Toward a Document-Centered Ontological Theory for Information Architecture in Corporations

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Abstract
The beginning of the 21st century attested to the first movements toward information architecture (IA), originating from the field of library and information science (LIS). IA is acknowledged as an important meta-discipline concerned with the design, implementation, and maintenance of digital information spaces. Despite the relevance of IA, there is little research about the subject within LIS, and still less if one considers initiatives for creating a theory for IA. In this article, we provide a theory for IA and describe the resources needed to create it through ontological models. We also choose the “document” as the key entity for such theory, contemplating kinds of documents that not only serve to register information, but also create claims and obligations in society. To achieve our goals, we provide a background for subtheories from LIS and from Applied Ontology. As a result, we present some basic theory for IA in the form of a formal framework to represent corporations in which IA activities take place, acknowledging that our approach is de facto a subset of IA we call the enterprise information architecture (EIA) approach. By doing this, we highlight the effects that documents cause within corporations in the scope of EIA.

1 | INTRODUCTION

The first reference to “information architecture” (IA) dates back to the 1990s. Today, it is agreed that Saul Wurman, a famous architect, originally coined the expression (1996). The metaphor connecting “architecture” to “information” originated from Wurman’s insight that issues of collecting, organizing, and representing information were similar to those faced by an architect in designing buildings. IA was then defined as the building of a structure to assist people in understanding information (Wurman, 1996). As a result of the work of Rosenfeld and Morville (1998), also pioneer authors on the subject, IA was generally identified with the design of digital environments, primarily for the Internet. IA was delineated in the context of then and there emerging web technologies, as both the process and the outcome of designing online environments that enable users to find information of interest (Rosenfeld & Morville, 1998).

The beginning of the 21st century testifies to the first concrete movements toward IA originating from the field of library and information science (LIS). Indeed, Rosenfeld and Morville (1998) had foreseen that LIS is one out of six fields that study and apply IA. Perhaps the first formal initiative may have been a call for articles regarding IA, labeled as a “new field” and characterized as “an important meta-discipline concerned with the design, implementation, and maintenance of digital
information spaces for human access, navigation, and use” (Blair, 2001, p. 1).

Yet in spite of the apparent relevance of IA, a successful metaphor to convey the idea of knowledge and information organization, only a few studies have examined the subject. Moreover, there are no effective initiatives to create a theory for IA. Indeed, some researchers admit the need for such a theory so that IA projects can be developed not only from a bottom-up perspective (Haverty, 2002). The present article is inserted into this context: it aims to present some basic theory for IA. Such a theory is based on ontologies, as they can provide a rigorous and formal framework to generically represent corporations in which IA activities take place.

To achieve our goals, we make use of both top- and middle-level ontologies to represent the main features of formal corporations, according to characteristics historically assigned to them. In the scope of such ontologies, we elect the “document” as the key entity for IA, as documents are capable of giving rise to and governing the majority of actions within formal corporations. In theoretical terms, we start from the notion that certain kinds of documents not only serve to record information, but they also create claims, obligations, and rights within society (Smith, 2014). Indeed, documents that create claims, obligations, and rights assume a paramount importance in the scope of IA, as a trigger for all processes occurring within corporations.

Some of the terms we will be using are: Corporation, Ontology, and Ontological Models. There are several terms in Economics and Business Studies that are colloquially employed in an interchangeable way; for example, corporation, firm, organization, enterprise, and company. In this article, we follow Berle and Means (1932) in using the term “Corporation” to denote modern business institutions originating in the US. Regarding the term “Ontology,” we follow a combination of metaphysical principles and computational techniques, which philosophers have termed “Applied Ontology” (Munn & Smith, 2008). Henceforth, for the sake of clarity, we use the expressions “Ontology as discipline” and “Ontology as artifact” to distinguish the two meanings. In addition, we consider that “Ontological Models” are ontologies as artifacts built according to principles of “Ontology as discipline.”

It is worth emphasizing that this research is remarkably theoretical insofar as we need to provide background for a variety of other existing theories before we reach our own, in addition to provide historical and contextual aspects used to characterize corporations. Moreover, we build the main outcome we call “Document-Centered Ontological Theory for IA,” taking advantage of those existing theories. However, we advise that our approach is partial, as it is not yet able to deal with all forms of knowledge and information in the context of a corporation.

The remainder of the article is organized as follows: The second section presents research about IA in some of the most important LIS publications, and it explains our approach as a subset of IA we call enterprise information architecture (EAI). In the third section, we define the main topics about IA identified in the LIS literature. In the fourth section, we provide a background of the ontologies and other relevant co-related theories. The fifth section begins with the historical characteristics of corporations, which is followed by an ontological analysis of them. The sixth section puts it all together and explains how ontological models can be used to furnish a well-founded theory for EIA. Finally, the last section discusses some issues, limitations, and suggestions for future research.

2 OVERVIEW OF IA IN LIS

Since it was coined, IA has been an ambiguous expression, applied both by researchers and practitioners in several fields; for example, computer science, design, web development, and LIS. A search of the main journals and publications of LIS can provide the primary advances of IA during the last 20 years. We performed a literature review in the Journal of the American Society for Information Science and Technology (JASIST), the Knowledge Organization Journal (KOJ), and the Annual Review of Information Science and Technology (ARIST).

In JASIST, we found approximately 100 publications with the term “IA” in the body of their texts. Only 10 of them are really about IA and have the term “IA” stated directly in the title and approached as a research subject (Burford, 2011, 2014; Cunliffe et al., 2002; Dillon, 2002; Hauck & Weisband, 2002; Haverty, 2002; Hert et al., 2007; Latham, 2002; Rosenfeld, 2002; Toms, 2002). In ARIST, we found one publication, a literature review:Jacob and Loehrlein (2009). On KOJ’s, the International Society of Knowledge Organization (ISKO), we found three entries mentioning IA in the ISKO Encyclopedia of Knowledge Organization (IEKO) (Hjørland, 2019; Ridi, 2019; Satija, 2019). We favored academic resources, avoiding reports and commercial sources, such as the websites of professional institutions.

The authors of the aforementioned publications often presented shared views. We list and highlight some of the similar views transforming them into “topics,” which guide us in describing and explaining IA (Tables 1–5).

After describing the five main topics identified in the LIS literature, we suggest a unique term to represent each
topic listed, respectively: (i) blueprint, (ii) structure, (iii) coverage, (iv) orientation, and (v) theory. From these selected words, we extract pertinent aspects to characterize IA in the scope of LIS.

The notion expressed in Topic 1, **blueprints**, works very well in clarifying for people the nature of organizing large sets of information via a metaphor, despite advice not to take the analogy of architecture too literally (Jacob & Loehrlein, 2009). Indeed, to literally consider the metaphor, one should include the set of other projects required to build a house (electrical, piping, foundation, and so on), where the architectural plan is just one of many projects involved. Taking this metaphor a step further, we present Figure 1 to enhance understanding.

Topic 2, **structure**, is the most important topic, since, in addition to providing the backbone for IA, it is closely related to the main principles of Knowledge Organization. Among several possibilities in the Knowledge Organization field, one may choose from a variety of classification systems and thesauri, even though all of them can be understood as being restricted ontologies (Hjørland, 2019). Topic 3, the **coverage** of IA, is defined by many different factors; however, the coverage is not restricted to the Internet. Web environments, online or Intranets, are possible information spaces that can be organized via IA within a corporation, but they are not the only ones. Topic 4, **orientation**, concerns the direction that the activities of IA should take in case of either a bottom-up or top-down approach. Some of the literature suggests bottom-up approaches because there is no theory to guide the activities of researchers or practitioners. This then takes us to Topic 5, **theory**: any formal discipline; for example, biology, medicine, or architecture, that is a knowledge branch grounded in theory, which guides the activities of professionals in a scientific or business community. The lack of theory leaves researchers and practitioners starting from scratch with each project.

Finally, it is worth acknowledging that some of the useful texts for a pragmatic IA approach might be found in journals, books, and blogs or websites, which are not referenced here; for example, the *Journal of Information Architecture*, the *Journal of Web Librarianship*, and the blog Boxes and Arrows. These resources were not referred to because of our decision to use only academic articles (see first section). Accordingly, we believe that the expression “IA” is somehow broad, considering that it applies all the more to websites providing information to the outside world, not within a corporation. Thus, from now on we will adopt the term EIA for our approach.

### 3 | TOWARD A THEORY FOR EIA

In the prior section, we defined the main topics identified in the LIS literature. Here, we put forward a formulation

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**TABLE 1**  IA as a blueprint

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<th>Topic</th>
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**TABLE 2**  Classification as central issue for IA

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<th>Topic</th>
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<td># 2: The centrality of classification and knowledge organization (KO) for IA.</td>
<td>IA includes classification structures that determine classes and subclasses distributed through a hierarchy, according to KO theories. Both the structural model of the content for IA and the user’s conceptual organization of the content are essentially based on a hierarchy. IA relies on classification principles to assure the coherence of the information structure in a corporation. IA makes use of principles of knowledge organization: Classification systems; for example, taxonomies, thesauri, facet classifications, and ontologies.</td>
<td>Toms (2002) Cunliffe et al. (2002) Jacob and Loehrlein, 2009 Hjørland (2019).</td>
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for EIA that will be complemented as the investigation follows:

“EIA is a metaphor that corresponds to a set of building architectural processes required for knowledge and information organization. Among these latter views, information and knowledge structure are the backbones capable of guiding the whole project of EIA. EIA has a broad coverage not limited to web environments. The orientation by which to approach EIA in corporations may be top-down by employing a theory.”

Accordingly, it is appropriate to develop a theory composed of models according to a top-down approach. Indeed, theories should have a deductive direction (Reynolds, 2007). Hence, we developed some basic theory composed of ontological models, which, in turn, are able to work as a hierarchical structure for EIA. It is beyond the purposes of this article to investigate the literature of models and theories, as it is extensive and nonconsensual; however, some basic notions about theories, models, and ontological models are in order.

In general, scientists are satisfied with a rough understanding of nature, describing selected groups of phenomena and neglecting others that are not relevant (Reynolds, 2007). Science makes use of models and theories as instruments to achieve such understanding. These two terms are often seen as synonymous; however, there are differences in their meanings. While models are generally identified as representations of a specific part of reality, theories consist of a set of statements logically organized, capable of explaining general events (Downes, 1992).
With respect to the value of models and theories for scientific practice, two positions are typically highlighted (Reynolds, 2007): (i) the syntactic view of theories (Carnap, 1938; Hempel, 1965) and (ii) the semantic view of theories (Giere, 1988; Van Fraassen, 1980). While the former take models as systems of rules to interpret an abstract calculus, the latter states that theories are containers of a semantic component that renders them with superior appeal.

There are models and theories created in the scope of LIS (Pettigrew & McKechnie, 2001). Indeed, the existence of well-founded models and theories is indicative of the scientific maturity of either a discipline or field. This idea matches the need of theories for EIA. As noted, we choose to represent our basic theory for EIA, the structural part, through ontological models that renders them with superior appeal.

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![FIGURE 1 Views of an architectural project (left) corresponding to IA views (right)](image)

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Therefore, ontological models, in addition to being components of a theory, are able to encompass all raised topics discussed in the prior section: (i) they meet several LIS authors’ claims that hierarchy is ubiquitous for EIA, (ii) they can be built using well-founded and tested top-level ontologies, (iii) they favor the structural component of EIA closely related to KO and LIS tenets, and (iv) they contain both syntactic and semantic resources according to the view of scientific theories. Ontological models can be a good guide to begin with in EIA, and their use does not exclude bottom-up verifications.

In light of the above, our theory is built according to the following sequence: (i) a background for a top-level ontological model to explain the spatiotemporal elements of a corporation, (ii) a background for a middle-level ontological model to explain the social elements of a corporation, (iii) a historical characterization of corporations, (iv) an ontological analysis of corporations according the two aforementioned elements, and (v) a characterization of documents as key entities capable of driving EIA projects.

4 | BACKGROUND TO APPLIED ONTOLOGY

In this section we provide summarized information about the required background to understand ontological models, which are fundamental to develop our theory for EIA. First, we briefly explain spatiotemporal ontologies (Grenon & Smith, 2004), as well as co-related theories, which allows one to represent the most generic entities existing in time and space. We then advance a set of theories that have been gathered under the label Social Ontology (Jansen, 2009).

4.1 Essentials in spatiotemporal ontology and whole-part theory

Basic Formal Ontology (BFO) (Grenon, Smith, & Goldberg, 2004) combines a spatiotemporal view and a top-level ontological orientation, which means that it is an ontological model created to represent the most general classes of entities for purposes of automatic reasoning (Smith, 2004). We chose BFO because it has been developed by philosophers (Arp, Smith & Spear, 2015) and therefore, it is closer to Humanities and Social Sciences tenets. For the sake of brevity, we describe just the essentials of BFO levels relevant to understand the material nature of corporations. A full account of BFOs can be found in Grenon and Smith (2004), Spear (2006), and Arp, Smith & Spear (2015).

BFO is comprised of two distinct groups of entities: (i) continuants, which are substantial entities that endure over time while maintaining their identity (that is, a person, a fruit, an orchestra, a law) and (ii) occurrents, which are processual entities that unfold and develop through time (that is, the respiration, the functioning of a body organ, life). Continuants (BFO’s third level, left side of Figure 2) include other kinds of entities among which “object” is the prototypical one. There are also other
kinds of entities under occurrents (BFO’s third level, right side of Figure 2), among which “process” is the prototypical one.

We need two co-related ontological theories to deal with wholes and parts in the spatiotemporal realm—Mereology and Granular Partitions—that are relevant to characterize the corporation and its units (sectors, departments, divisions, and so forth). In the scope of Mereology (Simons, 1987), one can find the following types of wholes: summative (that is, a set), integral (that is, an organism), and aggregate (that is, a pile of rocks).

The Theory of Granular Partitions (Smith & Bittner, 2008) is based on partitions, understood as cognitive mechanisms that people employ to label and sort activities performed by other people. In this context, objects can be either bona-fide objects or fiat objects: while the former exists independently of human demarcating activities, the latter exists only because of the very same activities (Smith & Bittner, 2008). An example of bona-fide limit is the Atlantic Ocean coastline of the State of New York; an example of a fiat limit is the border between the states of New York and Pennsylvania.

The formal Theory of Granular Partitions is comprised of two subtheories: Theory A reflects the notion that partition units can recognize fiat objects according to human cognition, and Theory B explains how fiat objects are created through the projection of partitions in reality (Smith & Bittner, 2008). These two theories are depicted in Figure 3.

According to Theory A, we form partitions dividing reality into units and subunits, also called, respectively, cells or subcells. An example is the relationship between a class of fruits and a class of food (see Figure 3). Units can be nested one inside the other, constituting subunits. Conversely, Theory B is the theory between partitions and reality; for example, the relationship between the fruit partition and fruits in reality (Figure 3). Theory B allows one to project partitions onto reality and to locate objects in the partition.

4.2 | Essentials in social ontology

An expressive number of entities ubiquitous in Business, Economic, Social, and Legal Sciences have recently been addressed from an ontological perspective. This perspective has been identified by the label “Social Ontology” and employed to characterize studies that seek to understand the ontological status of social entities beyond the spatiotemporal realm (Jansen, 2009). To reach the analysis required to explain the social dimension of corporations, we advance speech acts (Austin, 1962) and document acts (Smith, 2012).

The Theory of Speech Acts, originally a subject of the Philosophy of Language, was introduced by John Langshaw Austin in the 1960s establishing that, in any language, a speaker performs three types of acts: locutionary acts, in which one is speaking the words with the meaning they really have; illocutionary acts, in which one is using the words to ask a question, give an order, make a promise, and so forth; and perlocutionary acts, employed to convince someone to do something (Austin,
Austin focused on certain kinds of sentences that lead to actions, or performance acts, and he called them performative sentences (Morris, 2007). Speech acts as performative sentences allow one to do things, in contrast to declarative sentences, which are simply descriptive (Searle, 1995). For example, when John promises Mary to take her for a walk, the utterance creates an obligation to John (to take Mary for a walk) and a right to Mary (to have a walk with John). Speech acts are capable of creating obligations in society, in distinctive levels of formality. Accordingly, speech acts also create corporate obligations.

Nonetheless, speech acts are evanescent as a result of their inherent orality: it only exists in the moment of its performance. On the other hand, documents are continuous entities, able to persist in time, while absorbing changes through their history. In small communities, promises and obligations can be established through speech acts, but this cannot be maintained in large societies. This is the basis for the Theory of Document Acts (Smith, 2012). This theory establishes that documents not only record information, but create a variety of social and institutional powers, which, in turn, allow the establishment of ways of life in society. Therefore, as speech acts, document acts are able to create claims and obligations in society, yet in an extended fashion (Smith, 2012).

To implement the Document Act Theory, we use the Ontology of Document Acts (Brochhausen, Almeida, & Slaughter, 2013), a middle-level ontological model that has been developed to represent legal roles that documents can assume in society and, consequently, within corporations. The Ontology of Document Acts (henceforth, D-acts Ontology) was created under BFO, presuming that claims and obligations are subtypes of sociolegal generically dependent continuants, which, in turn, are subtypes of BFO’s generically dependent continuants (see Figure 2).

For the sake of brevity, we show only two branches of D-acts Ontology relevant for explaining the social dimension of corporations. One branch concentrates on the roles required to trigger a document act (see Figure 4): (i) the obligee role, (ii) the obligor role, (iii) the declaration target role, (iv) the D-acts template creator role, and (v) the D-acts performer role. There is another branch that gathers documents and acts that contain (Figure 5): (a) social acts, (b) declaration, (c) document acts, (d) documents, and (e) d-act input documents. The two branches are linked by the class “declaration” that appears in both Figures 4 and 5. Moreover, there are classes depicted by a shaded rectangle that are not D-acts classes, but BFO classes that illustrate the connection with the top-level Ontology.

The use of the Document Acts Theory and the related ontological model (D-acts Ontology) assigns a central role to the entity “document” in the scope of the theory under development. Thus, we provide a second formulation for our theory adding documents to the first attempt:

“EIA is a metaphor that corresponds to a set of building architectural processes t required for knowledge and information organization. Among these latter views, information and knowledge structure are the backbones capable of guiding the whole project of EIA. EIA has a broad coverage, not limited to organizing web environments. The orientation to approach EIA in corporations could be top-down by employing a theory. The key entity to the theory is the document entity, in the sense in which some of them are capable of creating claims and obligations within the corporation at different levels.”

5 | AN ONTOLOGICAL INVESTIGATION OF CORPORATIONS

In this section, we provide an ontological analysis of corporations using the background knowledge presented in
the fourth section. Since ontology as a discipline deals with what exists, we first try to understand the roots of the concept of corporations through historical overviews from law and business. We then provide the analysis in two parts: descriptive, which considers the physical dimension, that is, what a corporation is from a spatio-temporal perspective, and normative, which considers what a corporation is from a social perspective. Only these two views combined can furnish a suitable ontological framework to explain what a corporation is.

5.1 | The nature of corporations: Historical, law, and economic views

The notion of the corporation has roots in Roman civil law from the ninth century (Williston, 1888). During the 13th century, Pope Innocent IV promulgated a theory about “ecclesiastical bodies” as personae ficta; that is, they do not have body or soul, and thus, could not be punished. A substantial understanding of the legal nature of corporations already existed when the English Crown chartered the first
business corporations during the 15th century. The pioneer jurists who formulated treaties defining a corporation and its legal attributes were, Sir Edward Coke (early 18th century), Sir William Blackstone (middle 18th century), and Steward Kyd (late 18th century) (Dewey, 1926).

These first jurists, while keeping old ecclesiastical bodies in mind, described the corporation in a formal way that still applies to current business corporations. Therefore, a corporation is: (i) a legal unit with its own legal rights and responsibilities, (ii) an entity distinct from the constituent individuals who are its members over time, and (iii) an entity that could achieve legal status by an act of the state.

The classical formulation of these main attributes has come to be known as the “artificial person” doctrine of the corporation (Koessler, 1949). In the Anglo-American world, the formulation in which a corporation is treated as a person has been widespread; however, in some European countries different theories arose (Dewey, 1926). The best-known theories are described in Table 6:

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<th>Theory</th>
<th>Description</th>
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<td>Fiction theory, also called artificial person, concession theory, purpose theory.</td>
<td>It was stated by Friedrich Carl von Savigny (German jurist and historian, 1779–1861), proposing a fictitious person to solve the issue of who the real owner of a property is, since a property, by law, can belong to a corporation.</td>
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<tr>
<td>Real entity theory, also called group theory, organic theory.</td>
<td>It was proposed by Johannes Althusius (German jurist, 1,563–1,638) and later by Frederic William Maitland (English lawyer, 1850–1906), considering that corporations have a real will; they are social organisms, which law has no power to create, but only to recognize.</td>
</tr>
<tr>
<td>Associational theory, also called symbolist theory, bracket theory.</td>
<td>It was stated by Rudolph Ritter von Jhering (German jurist, 1818–1892), suggesting the corporation is an economic device by which one can simplify legal relations.</td>
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More recently, some features of the corporation have been acknowledged as commonplace: (i) they maintain their identity over time, (ii) they have real existence separate from their members, (iii) they are artificial entities, (iv) they are equal to their parts, and (v) they are long-lasting entities (Blumberg, 1993). In the next sections, we check these features against an ontological analysis, which reveals the multitude of entities, both natural and social, that comprise a corporation.

5.2 | The descriptive ontological analysis

We make use of the formal ontology machinery presented in the fourth section to describe the structure of a corporation according to a descriptive dimension. Descriptive (or scientific) statements describe facts as either true or false (Sparkes, 1991). In our approach, the descriptive dimension considers, in addition to what a corporation is in the spatiotemporal view, the way in which a corporation is organized into units and subunits. We list the aforementioned features for corporations, adding to them details according to the ontological parlance for better characterization:

1. They maintain their identity over time, which means that they remain numerically one and the same over time.
2. They have real existence separate from their members, which means that they do not depend on other entities unless they are constitutive entities.
3. They are artificial entities, that is, corporations can only indirectly stand in as causal relationships, through their members, as they do not exist through a natural process.
4. They are equal to their parts, which indicates that can be considered a specific type of a whole.
5. They are long-lasting entities, which means that it may be continuants.
Now the strategy assumes that the corporation and its units are entities of BFO, and then check the correctness of that assumption.

First, we check whether corporations are independent continuants. At any given time, all of a corporation’s parts are present, and its existence does not depend on other distinct entities. Therefore, the answer for the first verification is that corporations can be represented as a BFO’s independent continuant (Vizenor, 2006). The path in BFO’s hierarchy (see Figure 2) is: thing $\rightarrow$ continuant $\rightarrow$ independent continuant.

The second verification discusses what kind of “whole” a corporation is:

- Are corporations summative wholes? Summative wholes are defined by their constituent parts and they do not conform to the intuitive notion that corporations can preserve identity even undergoing changes in membership.
- Are corporations integral wholes? Different from corporations, which are not maximally connected, integral wholes exhibit strong connections.
- Are corporations aggregate wholes? Aggregate wholes have detached parts; they are material entities consisting exactly of a plurality of objects, and these objects are member-parts of it at all times at which it exists.

Therefore, the answer for the second verification is that corporations are aggregates (Vizenor, 2006). The full path in BFO’s hierarchy (see Figure 2) is: thing $\rightarrow$ continuant $\rightarrow$ independent continuant $\rightarrow$ material entity $\rightarrow$ object aggregate.

The Granular Partitions Theory considers how people divide the world through cognitive acts. Using Theory A, one can define units, subunits, as well as the relationships between them. In Figure 6, an automobile company is partitioned into two subunits, namely, the Human Resources Department and the Board of Directors.

Likewise, with the application of Theory B to corporations, one can define the projection relationship (from a cell to reality), as illustrated in Figure 7. The same automobile company encompasses the location relationship (from an object to a cell). For example, “real” John projects onto the John cell within the corporation, and the John cell is located within “real” John. We can also say that the Human Resources Department is a cell within the corporation, but the minimum cell is John. The same relationship holds true for Mary.

5.3 | The normative ontological analysis

A normative statement is concerned with which has to be done (or not) (Sparkes, 1991). As presented in the prior section, if a corporation can be considered a maximal cell (a cell in which every other cell is a subcell), then corporate units are cells and subcells. Thus, units and subunits are fiat object parts. As such, they come to existence through human cognition. Since corporations are long-lasting entities, the correspondent fiat object must be sustained in reality. This is done when the verbal form of corporate norms is translated to the written form.

To explain the verbal form, we use the Theory of Speech Acts. To explain the written form, we use the Theory of Document Acts (see fourth section).

From a prescriptive analysis, the corporation is a kind of aggregate in which units are fiat objects defined by cognitive partitions. Thus, one can say that a colony of ants or a swarm of bees are also aggregates. Nonetheless, in contrast with a colony of ants, corporations have normative partitions. D-acts Ontology contains social entities that allow the proper representation of facts in society, including those related to normative partitions. It incorporates the kinds of acts listed in the Document Acts Theory, namely:

- Social acts: processes carried out by one and directed toward another one.
- Declarations: social acts that bring about, transfer, or revoke roles.
- Document acts: declarations made using a document to temporally extend its effects.
- Several kinds of roles: entities that are not essential for the existence of an entity.

In the context of D-acts there are several roles assigned to agents that participate in a document acts process. To understand the operation of D-acts Ontology, we will examine a consent letter that one has to sign to permit the process of blood donation at a blood bank.
A consent letter is a document that triggers claims and obligations, because when one signs it, s/he gives license to a nurse to perform blood donation procedures. In this case, the declaration is performed by a candidate to donate blood, which verbally or written, gives consents for a nurse to draw blood. The document act is the process of a person signing a consent letter, authorizing the procedures to draw blood. The D-act input document is the consent letter. The doc-act template creator role is the role of clerks in managing the blood bank, while the declaration performer role is the candidate who donates blood. Finally, the declaration target is the person who acts as a phlebotomist.

6 | EIA ORIENTED BY ONTOLOGICAL MODELS: PUTTING IT ALL TOGETHER

Now we will put all the theories and resources together to reveal the core of the theory for EIA. A fictitious case of recruitment in the fictitious XYZ Corporation illustrates the operation of ontological models in composing the structural component of IA projects.

“XYZ Corporation needs to hire a new Sales Manager to face an unexpected increase of sales. The Executive Secretary of the Board of Directors prepares an official memorandum, properly stamps, and sends it to the Human Resources Head. The head signs the memorandum that allows recruitment of a new Sales Manager and sends it to the Human Resources Manager, who also signs it. The Office Clerk responsible for the recruitment procedures receives the memorandum that triggers the recruitment process within the Human Resources Department. The process of recruitment is then performed according to the Recruitment Policy of XYZ Corporation. The selection of candidates takes place.”

The prescriptive dimension provides the characterization for corporations and their parts. As we have seen
(fourth section), corporations are represented by an aggregate of units, so XYZ Corporation is an instance of the BFO’s Object Aggregate class. Similarly, a unit of XYZ Corporation, in this case, the Human Resources Department, is an instance of the BFO’s Fiat Object Part class (Figure 8). This finding solves part of the puzzle of the ontological status of a corporation.

The normative dimension provides the characterization for the claims and obligations that take place within the corporation. To represent this situation, we must identify D-acts entities in the recruitment case (Figure 9):

- The document act is the process of signing and stamping the official memorandum written by the director.
- The document act input document is the official memorandum, which legally enables the recruitment process.
- The document act template creator role is the Human Resources Manager responsible for the recruitment process.
- The document act performer role is the director role.
- The declaration target role is the human resources clerk responsible for the recruitment procedures, which becomes endowed with the right to perform procedures enabling the recruitment (Figure 9).

In Figure 10, the lower level is reality. Through cognition, people create partitions of reality. The granular partitions are used to create the intermediary level, including the relationships between reality and partitions (projections), then the relationships between partitions and the BFO top-level.

In Figure 11, the lower level still represents reality. However, the intermediary level is now D-acts Ontology, where we have roles, documents, and document acts connected to reality through relationships as “bear of,” “realizes,” and “is input.” The third level is still BFO, and one can notice the connections between D-acts Ontology and the BFO top-level via the relationships between “is a” and “concretizes.”

Finally, Figure 12 put together the levels presented thus far, namely, partitions and document acts. Adding BFO, we compose the full picture to structure the theory.
**FIGURE 10** Reality, partitions, and BFO (prescriptive dimension)

**FIGURE 11** Reality, D-acts Ontology, and BFO (normative dimension)
At this moment, we are ready to put forward the full characterization of our theory, “Document-Centered Ontological Theory for EIA.”

The starting point for our theory is the first empirical initiative registered in some of the main LIS publications (see third section), which work here as some available empirical evidence. The main theoretical foundations are top- and middle-level ontological models plus complementary theories (see fourth and fifth sections). We now present definitions and axioms that compose the theory in a formal sense, which are the components of the employed ontological models. Since the prescriptive dimension is used only to determine the ontological status of a corporation, for the sake of brevity we represent only the normative dimension centered in the documents and their acts.

The following notation is employed in descriptions presented below: classes are written in **bold**, relationships are written in *italics* (words separated by underscores), and OPERATORS are written in capital letters. The axioms are written in a syntax for Web Ontology Language (OWL), called *Manchester Syntax* (Horridge et al., 2006), in which the terms *some* and *all* are operators corresponding, respectively, to logical existential and universal quantifiers.
OWL is a type of description logic (Baader, Horrocks, Lutz, & Sattler, 2017), a decidable fragment of the first-order logic, which exhibits a well-defined semantics (Patel-Schneider, Hayes, & Horrocks, 2004). Thus, the theory represented by the following definitions and axioms (from Tables 7–14) conveys not only a syntactic character, but it pertains to the semantic view of theories (see third section). As we have been evolving a formulation for EIA, it is possible at this point to write the final version.

"EIA is a metaphor that corresponds to a set of building architectural processes required for knowledge and information organization. Among these latter views, information and knowledge structure are the backbones capable of guiding the whole project of EIA. EIA has a broad coverage, not limited to organizing web environments. The orientation to approach EIA in corporations could be top-down by employing a theory. The key entity to the theory is the document entity, in the sense in which some of them are capable of creating claims and obligations within the corporation at different

**TABLE 9**  
Formal definition of declaration, adapted from Brochhausen et al. (2013)

<table>
<thead>
<tr>
<th>Entity: Declaration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
</tr>
<tr>
<td>Example</td>
</tr>
<tr>
<td>Axiom</td>
</tr>
</tbody>
</table>

| Elucidation 1. | The relation of\textit{realization} (in the axiom) is the BFO relation between a generically dependent continuant (realizable entity) and an occurrent (process), for example: The role of a doctor is realized when s/he examines or treats patients. |

| Elucidation 2. | The relation of\textit{bearer_of} (in the axiom) is the BFO relation between an independent continuant and specifically dependent continuant, for example: John is the bearer of John’s headache. |

**TABLE 10**  
Formal definition of legally revokes, adapted from Brochhausen et al. (2013)

<table>
<thead>
<tr>
<th>Entity: Legally revokes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
</tr>
<tr>
<td>Example</td>
</tr>
<tr>
<td>Axiom</td>
</tr>
</tbody>
</table>

**TABLE 11**  
Formal definition of document act, adapted from Brochhausen et al. (2013)

<table>
<thead>
<tr>
<th>Entity: Document act</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
</tr>
<tr>
<td>Example</td>
</tr>
<tr>
<td>Axiom</td>
</tr>
</tbody>
</table>

**TABLE 12**  
Formal definition of declaration performer role, adapted from Brochhausen et al. (2013)

<table>
<thead>
<tr>
<th>Entity: Declaration performer role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
</tr>
<tr>
<td>Example</td>
</tr>
<tr>
<td>Axiom</td>
</tr>
</tbody>
</table>

| Elucidation | The relation of \textit{inhering} (in the definition) is the BFO relation between a dependent continuant and independent continuant, for example: The thought of Einstein inheres in Einstein. |

**TABLE 13**  
Formal definition of declaration target, adapted from Brochhausen et al. (2013)

<table>
<thead>
<tr>
<th>Entity: Declaration target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
</tr>
<tr>
<td>Example</td>
</tr>
</tbody>
</table>
| Axiom | \( \text{(human \ OR \ corporation) \ AND \ bearer_of \ SOME \ ([\is_concretization_of \ SOME \ SGDC] \ AND \ participates_in \ SOME \ declaration}) \)
levels. All the representational models that comprise the theory are supported by formal axioms with well-defined semantics, written not only for computational purposes, but also for the sake of reducing ambiguity, improving communication, and providing guidance to EIA projects."

Finally, we provide some basic guidance about how to start using the theory. The suitable starting points are the entities, “document” and “document act.” In the corporate environment, one should identify the document acts and the corresponding documents that are the inputs of these document acts. One should remember that not all documents are bearers of document acts. In identifying these special types of documents, the information architect can also recognize the corporate processes involved in the formal power chain of the corporation, and then collect relevant information to instantiate each class of the ontological model.

The information architect can also organize information regarding the document acts produced, the involved documents, and the several kinds of roles that people assume in the workflow of the corporation. By doing this, the architect is mapping all the objects and processes that portray the corporate reality. Indeed, Document Acts Theory enables one to record the cause of claims and obligations in which people perform social acts by filling out the appropriate paperwork and approving it with appropriate authorities, bringing into being new types of ownership relationships in business corporations (Smith, 2012).

### Table 14

**Entity: Document act template creator role**

<table>
<thead>
<tr>
<th>Definition</th>
<th>A role that inheres in a human being or corporation that prepares a document that is the specified input to a document act and is the input document of a document act.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>The role of the US citizenship and immigration service realized by the creation of an immigration form being filled in.</td>
</tr>
<tr>
<td>Axiom</td>
<td>inheres_in SOME ([human being OR corporation] and is_realized_by ONLY (process AND has_specified_output SOME [document AND participates in SOME document act]))</td>
</tr>
</tbody>
</table>

7 | FINAL REMARKS

In this article we articulated a theory for representation of an information structure with the aim of improving IA initiatives. To reach our goals, we described both top- and mid-level ontological models that comprise levels of representation in formal corporations, and acknowledging that our approach is better characterized as a subset of IA we called EIA. We then provided well-founded theories that help us in the representation of corporations, according to a system of classes, namely, an ontological model. We also chose the document as a key entity for our theory, not the documents that only record information, but those capable of giving rise to obligations. According to this view, documents are able to explain the diversity of both actions and decisions within the corporation and guide EIA activities. With the theory sketched in the last section, what is left is to test the theory, to offer our final remarks, to explain limitations, and present future developments.

To include a test of what we submit as a theory, we briefly enumerate the desirable characteristics of scientific knowledge (Reynolds, 2007):

1. Abstractness.
2. Intersubjectivity regarding both meaning and logical rigor.
3. Empirical relevance.

The characteristic of abstractness, the independence of time and space, is fulfilled by our theory, as it is not related to a temporal (historical) time or specific spatial location. Indeed, both BFO and D-acts Ontology classes are conceived to be as general as possible, and historical aspects were used simply as clues for ontological analysis.

The theory also fulfilled the characteristics of both kinds of intersubjectivity because there is first an explicit meaning for the top- and middle-level terms employed, as well as a logical system that makes these terms formally defined without ambiguity. This means that, if a term is not totally consensual, where at least one can know exactly what its intended meaning is through logical axioms, working as a way of vocabulary control. If underlying ontological theories as presented do not satisfy one, s/he can choose their own ontological model as a guide to structure EIA. While one may use another subjacent ontological model, the desirable characteristics of scientific knowledge maintain validity in the form of a theory for EIA, as articulated here.

Finally, the characteristic of empirical relevance is fulfilled in the sense that there is the possibility that other scientists evaluate the correspondence between the theory and the results of the empirical research carried out after the proposition of the theory. We employed philosophical grounds and provided examples; however, it is clear that additional empirical investigation is required to complement these first steps.
The most important result is that some basic formal theory is reached, as one of the main claims in the LIS literature is the lack of a theoretical basis for EIA, constraining its construction to ad-hoc and informal procedures. One can think in a knowledge formalization continuum in which knowledge elicited in diverse units of the corporation can be represented at different degrees of formality: “[...] in the extreme cases knowledge about a domain is given as data at a very informal level (images, text) or the knowledge is represented by formal knowledge representations [...]” (Baumeister, Reutelshoefer, & Puppe, 2011, p. 3). It should be noted that all other subprojects that could comprise a full IA project are not covered, as explained in the third section.

As limitations, we note that the information architect must acquire some background knowledge on ontology as a discipline, involving not-so-simple philosophical insights. Moreover, background in ontologies as artifacts, including an extensive range of technological developments in the scope of the Semantic Web must be investigated. Another limitation is that the theory did not consider the many kinds of recorded information in a corporation. One solution to mitigate this issue is to expand EIA theory to include the ontological model of Information Artifact Ontology (IAO) (Ruttenberg, 2009). IAO can deal with documents that only record information and have been developed as D-acts Ontology under the BFO.

While the necessity of this theory and framework may be questioned, as there are several so-called standard architectures or methodologies for business available, that is, TOGAF Standard or the ArchiMate Tool (The Open Group, 2019a, 2019b), our framework takes advantage of well-founded and solid philosophical principles, which can turn the ontological model into a rigorous meta-model capable of reducing the inherent ambiguity of other models. This use of metaphysical principles in modeling is not a novelty. The idea was first cited in the 1960s (Mealy, 1967), but implemented only in 1980s (Wand & Weber, 1990).

In addition, while the meaning of some of the entities of a certain model may be ambiguous, our framework posits exactly what the model means through the definitions in common language supported by logical axioms. The rationale for using granular partitions is the Aristotelian principles embedded in BFO, as well as the legal tenets in D-acts. Thus, incorporating them as premises for our own theory means that it will have a logical counterpart and be ready for implementation in systems like those we have seen in the Semantic Web.

Finally, it is worth emphasizing that the connotation of documents that we adopt do not challenge any established theories of Information Science, in which the document is the central subject and a valued concept. Some documents may be used to record information; however, this article deals with those that create claims and obligations for people, as well as new social facts in society.

In future developments, we intend to construct our theory in a clearer and more accessible way for researches and practitioners, since, as mentioned, they are grounded in somewhat less straightforward philosophical theories. A relevant demand is also to obtain empirical data from a real application of the theory, a requirement to effectively test if the theory meets the principle of empirical relevance. With some background established here, future articles should favor the empirical side. Indeed, this activity is already in progress with the application of the theory in government systems architecture for purposes of integration.

ACKNOWLEDGMENT


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REFERENCES


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