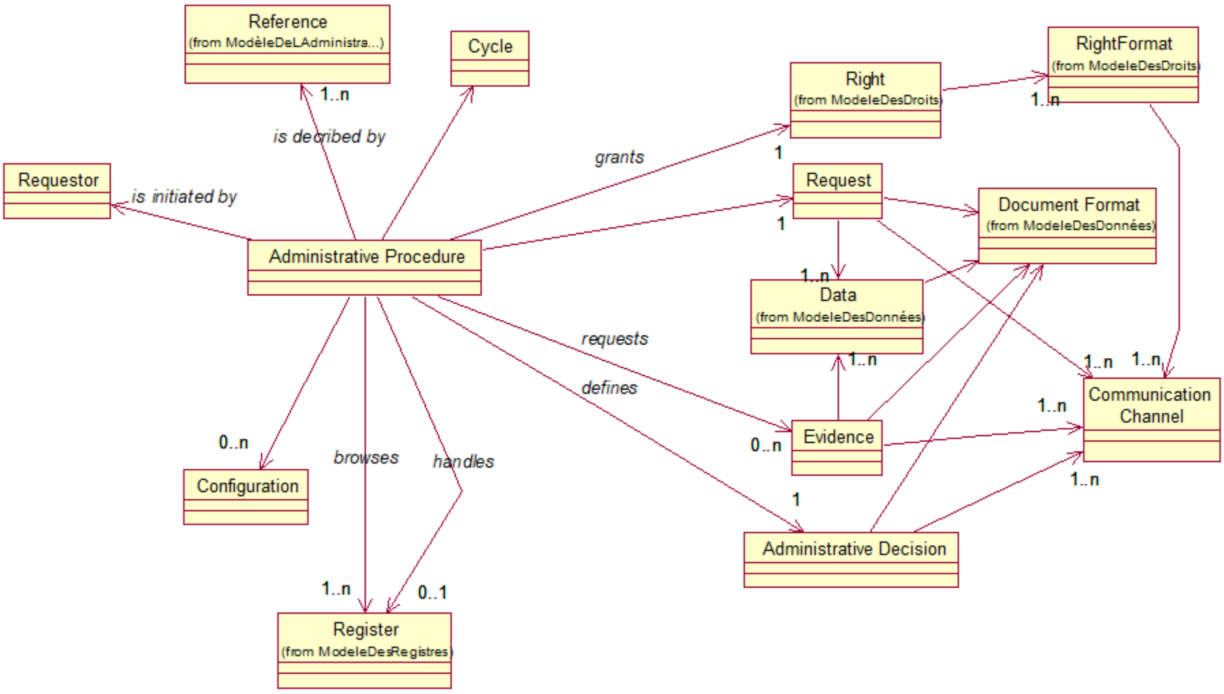

Figure 6: Overview of the administrative procedure model

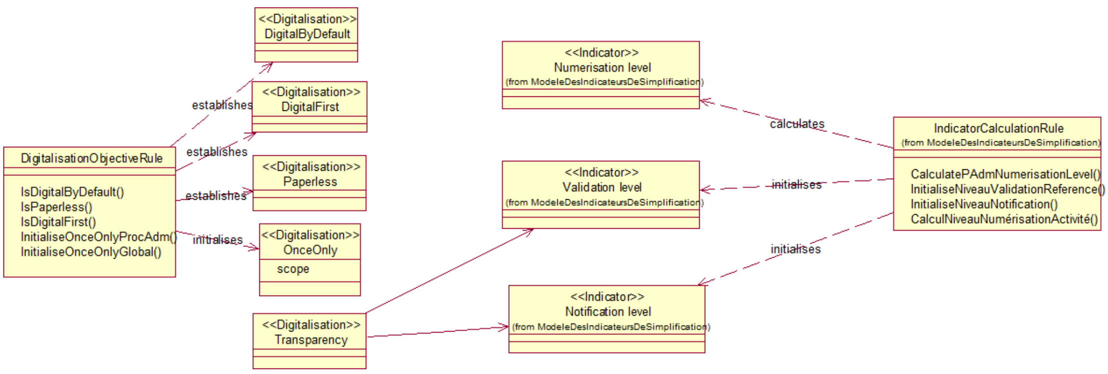

Figure 7: Indicator calculation rules

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mapping from TREE framework was exploited to setup an inventory of administrative procedures across business lines, in the form of an Excel workbook. The inventory was built both by SSI team members and by business lines' operational agents. Besides the description of procedures, data on annual volumes of granted/rejected requests were also collected, providing the basis for computing the digitalisation indicators. The calculation itself is implemented in Visual Basic/Excel macros.

In several other projects, realised upon the initial submission of the paper, the same pattern for managing specific functional models has been used for the analysis of other major administrative components relevant from the digitalisation perspective (such as administrative processes and base registries): design of the conceptual model, reflected in the structure of an inventory nourished by internal agents.

4.4 Visualisation of models for decision-makers

Although the architectural models enriched with transport-specific regulatory policy semantics are useful for operational agents, decision-making requires to synthesize the information, and present it according to the relevant dimensions. We therefore designed and developed dashboards oriented towards decision-makers at DMT. Technically, the dashboard directly connects to the inventory of administrative procedures, and its semantically rich information. It gets the available information on instruments, regulated entities, administrative procedures, their volumes and status of digitalisation and presents the information to decision-makers. It provides semantically-rich filtering of information across business lines, regulatory delivery cycle, instrument life-cycle, transport mode, or regulated entity type. It gives the possibility to compare the business lines on common grounds. It is a first experimentation in sharing common knowledge about regulatory delivery procedures at DMT. Some examples of these dashboards are given in Fig. 8 and Fig. 9.

The decision-making stakeholders were positively surprised with the richness of information

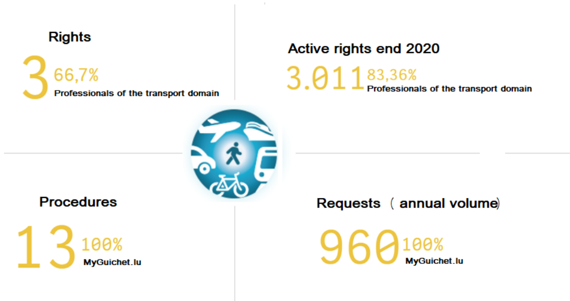

Figure 8: Overview of service taxi with digitalisation assessment for top management

gathered, processed and aggregated in a short period of time. Simple indicators centralised in a single dashboard such as the number of (categorised) delivered instruments, the number of (categorised) regulated entities, the annual volumes and most represented format of request, is a very valuable way of presentation in a divisional organisation like DMT.

This kind of specific presentation of information definitely helped to get support for future efforts in enabling informed governance of digitalisation and administrative simplification. An illustrative example is the immediate understanding of the value of impact analysis in terms of (digital) transformation, e. g.: extending the (legal) validity period of the instrument in order to reduce the volume of requests; easily identifying the geographical validity of the instrument and the associated constraints (i. e. an EU instrument should not be digitalised without European decision and roadmaps).

Decision-making stakeholders also identified the opportunity to adopt this structuring approach to redesign the public portal and provide citizens and businesses with more intuitive navigation through the regulatory instruments and their procedures. Here again, the inclusion of transport-specific regulatory policy model is very valuable, as it is aligned with the needs, the interest and the vocabulary of the beneficiaries of DMT public services.

Besides aggregated presentations for decision-makers, the project delivered another valuable

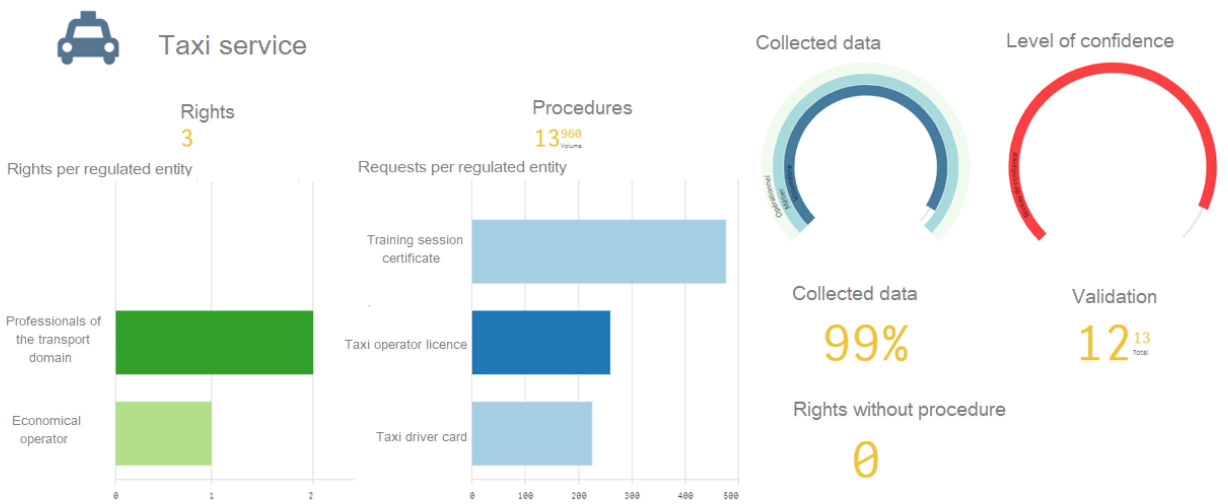

Figure 9: Overview of service taxi for business line management

visualisation: the regulatory framework web site, which provides interactive navigation through the legal framework underlying the regulatory delivery, linking legal acts with transport sectors, and corresponding regulated entities, regulatory instruments and administrative procedures. The technical implementation of this documentation-oriented and highly interactive web site, illustrated in Fig. 10, went beyond the scope of the reported project. However, the richness of the website relies also on the domain-specific semantics and architectural models contained in TREE repository, and used to generate the site. It is open to internal agents, and will be integrated in the future DMT extranet, while the longer term ambition is its integration in the public transport portal.

5 Reflection on RoME

Fundamentally, the notion of RoME argues for an explicit consideration of cost-benefit ratio in between time invested in model creation and expected returns (Proper and Guizzardi 2022), and in balancing these two. In our project, there are several aspects which in our view contributed to maximise RoMe through the modelling process, which we discuss in the following.

Organisation of modelling effort. Having in mind the limited resources and relatively short duration of the project, the process of modelling was organised in line with the original idea of agile project management: short iterations, with increments and expected outcomes clearly defined, regular weekly progress meetings in physical space, and intense asynchronous communication in the meanwhile. Such a setup allowed for frequent feedback loops, better insights and prioritisation changes where relevant. This also contributed to manage the risks of investing resource in the design of domain-specific regulatory policy model. At any point of divergence from original objectives of the project, there was the option to abandon it and refocus on immediate impact with minimal loss.

Incremental model validation through data collection. Both functional domain model and metamodels of TREE framework were progressively evaluated and improved through data collection. Model and real world system were therefore constantly linked, and a first step towards a digital twin (digital shadow) is being established. Relatively short iterations ensured this progressive validation of models, and where needed, model improvement. Furthermore, the choice to organise iterations per particular business line was quite valuable: each iteration covered model development and application for a particular

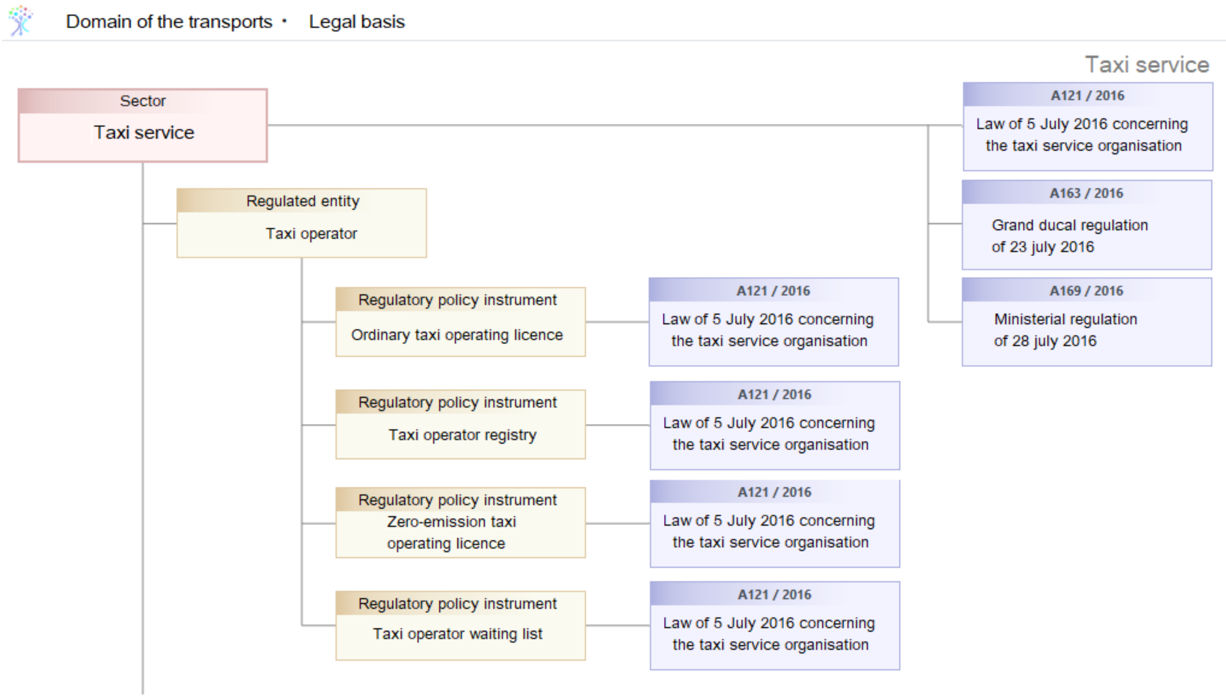

Figure 10: Overview of the legal basis for the regulation of taxis on the documentation site

transport mode (and corresponding business line), not only facilitating our learning of the regulatory domains, but also turning out to be the catalyst for us to progressively apprehend domain-specific patterns that we translated in the model of transport-specific regulatory policy. While typically this abstract level of modelling comes with a temptation for analytic drift (in particular for already analytically oriented profiles), the focus on progressive validation of models in light of available data and limited time-frame for delivery of results forced practical orientation.

Separation between a (primary) model and its stakeholder presentations. Another factor that positively contributed to the return on investment in abstract models was the decision to present the information in the targeted way for each stakeholder group. Our relatively simple (but abstract) conceptual structure of transport-specific regulatory policy model and architecture model, and primary models of instruments and procedures for each business line were efficiently transformed into highly relevant information presentations for stakeholders. One can argue that the impact of these presentations is mainly related to the (visualisation) capabilities provided by the business intelligence tool or the system for generating documentation site. This certainly is to some extent true, however, the underlying structure and organisation of information according to key concepts is the actual value acknowledged by all involved stakeholders. Without the clarity of structure, the information would not have the same impact. In this context, we believe that the value of a highly abstract model could only be generated using similar strategy. In our experience, this strategy can enable to harness a lot of benefit from a relatively modest investment, both for the decision-making stakeholders and the team invested in formulating and applying the developing TREE approach. We can say even that both formats of presentation discussed in Sect. 3 can be considered as views of primary model(s) of regulatory policy and procedures, and that the value of views that were generated is dependent on the structuring of a primary model. We also demonstrated that there is a real value in separating the conceptual content from the representation. Each stakeholder requires specific presentation fitting its own concerns. This refers not only to the level of details, but also the visualisation mode, and even the choice of information structuring.

Strategy on valorisation of modelling effort. The modelling project discussed in the paper is part of a model-based informed governance initiative in the DMT. This initiative is managed as a product, and has its own development roadmap, articulated around the value created by the models. The governance of digitalisation is only a facet of TREE (the product): the structuring and formalisation of knowledge is at the core of the product. The first phase in the roadmap goes beyond setting up the domain and the multi-perspective framework: it creates value by disseminating the structured knowledge to various stakeholders through a variety of channels: web portal, digital dashboards, graph database, excel sheet, and others. The TREE product design is inspired by the NIST Big Data Reference Architecture (Chang et al. 2019) and is at the intersection of two value streams: the modelling value stream (from collecting data to disseminating knowledge and exploiting the models) and the technical value stream (from infrastructure to business services). The development of the domain-specific language, the integration of functional models and of the infrastructure all progress in parallel so that each milestone delivers actual value from modelling efforts. In this setting, each component facilitates the maximisation of the value of models.

Removal of all modelling infrastructure constraints and focus on concepts. In modelling projects, tooling is frequently considered as a major factor to reduce the costs of modelling, and optimise RoME. In our example, metamodel development has been a primary concern at this stage of the maturation of the entire approach, and sound conceptual basis was of primary importance, instead of technology. Given the overall EA approach and parallel investment in the development of flexible modelling infrastructures (as part of our product development), typical constraints related to the use of heavy modelling standards and environments were not present. At this stage of maturation of the approach, this has been an advantage. Effectively, we have produced several models in various formats: architecture models expressed in customised EA metamodels, UML diagrams, Excel-based inventories, Excel-based prototypes, etc. Although all these artefacts have evolved in a parallel manner, we maintained a common view, with validated metamodels, and ensured the global consistency across all our models, with no real merging or maintenance effort.

Reduced scope but strategic vision. All major project deliverables were developed and managed with the strategic vision of our global approach. This is in particular the case for model of transport-specific regulatory policy. While a significant effort was invested to reach a relatively abstract structuring, the effort was approved because of its potential to facilitate the answers to key operational questions, and not only regarding digitalisation. The structure directly anchored in transport regulatory delivery business helps to quickly view the distribution of market access licences across business lines, the regulatory divergences in terms of licence validity duration, and address many other aspects of the regulatory system. Although policy-making practices are shared in DMT through the state-level standard law making process, regulatory delivery practices are still only informally shared across business lines. Our common foundation of transport regulatory delivery, applicable to any transport mode contributes to identifying common practices and standardisation at the operational level. From the point of view of informed governance, such a conceptual unification allows to capitalise on architecture models in many ways. It offers a terminology which speaks directly to domain experts, but also to beneficiaries of services. For instance, using this model as a base for public portal presentation of administrative procedures per transport mode, but also crossed with responsible business line has been proposed by the department management.

In the reported project, the scope of the semantic domain model has been limited on purpose, and not all concepts have been equally elaborated. It has been allowed that the artefacts stay incomplete, as long as their exploitation in a useful, value generating way was still possible. In fact, all the artefacts produced have evolved with subsequent projects and the application of the framework, cumulating the value obtained from models across the projects. This has allowed us to achieve great impact with models at various management levels, and get their support for the approach, although still not fully developed. This has not been the objective of the initial project, and yet, the invested effort was valued thanks to its potential wide impact, which indeed materialised.

6 Conclusion

The reported modelling project is, we believe, rich in experience and lessons learnt. We have demonstrated that the design and use of a domain specific language helps, as expected, to better understand the domain, but also that domain-specific knowledge can be used to optimise, adapt or specialise generic modelling concepts of architecture, as well as to harness benefits in information presentation and communication with relevant stakeholders. These elements, although not directly part of model as artefact, cannot be, in our view, neglected in the discussion on RoME. In enterprise modelling setting, models and modelling are always instrumental to the objectives stemming from the wider organisational context, and this needs to be taken into account as a dimension of value generated by the model. In the organisational environment of DMT, the investment in abstract modelling of transport regulatory policy and subsequent specialisation of EA framework to this class of problems was justified by and contributed to break business lines silos by unifying differing business practices via simple domain terminology, and enabling the transversal sharing of best practices.

As mentioned before, this project is part of a wider initiative, with its own development roadmap. The knowledge dissemination phase will be followed by the development of other features bringing value to the stakeholders: transition to digital product realisation, regulatory watch and impact analysis, digital transformation roadmap. The design of specific model viewpoints relevant for governance will be addressed, some of which will cover transversal concerns of domain-specific regulations, also spanning the architecture vertically. Data protection, open administrative data, administrative transparency are such concerns, independently regulated and applicable to all business lines. They impact many elements in the architecture models, from services, processes and information to application and technology. TREE will provide specific applications, supported by the modelling infrastructure and create value by empowering the business owners to directly manage and maintain their own information in relation with the governance's perspective, and therefore actually take responsibilities for their actions.

While the cost-benefit analysis of RoME is often directly linked to the very process of model creation and direct use of the model itself, our experience suggests that RoME could be conceived of as a metric of a more strategic character (instead of interpreting it as related to a single modelling effort/project). If the parallel is to be drawn between the investment metric Return on Investment (ROI) and RoME, we believe that the cost-benefit analysis in relation to RoME needs to also take into account the benefit of created models more on a mid-term scale, as not all benefit from the investment in creating models may be realisable immediately.

Similarly, while RoME forces one to think on optimal resource use in the direct modelling context, we suggest that the creation of future debt, due to not modelling and not using models, should also be considered in such cost-benefit equations. This is in particular relevant in enterprise modelling setting, and in our view critical for digital transformation of public administration in the context explained in the paper. We observed that the divisional structure justified by regulatory fragmentation, rapidly spills over to business lines' technological choices and understanding of digitalisation itself (and this despite the mandate attributed to SSI). In such a context, a generalised perspective which unifies across business line commonalities coupled with the (domain-specific) architectural approach seems a smart way to break the silos and raise the awareness of its risks to management. Therefore, one could ask if we even had the choice not to model in such a context, and what debt would result from not investing time to create architectural models and find appropriate ways (conceptually and visually) to communicate insights to management and domain experts. More generally, therefore, the concept of RoME could, in our view, benefit from including, beside time invested in model creation, also the time and resource waste that is being created in the future as a result of not modelling in a given context. In other words, what future debt is being created by the decision not to model?

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