An Ontological Approach to Digital Transformation: Toward a Semantic Infrastructure at the Royal Dutch Association of Civil-law Notaries*

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Abstract

Digital transformation is a business strategy initiative that incorporates digital technology across all areas of an organization, including the business domain, processes, products, employee experience, and customer experience. A large number of documents, implicit domain knowledge, and accumulated experience pose challenges for the digital transformation of large organizations. We propose an ontological approach to digital transformation, aiming to build a semantic infrastructure as the backbone of several services. Our approach relies on the Unified Foundational Ontology (UFO), gUFO (a lightweight implementation of the UFO suitable for Semantic Web OWL 2 DL applications), and the OntoUML modeling language. We prioritize domain understanding through conceptual modeling and Applied Ontology principles over particular Linked Data implementations. We report preliminary results about how this approach has been adopted in a real-world industry project for the Royal Dutch Association of Civil-law Notaries (KNB: Koninklijke Notariële Beroepsorganisatie), in the Netherlands.

Keywords

digital transformation, ontology engineering, Unified Foundational Ontology, OntoUML, gUFO, Royal Dutch Association of Civil-law Notaries

1. The Need for Digital Transformation

Large organizations accumulate a myriad of text documents in multiple formats (PDF, TXT, DOCX, ODT, etc.). Managing these documents for knowledge management to support business processes and analytics is a major challenge. Vector databases provide a popular approach to storing these files and enabling similarity search. Although useful, this kind of technique does not preserve the structured knowledge and experience implicitly embedded in those documents. Consequently, complex queries and automation are not possible. The lack of this capacity forces organizations to spend time and effort on tedious, manual processes, such as checking whether pieces of information from different documents match or comply with requirements. Ideally, organizations would like their pile of files to be accessible as structured information and commonsense knowledge, reflecting how stakeholders read them and understand the domain.

This goal can be seen as part of a broader strategy for digital transformation within organizations (see [1] for several definitions of digital transformation). According to IBM's knowledge base[1], "digital transformation is a business strategy initiative that incorporates digital technology across all areas of an organization", including the business domain, processes, products, employee experience, and customer experience. There are multiple ways to materialize digital transformation within an organization. In

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[1]https://www.ibm.com/think/topics/digital-transformation.

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this paper, we present an ontological approach to digital transformation, aiming to build a semantic infrastructure as the backbone of several services. Our approach relies on the Unified Foundational Ontology (UFO), gUFO (a lightweight implementation of the UFO suitable for Semantic Web OWL 2 DL applications), and the OntoUML modeling language. [2, 3, 4, 5, 6] *We prioritize domain understanding through conceptual modeling and Applied Ontology principles over particular Linked Data implementations.* This means our knowledge models are independent of specific technologies and are implemented according to the use case. For example, the same conceptual model informs the design of an OWL ontology and SHACL shapes for data validation.

This approach has been adopted in a real-world industry project for the Royal Dutch Association of Civil-law Notaries[2] (KNB: Koninklijke Notariële Beroepsorganisatie), in the Netherlands. In the next section, we provide more details about the approach and the project.

2. An Ontological Approach to Digital Transformation: the Case of the Royal Dutch Association of Civil-law Notaries

KNB is a Dutch organization that faces major challenges in knowledge management. Moreover, customers and stakeholders, such as banks, notaries, and law firms, use KNB's services. This is why KNB seeks a broader digital transformation strategy that would benefit not only KNB's employees but also all stakeholders. Since 2025, there has been an ongoing project between KNB and Y.digital[3] related to knowledge management and information extraction. However, a small part of this project explores a wider solution to the problem. This is where our proposed approach fits in, generating promising results (after a few months of work in the first semester of 2026). After these preliminary outcomes, further exploration awaits funding. From the project management's perspective, this is the current state.

KNB and notary activities in general, in the Netherlands, are structured in three major domains: (a) Real Estate Law (in Dutch, *Vastgoedrecht*), (b) Family and Personal Law (*Personen- en Familierecht*), and (c) Business and Corporate Law (*Ondernemingsrecht*). For example, mortgage deeds (*hypotheekakte*) and Deed of transfer (*akte van levering*) belong to the Real Estate Law domain; will (*testament*) and living will (*levenstestament*) are document types that belong to the domain of Family and Personal Law; a BV incorporation (*akte van oprichting BV*), which creates a Dutch private limited company, belongs to the domain of Business and Corporate Law.

KNB's notarial setting differs from adversarial legal practice in three respects that make a semantic approach particularly apt: impartial fixation of meaning at formation, statutorily prescribed authentic form, and longitudinal validity across vintages of law. To cover all these aspects, our approach intends to build ontological conceptual models for each KNB domain, following different document types, using OntoUML and UFO-based ontologies (for example, about legal relations [7]). In sequence, we implement this understanding using gUFO and the Semantic Web stack to support several applications and services. This way, we can progressively build a semantic infrastructure for KNB.

Our initial results concern the mortgage subdomain and ancillary general legal concepts. We report the following outcomes: (1) an OntoUML ontology of the mortgage domain, including attributes and datatypes according to the KNB mortgage deeds; this domain ontology follows a UFO-based reference domain ontology describing legal contracts in general [7]; (2) an OntoUML hierarchy that represents the major Dutch legal concepts, such as legal subject, natural person, legal person, public legal person, province, etc.; this taxonomy supports the domain ontologies; (3) these models are implemented in OWL 2 DL, following gUFO; (4) we also design SHACL shapes according to our conceptual model and OWL domain ontology for data validation; for example, translating the cardinality constraints to SHACL; (5) we employ NLP techniques, including regex and various language models (via Cursor CLI), for extracting triples from the mortgage deeds; (6) then, these triples are tested against the SHACL shapes; for instance, given a particular mortgage deed, a LLM-based AI agent can generate triples

[2] https://www.knb.nl/.
[3] https://www.y.digital/.

to reflect information from this document, following the ontology, and it can validate these triples iteratively against the SHACL shapes; if they pass the test, they can be added to the mortgage ontology, corresponding to a well-founded RDF representation of the text document.

These results allow things that were previously impossible: (a) a high conceptual clarification of the domain, expressed in OntoUML; (b) extensive documentation thanks to the diagrams, the RDF implementation, and embedded annotations; (c) precise SPARQL queries to find specific pieces of information in the mortgage deed corpus; (d) requirement enforcement via SHACL shapes, which guarantee that the mortgage deeds contain valid data and, more importantly, do not lack necessary elements; (e) SHACL-based forms[4] that can support KNB personnel, generating mortgage deeds with built-in data validation; (f) the capability to export subgraphs as text documents (for instance, generating a complete mortgage deed text from a query over the database).

Declaration on Generative AI

Generative AI tools had a minor impact on the writing, but were used for coding assistance in the project. During the preparation of this submission, we used Grammarly for minor grammar and spelling checks. Furthermore, we used various language models available on the Cursor CLI for coding assistance and Named Entity Recognition (information extraction from text) in the exploration of the project's execution.

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A. Online Resources

Permanent URL for the repository that demonstrates our ontological approach to digital transformation:

- https://w3id.org/dutch-mortgage-ontology/git

[4] https://www.w3.org/TR/shacl12-ui/.