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Information Architecture for Organizations: An Ontological Approach

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Abstract

In the scope of corporations, information and knowledge management are essential practices that are carried out through information systems. In this chapter, we discuss the foundations of an ontological-based architecture for organizing information and knowledge within corporations. Our research focus on three main efforts: (i) to shed some light on the ontological status of corporations, (ii) to understand the relations between corporate units, and (iii) to approach the duties that corporations have to manage. After presenting background theories, we analyze the corporation through two dimensions, namely, a descriptive and a normative. While the former approaches the structure of the corporation from the point of view of its units, the latter approaches it from the point of view of duties and obligations. The descriptive side of our investigation is conducted through principles of top-level formal ontologies; the normative side is addressed through the so-called social ontology. The relevance of developing such analysis rests on the need of a better understanding of corporations, its structures, and its activities. Such insight can provide a formal framework suitable to be applied in information systems, working in the context of modern technologies like the Semantic Web.

Keywords: corporation, ontology, theory of corporation, knowledge management

1. Introduction

In recent years, corporations have made significant investments in information and knowledge management initiatives mainly through the development of information systems. Among the many techniques utilized for this end, ontologies are an alternative that have received an increased amount of attention [1–3].

Ontology is a term originated in Philosophy also employed to describe a hierarchical structure composed by entities and relations for purposes of representation. The issue of defining ontologies lies on the fact that different research communities have adopted different perspectives: Computer Science, for example, Artificial Intelligence, Databases, and Software Engineering; Library and Information Science; and Logic and Philosophy, to mention but a few [4].

A diversity of initiatives for using ontologies in corporations can be found in the literature since the 1990s [5–8]. However, the research on ontologies lacks an applied ontology approach for corporations that mirror two main applications of ontologies: ontology as an inventory of entities for information systems modeling and ontology as a formal theory for purposes of automatic reasoning. This chapter presents an ongoing research that seeks to cover this gap. At this point of our ongoing research, we focus on three efforts: (i) to shed some light on the ontological status of corporations, (ii) to understand the relations between corporative units, and (iii) to approach the duties that a corporation has to manage.

In order to reach our purposes, we first present a background of formal theories and doctrines of the nature of corporation. Subsequently, we provide an analysis of the corporation through two dimensions, namely, a *descriptive* and a *normative*. In the *descriptive dimension*, we approach the structure of the corporation from the point of view of units and subunits; in the *normative dimension*, we approach the structure of the corporation from the point of view of its rights, duties, and obligations. In the descriptive side of our investigation, we employ principles and notions of top-level formal ontologies; in the normative side, we make use the so-called social ontology approach, including theories of social acts, speech acts, and document acts.

We believe in the relevance of developing this kind of analysis in order to improve the understanding of both corporations and the activities that take place within them. We also can provide a formal framework to be applied in the context of modern technologies like the Semantic Web. In addition, an ontological theory for corporations can be the basis for architecture for organizing information and knowledge within corporations, allowing the integration and coordination of the extensive variety of information systems in charge of corporate procedures.

The remaining part of the chapter is organized as follows: Section 2 provides some introductory background; Section 3 presents an overview of the main doctrines, legal and economic, about the nature of corporations; Section 4 addresses corporations through an ontological analysis; Section 5 discusses our findings; and finally, Section 6 presents our final remarks and prospects for future research.

2. Background

In order to properly understand our organization of entities that compose a corporation from an ontological point of view, we need to explain essentials of some subjects. This section

brings those explanations organized as follows: Section 2.1 explains the basic of the discipline of ontology; Section 2.2 explains formal ontology and top-level ontology; Section 2.3 briefly presents ontological theories related with whole and parts; and finally, Section 2.4 deals with essentials of the social ontology.

2.1. Essentials of ontology

Ontology is a term that assumes diverse connotations in different scientific fields like Philosophy, Computer Science, and Library and Information Science.

In *Philosophy*, ontology is a branch of Metaphysics, which includes notions of being, identity, change over time, dependency, quality, and so forth. Systems of categories structured in hierarchical levels are the most important topic to be studied in any ontological approach. There are several philosophical systems of categories developed since ancient times, but new systems have been introduced in the last 50 years, for example, see [9–12].

It is worth mentioning a relevant distinction about ontology within Philosophy, which is not always apparent, but is important for our purposes here. The term ontology, in general, refers to which one could call “natural ontology.” Such a natural ontology corresponds to an exhaustive classification of natural types and relations by which entities are tied together. When one says “natural types,” she should not consider the realm of artifacts created by humans [13]. In contrast, there is another philosophical approach one can call the ontology of the social reality, or “social ontology,” which deals with the full range of human artifacts and social devices, for example, money, property, governments, nations, marriages, and so forth [14].

In *Computer and Information Science*, two senses for the term ontology are considered the most important: (i) the use of ontological principles to understand and represent reality, as support to modeling activities [15] and (ii) the representation of a domain of knowledge through a formal language to be processed by automatic reasoners [16]. In the former application, ontology is aligned with its original role of providing an account of reality; in the latter application, it corresponds to a software engineering artifact.

As a result of the current widespread prevalence of digital resources, new category systems for knowledge representational have been developed to meet specific goals of modeling, automatic reasoning, and information retrieval. The most currently referenced systems are DOLCE, which stands for *Descriptive Ontology for Linguistic and Cognitive Engineering* [17], and BFO, which stands for Basic Formal Ontology [18]. This kind of category system, in general is called as top-level ontology, conveys the two senses of the term ontology: they are computational artifacts founded in philosophical theories specified in a formal language.

In the context of the research conducted under the label applied ontology, a well-known approach is the so-called ontological realism [19]. The main instrument of ontological realism, largely applied in the information systems realm, is BFO. As a top-level ontology, BFO intends to define the most generic categories and provides means of categorizing entities in a domain to be represented. BFO has a large acceptance in medicine, biology, bioinformatics, and related fields.

2.2. Formal ontology and levels of BFO

Defining “formal ontology” is not a simple endeavor. Ref. [20], for example, dedicates a full chapter in trying to accomplish such a task. There are, certainly, several good definitions in the literature, but we do not discuss the merits of each one here. For the sake of simplicity, we adopt the notion of formal ontology as the set of terms specified in logical statements and applied to represent the reality in a domain. In this sense, BFO can be called a top-level formal ontology. In the remaining part of the section, we describe the BFO’s levels.

BFO is comprised by some levels of well-characterized kinds of entities. We do not describe all levels here, but just that one required to understand the essentials of BFO, which is adopted as the starting point of our investigation. A full account of BFO can be found in Ref. [21]. Several examples presented here are due to Ref. [22]. All levels and categories mentioned are depicted in **Figure 1**.

BFO’s first level has the general designation of “entity.” The second level (below) acknowledges two distinct groups of entities. On the one hand, it considers substantial entities called *continuants*; on the other hand, it considers processual entities called *occurrents*. Continuants endure over time while maintaining their identity. Examples of continuants are a person, a fruit, an orchestra, and a law. Occurrents happen, unfold, and develop through time. Examples of occurrents are the respiration and the functioning of a body organ, a part of your life.

Listed under continuants, BFO’s third level contains three categories: (i) *independent continuants*, (ii) *specifically dependent continuants*, and (iii) *generically dependent continuants*. Independent continuants are bearers of qualities, that is, there are qualities that inhere in them, for example, the red color that inheres in a tomato. Specifically dependent continuants are entities that depend on one or more specific independent continuants for their existence, for example, the pain in my

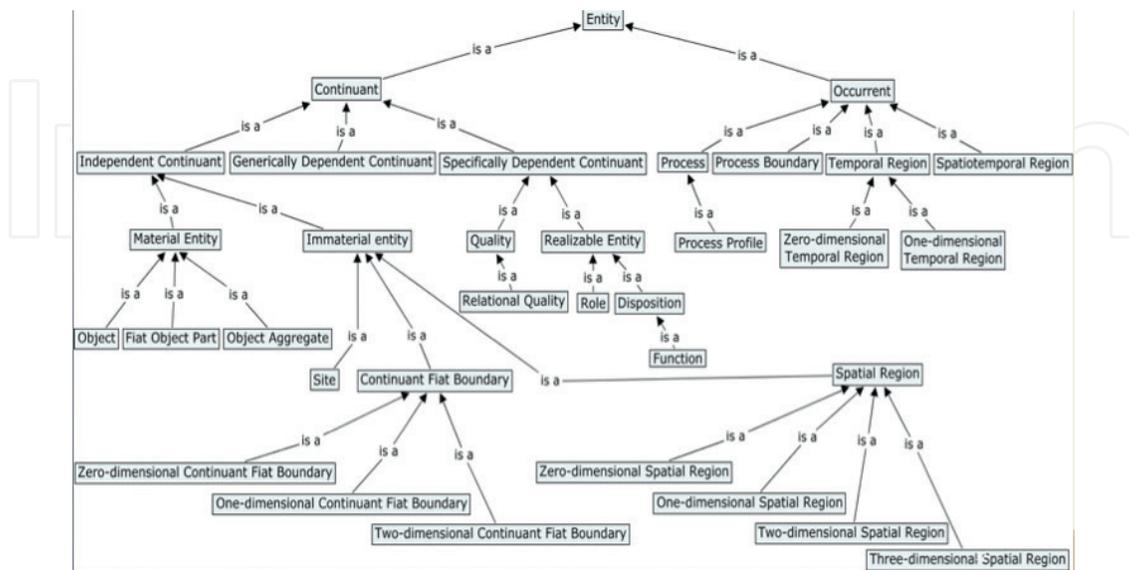


Figure 1. BFO top-level ontology, its levels, and its categories. Source: [21].

head depends on me, the disposition of fruits to decay depends on fruits, and the role of a professor in a university depends on a person. Generically dependent continuants are entities that also depend on independent continuants, but in contrast to specifically dependent continuants, the instance that works as bearer can undergo changes over time. One example is the *Odyssey* by Homers that has many bound copies.

Under occurrents, BFO's third level contains four categories: (i) *processes*, (ii) *process boundaries*, (iii) *temporal regions*, and (iv) *spatial temporal regions*. Processes are entities that unfold in time, have temporal parts, and always maintain a relationship of participation with independent continuants. Examples are the process of digestion, the course of a disease, and the flight of a plane. Process boundaries, temporal regions, and spatiotemporal regions are not described since they are not important for our purposes.

BFO's fourth level of continuants contains important categories, such as (i) *material entities*, for example, *objects* and *aggregates*; examples of objects are an apple and a mountain; examples of aggregates are an orchestra and a pile of stones; (ii) *qualities* are properties of entities, for example, the color or the smell of something; and (iii) *realizable entities* are entities whose instances contain periods of actualization in the course of their existence, for example, the role of antibiotics in healing a disease and the disposition of people to grow. The fourth level of occurrents also contains categories for representing the world, such as *processes profile* and *temporal regions*.

2.3. Essentials of mereology and granular partitions

A variety of formal frameworks is available for creating and testing ontological developments. Indeed, one can count with a range of theories deriving from the advances of formal logic and set theory in terms of which ontologies can be formulated. These theories allow ontologists to both express intuitive principles in a rigorous way and test ontologies developed for consistency and completeness [13].

One can argue why it would be required to resort to theories that deal with parts and wholes to explain corporations. As we will see later in this chapter (Section 4), one can benefit from employing these aforementioned theories in describing the descriptive dimension of corporations, which involves units, subunits, and members. Two well-known of these theories—*mereology* and *Theory of Granular Partitions*—are explained in the remaining part of this section (respectively, in Sections 2.3.1 and 2.3.2).

2.3.1. Mereological principles

Mereology is a theory that deals with the relations of parts to the whole and the relations of part to part within a whole, from a formal point of view. There are two main groups of principles one can use to explain these relations between parts and wholes: *principles of decomposition*, which take one from a whole to its parts, and *principles of composition*, which take one from the parts to the whole. These principles, in addition to some basic notions, give rise to the core of mereological theories. All introductory notions presented in this section are based mainly on Refs. [23, 24].

A single part of relation between two elements— x is part of y —has the mathematical properties of *reflexivity*, *transitivity*, and *asymmetry* [25]. An example of *reflexivity* is John resembles himself; an example of *transitivity* is if John is in front of Harry and Harry is in front of Bill, then John is also in front of Bill; an example of *symmetry* is if John is married to Mary, Mary is married to John.

These properties capture some intuitions what people have regarding the aforementioned properties and the part-whole relation. The reflexivity property means that everything is part of itself; the transitivity property means that any part of any part of a thing is itself part of that thing; the asymmetry property means two distinct things cannot be part of each other. These notions compose what is usually called *basic mereology*. It is the common basis for any part-whole theory, but other properties can be added to this basic framework, like *equality*, *proper part*, *overlap*, and *underlap*.

The first extension to the *basic mereology* is called *extensional mereology*. It involves the so-called decomposition principles: principles that take one from a whole to its parts. The intuitive notion behind decomposition is that whenever something has a proper part (a part that does not correspond to the whole), it actually has more than one. In other words, nothing can have a single proper part, which implies the existence of a remainder between a whole and its proper parts (*mereological difference*) in any process of the decomposition.

There is more than one possibility to capture the intuition behind the mereological difference. One possibility is called *supplementation*, a principle holding that every proper part of a whole must be supplemented by another part, which is disjointed from the first one. There is a slightly different version of this principle known as *strong supplementation*, which corresponds to the idea that if an object fails to include another one among its parts, then there must be a remainder. The strong principle of supplementation gives rise to a property named *extensionality*, which ensures that entities are completely defined by their parts and that no composite objects with the same proper parts can be distinguished.

Finally, the so-called classical mereology involves *composition principles*, which are principles that take one from the parts to the whole. The notion behind composition is that whenever there are things, there exists a whole that is formed exactly by those things. This means that there is a unique sum for arbitrary entities. The uniqueness is guaranteed by the property of extensionality, implied by the principle of supplementation in the scope of the extensional mereology. The existence of this sum implies that there is always a fusion between two or more parts, called *mereological sum*.

There is more than one possibility to capture the notion behind the mereological sum, namely, the *upper bound* and the *sum*. The *upper bound* of two objects is another object of which both the original ones are parts. The *sum* is a mereological upper bound of which any part overlaps one of the two individuals summed [26]. In other words, a mereological sum between two objects must be something composed exactly of their parts and nothing else.

2.3.2. Granular Partition Theory principles

Granular partitions are a name for cognitive devices that people can employ to label, list, sort, or catalog activities performed by other people. Examples of granular partitions are lists,

hierarchies, classifications, and so forth. Ref. [27] introduced the notion of granular partitions corresponding to a generalization of the concept of classes as mereological sums originated in set theory. All principles presented in this section are based on Ref. [25].

As mentioned, there are several kinds of partitions, and all of them consider the existence of objects. In the context of granular partitions, an object is everything existent that can be recognized by some units of partition. Objects can be either *bona fide objects* or *fiat objects*: while the former exists independently of human partitioning or demarcating activities, the latter exists only because of the very same activities. Indeed, partition units can recognize fiat objects from limits based on human cognition, and fiat objects are created through the projection of partitions in a portion of reality [28]. This distinction is very relevant for the purposes of this chapter, as we will make clear ahead (Section 4).

A formal Theory of Granular Partitions is composed by two different theories: Theory A reflects that partition units can recognize fiat objects based on human cognition and Theory B explains how fiat objects are created through the projection of partitions in reality. These two theories (**Figure 2**) are the mereological counterparts of set theory: Theory A is the counterpart of the relations between sets and subsets; Theory B is the counterpart of relations between a set and its member.

Theory A is a theory for formation of partitions. A partition can have *units* and *subunits*, also called, respectively, *cells* or *subcells*. A unit is defined by its position within a partition and by its relations to other units, for example, the relation between the class of fruits and the class of food. Conversely, Theory B is the theory between partitions and reality, for example, the relation between the fruit partition and fruits in reality.

Units in partitions can be nested one inside another constituting what is called *subunit*. The *unit-subunit relation* has several mathematical properties that are not important for our purposes here. Relevant, nonetheless, is its property of transitivity, which allows the formation of chains of units structured in a way that a *maximal unit* encompasses all the other

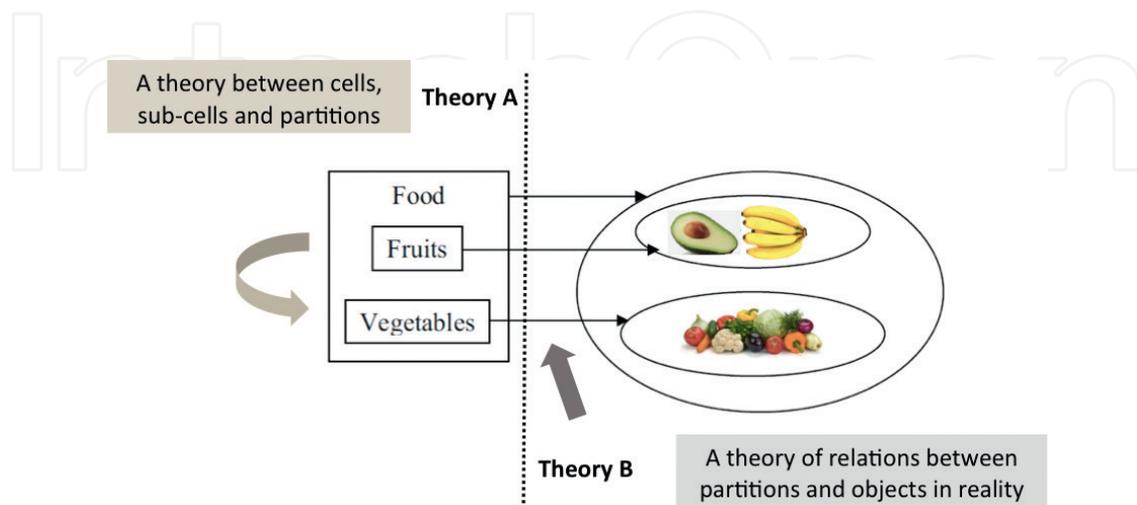


Figure 2. Theory of Granular Partitions. Source: adapted from Ref. [25].

existent subunits until to reach a *minimal unit*. So, if two units of a partition overlap, then one is subunit of the other.

Theory B involves the projection of partitions in reality and location of objects in the partition. Projection is then a relation, which is successful if an object on which a unit is projected is located in that unit. So, the result of a successful projection has a location as a result in two directions: from the mind to the world and from the world to the mind. Ref. [25] makes this point clear through an example:

“Projection is like the relation which holds between your shopping list and the items which, if your shopping trip is successful, you will actually buy. Location is like the relation which obtains between the items you have bought and the new list your mother makes after your return, as she checks off those items which you have in fact succeeded in bringing back with you.”

2.4. Essentials of s-acts, d-acts, mental states, and intentionality

In order to reach the aforementioned descriptive and normative analysis, we need to approach notions of some relevant related subjects, namely, *social acts*, based on the work of Reinach¹; *mental acts*, *speech acts*, *intentionality*, and *document acts*, mainly based on Searle [29–34].

The theories that try to explain people’s acts—spoken or written—as well as results of these acts were first advanced by Reinach. Reinach’s theory, based on ideas of Husserl’s² phenomenology, suggested the existence of an a priori law containing juridical concepts free of human interpretation and intellectually self-evident. In this effort of establishing the grounds of a theory independent of the positive law, the *spontaneous acts* were an important concept defined as the set of experiences a person could have in which the very same person has an active participation.

Some experiences require the existence of a subject for reference. Reinach called them non-self-directable. Such experiences involve acts that, in addition to refer to another subject, have to be perceived by the very same subject. Acts that need to be perceived are then called *social acts*, actually acts with intentional roots. Speech acts and document acts, which are relevant for the goals of this chapter, were developed from the social acts theory.

Mental states are another fundamental concept that needs some clarifications, since it contributes to the understanding of speech acts and intentionality (explained later in this section). Mental states are phenomena approached in Neuroscience and Philosophy of Mind.

In Philosophy of Mind, for example, Ref. [32] furnishes a view that avoids the mind-body dualism. In such view, one can realize an attempt to harmonize the mechanistic and the materialist accounts of the functioning of mind. In addition, this attempt includes an explanation of both subjective and intentional aspects of the human consciousness without to ignore the *qualia*—what constitutes the experience of to be conscious—of the mental experiences possessed and known by people.

¹Adolf Bernhard Philipp Reinach, 1883–1917, German philosopher, jurist and law theorist

²Edmund Gustav Albrecht Husserl, 1859–1938, German philosopher and mathematician

Such approach to mental phenomena guides one to an account of Philosophy of Language regarded as a branch of Philosophy of Mind [32]. The structural similarity between mind and language impacts in Searle's approach to speech acts, one of the most known and well-founded contemporary theories.

"It should not seem at all surprising to us that the structure of linguistic acts and the structure of mental states should be similar, because one of the chief functions of language is to express our thoughts and feelings, and even when we are performing speech acts [...]." [32]

The *Theory of Speech Acts* was originally proposed by Austin³ and conceived as a method to analyze philosophical questions. The analysis departed from the examination of language as a way to perform acts through words. Speech Acts Theory proposes that the elementary units to use and to understand natural language are speech acts. A speech act is the basic unit of meaning, constituted by three connected dimensions: *locutionary acts*, *illocutionary acts*, and *perlocutionary acts*.

The locutionary act corresponds to the linguistic dimension, which considers sentences endowed with both meaning and reference and employed according to grammatical rules. The illocutionary act, which is the core of the speech act, keeps as a fundamental aspect called *illocutionary force*. This force, which consists of the performative acts itself, represents the kind of act performed. For example, in the proposition "I promise to pay you tomorrow," there is an utterance (verb "promise") that constitutes the own act of promising and does not represent any description of intentions or of mental states. When a person utters the sentence, the promise is concretized, that is, the force that characterizes the act is the promise.

Searle [30] develops a classification of speech acts, in substitution of the initial proposal of Austin, which presents the following kinds of acts: *assertive*, *commissive*, *directive*, *declarative*, and *expressive*. In addition, seven components of illocutionary force are defined. Then, the result of a speech act is the combination three factors: (i) a proposition, which can be true or false; (ii) the semantic content related to the facts of the world; and (iii) the illocutionary force added to the proposition.

One issue regarding the speech acts is its evanescence, a result of its inherent orality. This makes the range of acting of a speech act temporally constrained. Smith [34] tries to approach this issue through the *Theory of Document Acts*. Indeed, a speech act exists only in the moment of its performance; documents, on the other hand, are continuant entities able to persist in time while absorbing modifications through its history.

In small communities, promises and obligations can be established through speech acts, but such compromises cannot be maintained in large and multi-faceted societies. Promises and obligations transcend the local character of personal contacts, since the psychological facts that could guarantee the fulfillment of a promise, mainly based on human memories, are not enough in large communities. On the other hand, documents maintain its identity through the time, and one can manipulate it in archiving, destroying, signing, registering, inspecting, or transferring it. Then, documents made possible new and persistent kinds of relations and

³John Langshaw Austin, 1911–1960, British philosopher of language

social entities that work as extensions of our memories. Documents do not only register information, but they can also be used to create a variety of social and institutional powers, which in turn allow the establishment of ways of life in society.

The last concept to be introduced here, which is relevant for the purposes of our goals in this chapter, is *intentionality*. It is a philosophical concept that traces back the medieval scholastics and was retrieved by Brentano,⁴ employed to define a statute for the fact that human conscience is directed to something or is about something. The term was also later employed by Husserl, who advocated the idea that consciousness is always intentional. Indeed, the intentionality distinguishes a property of mental phenomena, namely, the property of being directed to an object, real or imaginary.

Nowadays, a very accepted account of intentionality is due to Ref. [31]. In such account statements can be bearers of meaning. The performance of an illocutionary act necessarily specifies a mental state of who utters it, since illocutionary acts exhibit satisfaction conditions identical to the respective mental states. The performance of illocutionary acts depends on the ability of the human cognition in specify intentional mental states associated to the very same illocutionary acts and in assigning to latter the same satisfaction conditions of the former.

3. The nature of corporations

There are several theories and doctrines about the nature of corporations in scientific fields like History, Politics, Moral and Ethics, Philosophy, Metaphysics, and Theology, to mention but a few. This section focuses on doctrines originated in two scientific fields—law and economics—which, in general, have been taken as authoritative in defining and explaining the nature of corporations.

3.1. The nature of organization in law theories

In the scope of law, there has been a lot of discussion about the nature of corporations since the ninth century. Indeed, the corporation is a product of Roman civil law, and Ancient Rome had already perfected the notion of corporation to include all legal attributes one can see in modern corporations today [35].

Pope Innocent IV⁵ promulgated a theory about “corporate bodies.” The idea that corporations are *personae citae* (fictitious persons) was firstly directed to ecclesiastical institutions. Indeed, since these kind of institution did not have body of soul, they could not be punished or excommunicated. The doctrine suggested that being a person was denied to civil groups because of the dominant conception of a person. Such conception was due to St. Thomas Aquinas and took one back to metaphysical discussions of Aristotle about the nature of substance [36].

⁴Franz Clemens Honoratus Hermann Brentano, 1838–1917, German philosopher

⁵Innocent IV, 1195–1254, Pope from 1243 to 1254

A substantial understanding of the legal nature of corporation had already existed when the English Crown began to charter the first business corporations in the fifteenth century. The first jurists to formally establish what a corporation is and what are its legal attributes were Sir Edward Coke, author of the treatise *The Law of Corporation*, from 1702, and later both Sir William Blackstone—author of *Commentaries on the Law*, from 1765—and Steward Kyd, author of *Corporation*, from 1793 [37].

These pioneering jurists, although bearing in mind ecclesiastical bodies, described the corporation in a form that also applies to current business corporations. A corporation would be a legal unit with its own legal rights and responsibilities; it is distinct from the individuals who are members constituting it over time; it is a creation of law and could achieve legal status by an act of the state.

These core attributes assigned to corporations in England were borrowed by American jurists and applied in America, where a corporation possessed some legal attributes: it could contract, sue, and be sued; it could acquire and dispose property; it has its own seal by which it could act as a body distinct from its members; its shares are transferable; its membership may change without affecting its perpetual existence; it cannot commit assault or treason; and it cannot serve as a trustee [38].

The classical formulation of these attributes has come to known as the “artificial person” doctrine of the corporation. This is one of the several doctrines and theories that arose trying to understand the notion of “corporate personality.” Such a notion was needed to explain what would be the essence of this soulless and bodiless person. The orthodox doctrine of corporate personality considered that corporations are intangible legal entities. Thus, as a legal person, a corporation has a personality separated from the personality of the members that compose the very corporation.

In Anglo-American world, the orthodox statement was widespread. For example, law in United States⁶ maintains that a corporation must be treated as a person. This extension of rights and obligations from a natural person to a corporation comes from the interpretation of the word “person” in the Fourteenth Amendment. However, in countries like France, Germany, and Italy, there was a great debate and different theories arose [39]: *Fiction Theory*, *Concession Theory*, *Group Personality Theory* or *Realist Sociological Theory*, *The Bracket Theory* or *Symbolist Theory*, *Purpose Theory* or *Theory of Zweck Vermogen*, *Hohfeld’s Theory*, and *Kelsen’s Theory*.

The so-called Fiction Theory—first advanced by *Savigny*⁷—debated who would be the real owner of a property considering that property, in law, can belong to a corporation. The solution was the creation of a sort of *fictitious person*, which is the owner of the corporate property. The corporation would be a creation of law having no existence apart from its individual members, who form the corporate group and whose acts are attributed to the corporate entity. In this context, the personality of a corporation would be different from that one of its members, and any change in membership does not affect the existence of the corporation.

⁶US Code: Title 1,1. Words denoting number, gender, and so forth. Legal Information Institute (LII)

⁷*Friedrich Carl von Savigny*, 1779–1861, German jurist and historian

The property of a corporation is not the same property of its members, since a corporation can go bankrupt, while its members remain rich.

Concession Theory—advanced by *Savigny*, *Dicey*⁸, and *Salmond*⁹—is often mentioned as being part of Fiction Theory, but it has a different origin and rests on different interests. Actually, it is a product of a centralized model of national state that started to compete with the power of religious congregations and feudal organizations. Concession and Fiction Theories assert that corporations have no legal personality. However, while Fiction Theory is ultimately a Philosophical Theory suggesting that a corporation is a thing of the intellect, the concession theory focuses on the source of its legal power. Indeed, Concession Theory is indifferent to questions of reality and states that a juridical person is merely a concession of a national state.

Real Entity Theory, also called *Group Theory* and *Realist Sociological Theory*, was advanced mainly by *Althusius*¹⁰ and *Gierke*.¹¹ This group of theorists focused on sociological facts and in the belief that collective groups (as corporations) have a real mind, a real will, and a real ability to action. Thus, a corporation would have a real existence even though it does not receive recognition from the state. According to this theory, the existence of a corporation is not based on any fiction, because it is a psychological reality. A corporation is a social organism, whose law has no power to create, but only to recognize.

Associational Theory, also called *Bracket Theory* or *Symbolist Theory*, was propounded by *von Jhering*¹² and others, suggesting that the juristic corporate personality is only a symbol employed to facilitate the working of corporate bodies. On the one hand, this theory follows fictitious theory in maintaining the existence of a corporation as a fiction metaphor; on the other hand, it states that the corporate personality is not created by the state because actually it does not exist; it is solely an abbreviated form to represent several people that are members of the corporation. Only members of the corporation are real persons, and the corporation is a merely economic device by which one can simplify the task of coordinating legal relations.

Purpose Theory, also called *the Theory of Zweck Vermogen*, is a variant of the Fiction Theory created by *Bekker*¹³ and *von Brinz*¹⁴ to explain the ownership in charitable corporations. It also considers a corporation as a fictitious entity but is focusing on the purpose of those who manage the property, instead of focusing on the ownership of property by an object. This theory asserts that only human beings could be subject matter of rights and duties. Thus, a juristic person is not a real person, but merely a property destined for particular purposes. As in the context the legal relations involving corporations, there is ownership, but no owner; a juristic person could not be equivalent to a group of persons. Rather, it would be based on objects and purposes.

⁸Albert Venn Dicey, 1835–1922, British jurist and constitutional theorist

⁹John William Salmond, 1862–1924, legal scholar, public servant and judge in New Zealand

¹⁰Johannes Althusius, 1563–1638, German jurist and Calvinist political philosopher

¹¹Otto Friedrich von Gierke, 1841–1921, German legal scholar and historian

¹²Caspar Rudolph Ritter von Jhering, 1818–1892, German jurist

¹³Ernst Immanuel Bekker, 1827–1916, German jurist and professor

¹⁴Alois Ritter von Brinz, 1820–1887, German jurist and politician

There are also complementary theories of legal personality, like *Hohfeld's*¹⁵ *Theory* and *Kelsen's*¹⁶ *Theory*. The former declares that juristic persons are creations of arbitrary procedures. Human beings alone are capable of having both rights and duties, and when the law ascribes juristic personality to any group, it makes this merely as a procedure for dealing with legal rights. The latter said that there is no difference between the legal corporate personality and the individual personality. Indeed, the corporate personality would be only a technical personification of a set of norms that assign rights and duties to people.

3.2. The nature of the organization in economic theories

Economics and Management are research fields that maintain a special interest in defining corporations insofar as they involve many aspects of the society and play a central role in economic analysis.

The context for evaluating the nature of corporations involves two basic entities: persons and ownership. In general, if people are subjects of property rights and things are objects of property rights, then people own things and things are owned by people. In the traditional sole-proprietorship corporation, the individual capitalist is the subject of the property right, and the corporate assets are the object of property right. In the partnership corporation, a group of individuals owns the assets jointly. In order to perform activities and reach goals, corporations enter in several contractual relations with other parties, like employees, suppliers, customers, etc. Within this scenario, whenever there is a withdrawal or an admission of a new partner, each contract has to be rewritten. In addition, when the corporation grows and numerous outside relations take place, the transaction costs can be prohibitively high.

The corporation is then a solution for the existence of multiple transactions, insofar as a group of individuals in creating a corporation also create an additional person who has the same legal capacity to own real assets as the partners themselves have. Outside parties enter into a contract with this additional person, independently of the number of shareholders.

Considering that to evaluate the nature of corporations, one has to understand both persons and ownership relations, she can realize that corporations play a dual role: they can be a person and they can be a thing. The corporation (as person) owns its assets, and it is owned (as thing) by shareholders. In the former case, it acts legally as a person; in the latter, it acts legally as a thing. This duality gives rise to discussions about the origin of the corporate personality, since a corporation is in reality neither a person nor a thing, but an entity endowed with both personality and thingness. The fact that a corporation can be owned by persons means that it is not a person, unless we consider that slavery exists; the fact that it can own other things does not allow it to be a thing, since things cannot own other things. This can be considered a sort of indeterminacy, in which law is unable to determine the legal nature of a corporation within its own system [40].

¹⁵Wesley Newcomb Hohfeld, 1879–1918, American jurist

¹⁶Hans Kelsen, 1881–1973, Austrian jurist, legal philosopher and political philosopher

Despite controversies, these theories bear a resemblance to aforementioned legal theories of corporate personality. Differently from legal theories, the modern theories in Economics and Management fields aim to explain the economic behavior.

Some theories consider two different mechanisms within the economy: the price system, which could not explain all the economic behavior, let alone the decisions taken within a corporation, and the hierarchy employed in corporations to allocate and reallocate resources. So, to delimit a corporation within the market, one should consider two kinds of relations: those internal to the corporation, namely, authority relations, and those external, namely, contract relations [41]. This theory, known as the *Evolutionary Theory*, has several representatives, for example, Refs. [42–44]. There are evidences that these theories are descendants of the already mentioned *Real Entity Theory*. Winter Sidney and Nelson [43] say that organizations know how to do things, and individuals can come and go. This seems very close to the premises of *Real Entity Theory*, in which corporations exist as real persons, as social organisms have a real will that enable them to decide how to do things.

Other theories propose that there is only one mechanism at work in modern economy, namely, the price mechanism. A theory like this is the so-called Contractual Theory of the Firm [45], which also has different considerations about the form of delimiting the corporation within the market. It considers that the limits of a corporation are more permeable than one can think and that the distinction between the corporation and the market is not so clear. According to this kind of theory, corporations are really another type of market: they are legal fictions that serve as links between contracting relationships representing individuals. Several authors represent this slant, for example, Refs. [46–48]. There are evidences that these theories are descendants of the already mentioned *Associational Theory*. Ref. [45], for example, says that corporations are legal fictions which serve as a connection for contracting relations among individuals. This seems similar to the premises of the *Associational Theory*, in which there is no corporation, but just legal relations among groups of individuals.

3.3. Issues in Law and Economic Theories

After presenting a diversity of theories about the nature of corporation and about a so-called corporate personality, one can ask why additional analysis would be required. The answer is that all corporate theories presented so far, despite their historical and social importance, contain issues that do not make them eligible as the best candidates to an account for representing corporations.

Fiction Theory, for example, lies on the notion that corporations can own property, but corporations do not have will, and then the solution is to create a fictitious person. Likewise, a corporation is distinct from the sum of its members, that is, the corporate ownership is a non-summative collection. Indeed, for example, a school can preserve its identity independently of the different generations of students that left it behind.

We can organize the issues of Fiction Theory in three main contradictions [49]: (i) if one accepts that corporate ownership is non-summative and accepts that ownership involves the possession of will by the owner, then she is committed to the fact that corporations have will,

which contradicts one of the main statements of the theory; (ii) if one accepts that corporate ownership is non-summative and accepts that a corporation does not possess will, she must deny that ownership involves the possession of will by the owner; and (iii) if one accepts that ownership involves the possession of will by the owner and accepts that a corporation does not possess a will, then she must reject even the idea that the corporate ownership exists.

Real Entity Theory, as described before, suggests that corporations are organisms that possess real will and senses as natural persons. Naturally, it would be difficult to prove that a corporation is a real person. For example, a corporation can neither marry nor be given in marriage as a natural person. Actually, a corporation is not a rational being, it is not capable of understanding commands of law, and it has no will. In expressing commands to a corporation, law is speaking to the human beings that compose it [39].

Associational Theory, basically, advocates that the corporation is just a group of individuals, not an entity. This does not seem to be true: a company that has 100 years is not identical to its members. IBM, for example, is not a succession of entities in which every change in membership results in a cessation of one corporate entity and the creation of a new one. Also, “the Ford Motor Company today is very different from the same company of 1970, yet many essential characteristics remain so that Ford is still Ford, for better or worse” [50].

Finally, Economic Theories already presented just seek to describe and explain the economic behavior. There is no ontological debate about the kinds of entities that could exist in social reality.

4. Ontological analysis of the corporations

Despite the issues of Law and Economic Theories in explaining the nature of corporations, they gather several characteristics of a corporation as we currently know it. From what we have presented so far about such theories, one can sketch some hypothetical features to the corporation: (i) corporations maintain their identity over time; (ii) corporations have real existence separated from their members; (iii) corporations are artificial (or *fiat*) entities; (iv) corporations are non-summative aggregates; and (v) corporations are long-lasting entities.

In this section, we check these hypotheses by providing an ontological analysis, which reveals the multitude of entities, both natural and social, that compose a corporation: the corporation itself and its parts; entities that correspond to the several roles that a corporation can play, for example, plaintiff, property owner, taxpayer, etc.; and entities that correspond to the several events in which a corporation can participate, for example, paying taxes, selling or buying, auditing, etc.

We make use of the formal ontology machinery — mainly Basic Formal Ontology (BFO) and some theories presented before as background — in trying to describe the structure of a corporation according to two dimensions, namely, a descriptive and a normative. On one hand, a descriptive (or scientific) statement is true or false; it is not a command; on the other hand, a prescriptive (or normative) statement is concerned to which has to be done or not; it is about how to comply

[51]. In our approach, the descriptive dimension accounts the way in which a corporation is organized in units and subunits (Section 4.2); and the normative dimension accounts the way in which social entities — duties and obligations — can be handled within a corporation (Section 4.3).

4.1. The structure of the organization I: units and subunits

As BFO conveys transcategorial entities to be represented in information systems, we try to check which of its entities can account corporations or parts of corporations. In doing this, we try to answer the question (in the ontological sense): what kind of entity is a corporation? In this section, we discuss the descriptive dimension of the corporation, namely, that one which describes units and subunits, as well as the roles that compose them. The strategy is assuming the corporation and its entities as entities of BFO and then verifies the correctness of that assumption.

Considering the second level of BFO, our first verification is as follows: are corporations independent continuants? According to BFO, independent continuants are entities which change over time while retaining something of their identity [18]. Independent continuants are BFO's representatives of Aristotelian substances, which are characterized by the following: (i) substances exist on their own and do not require a support from other substances in order to exist; (ii) substances remain numerically one and the same, as well as can admit accidents at different times; (iii) substances are able to stand in causal relations; (iv) substances are "one by a process of nature"; and (v) substances have no proper parts which are themselves substances [52].

What about corporations? What of such features they possess? So, corporations do not depend on other entities unless constitutive entities; they remain numerically one and the same; corporations can only indirectly stand in causal relations through their members; they do not exist by a natural process; they are composed by substances, which are their members. As one can notice, corporations have in common with Aristotelian substances only the two first characteristics just mentioned. Thus, corporations are not exactly Aristotelian substances, but they have the marks of independent continuants insofar as at any given time, all of its parts are present, and its existence does not depend on any other discrete entities.

What kind of whole a corporation would be? We can divide this question in three parts: (i) are corporations summative wholes? (ii) Are corporations integral wholes? or (iii) Are corporations aggregate wholes?

Summative wholes are exhaustively defined by their constituent parts, and according to the principle of mereological extensionality, objects with the same parts are equal. However, this notion does not conform to the intuitive notion we have in which corporations can preserve identity even undergoing changes in membership. So, corporations are not summative wholes. Integral wholes, on the other hand, have strong structural connections among their parts, differently of corporations, which are not maximally connected, for example, organisms. Finally, in opposite of sums, aggregates are not defined in terms of their own elements. Otherwise, they have detached parts that integral wholes do not have. As corporations have members linked together (persons, units, for example), one can acknowledge that corporations are kinds of aggregates: they are material entities consisting exactly of a plurality of objects, and these objects are member parts of it all times at which it exists.

To start a way of representing the corporation and entities that compose it as BFO's entities, we seek inspiration in Popper's Theory of Three Worlds [53]. In this kind of representation based on levels, we can correspond corporations (and other entities) in reality to BFO's aggregates, as depicted in **Figure 3**. The first level is the reality level; the second level (above the first one) corresponds to people's cognition, in which people perceive and model reality; and the third level is the level of representations concretized from the cognitive models. In **Figure 3**, examples of entities in reality—Ford, IBM, John, NYC, etc.—are modeled and then concretized as representations in the third level, in this case, in BFO. Then, for example, Ford Motor Company is an instance of object aggregate, which is a BFO's transcategorial entity.

One can argue why it would be useful to represent Ford Motor Company as an aggregate. In the subsequent analysis, we hope the usefulness of this procedure becomes clear. For now, we inquire: how to divide the corporation in units and subunits? In order to answer, we make use of background theories presented in Section 2: mereology and granular partitions.

Mereology, despite to contain several relevant principles, deals with material entities and does not seem to be the best framework to explain corporations and its units because of several issues. It is hard to believe that the relation between a corporation and its members is a part-whole relation; insofar as in mereology, the part-whole relation is transitive. Accordingly, one might say inconsistent statements, for example, if John is part of a corporation, any part of John, as his eyes or his mouth, is also part of the corporation. In addition, mereology cannot account the fact that a corporation preserves its identity over time even when it loses or gains members [49].

The Granular Partitions Theory, on the contrary, uses cognitive devices to show how people divide the world. It relies on the distinction between bona fide objects and fiat objects, as mentioned before: bona fide objects exist independently of human subdividing activity; and fiat objects exist only because of the very same subdividing activity. Using the Granular Partitions Theory—namely, Theory A—one can define units, subunits (or cells and subcells), as well as the relation between unit and subunit (or cell and subcell). The application of Theory A to corporations is illustrated in **Figure 4**: there is a certain car company partitioned into two subcells, “the human resources department” and “the board of directors.”

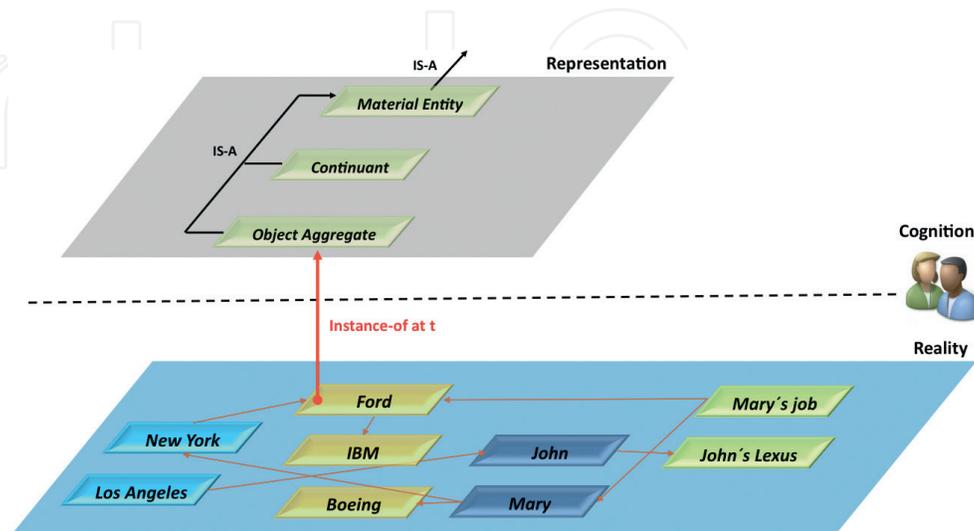


Figure 3. Levels from reality to BFO. Source: [49].

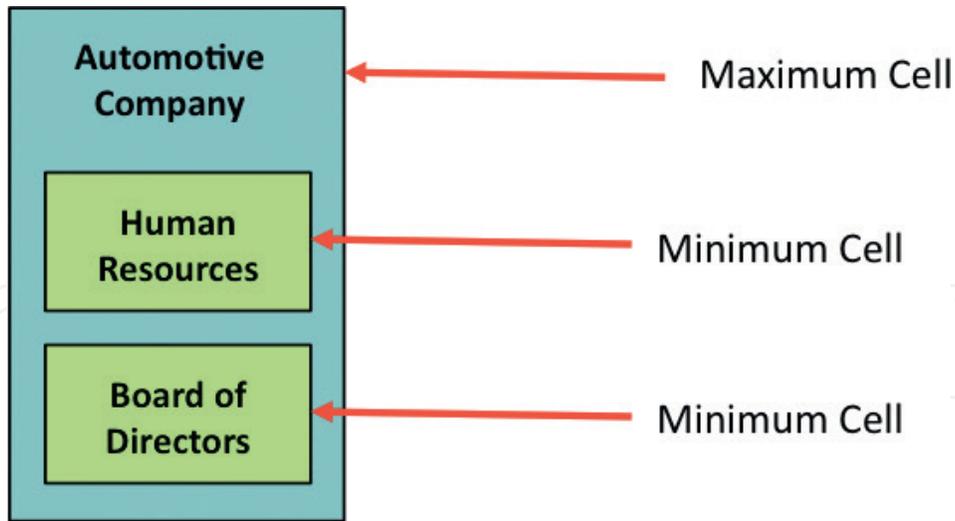


Figure 4. Theory A representing the structure of a corporation. Source: [49].

Likewise, using the Granular Partitions Theory—namely, Theory B—one can define the projection relation, which holds from a cell to the reality, and the location relation, which holds from an object to a cell. The application of Theory B to corporations is illustrated in Figure 5: there is a certain car company partitioned into two subcells, “the human resources department” and “the board of directors.” In addition, “John” in reality projects onto the “John cell” within the corporation, as well as “John cell” is located in “John” in reality. We also can say that “the human resources department” is a cell within the corporation, but the minimum cell is “John cell.” The same relations hold for “Mary.”

After applying the Granular Partitions Theory to the corporation, we are ready to make another attempt following our proposal of characterizing corporate entities. If the corporation can be considered a maximal cell, a cell which every other cell is subcell, then corporate units are cells and subcells. Thus, one can consider that units and subunits can be considered fiat object parts. A fiat object is another BFO’s transcategorial entity. Figure 6, similarly to Figure 3, presents three levels: the first level is the reality; and above the second level (of cognition), we draw two other representation levels—a level concretized in a Granular Partition Model and a level concretized in BFO.

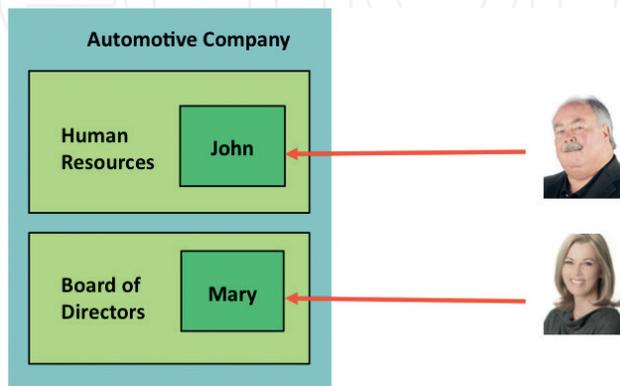


Figure 5. Theory B representing the structure of a corporation. Source: [49].

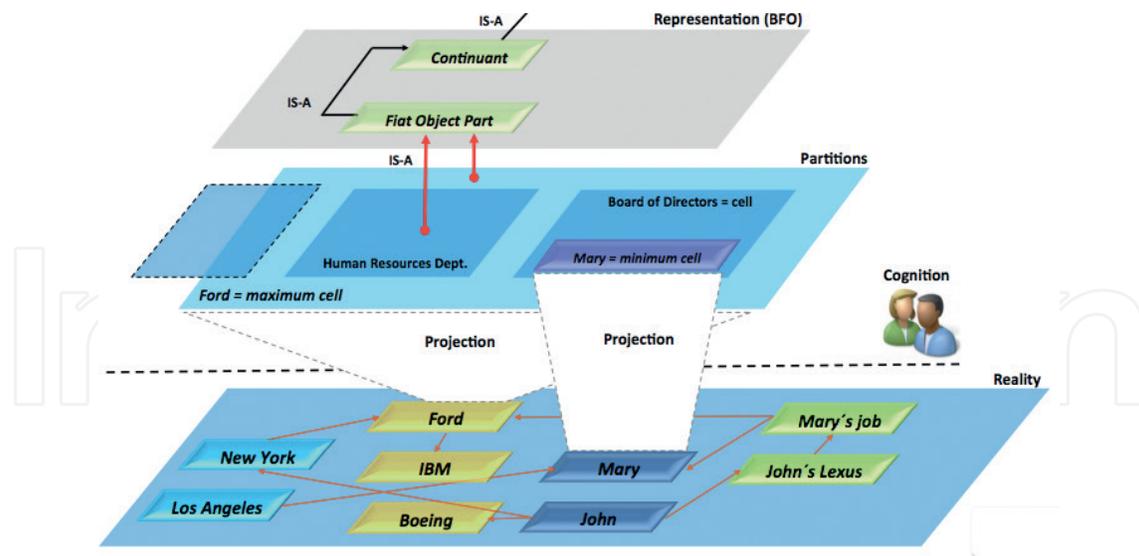


Figure 6. Levels from reality to partitions and partitions to BFO. Source: [49].

So, finally, as we suggested before, the corporation is a kind of aggregate. However, either a colony of ants or a swarm of bees also are aggregates. What is the difference between an “aggregate corporation” and other kinds of aggregates? What distinguishes a corporation from a colony of ants? To answer this question, we need to approach the normative dimension of the corporation.

4.2. The structure of the organization: duties, obligations, and responsibilities

As mentioned before, a corporation can be analyzed from two main dimensions. In the prior section (Section 4.1), we tried to approach the descriptive dimension of the corporation. At the present section, we cover the normative dimension in seeking to explain what distinguishes a corporation from other aggregates. As one can realize, unlike colonies of ants and other aggregates, corporations have normative partitions.

We begin by explaining how units and subunits are assigned with duties and obligations. So, according to Granular Partitions Theory, a successful projection lies on the side of the reality. For example, considering an architectural blueprint, the reality should match the blueprint by constructing something. Likewise, a corporation should match, for example, a statute of the company and its strategic plan, as well as other documents related to its creation and functioning.

If corporate units may be fiat objects, as stated in Section 4.1, one can argue: how a fiat object comes to existence? In this case, the answer is simple: a fiat object comes to existence through the cognition. A person can create a mental partition, which, for example, delimits a corporate unit. After all, more important is asking how a fiat object is sustained in existence, because corporations are long-lasting entities. So, a fiat object is sustained when the verbal form of corporate norms is translated to a written form. Here, we are approaching the realm of the social ontology: to explain the verbal form, we use the *Theory of Speech Acts* [14, 54]; to explain

the written form, which records the speech acts, we use the *Theory of Document Acts* [34]. In addition, we use the notion of *social acts* [55].

A social act is a kind of act that needs to be perceived by someone [55]. A special type of social act, which is relevant for our purposes here, is the *declaration*. Declarations express what ought to be, for example, a promise is a declaration of how things ought to be. Declarations can either create or demolish reality: a promise creates both an obligation to a person and a claim to another person; but a declaration can also revoke some order or obligation. We use the document acts theory to record the cause of claims and obligations. Indeed, documentation of the cause for claims and obligations is one of the driving forces in the creation of documents. Then, we reach a kind of “social partition” in which people perform social acts in filling appropriate paperwork and approving it with appropriate authorities. Ref. [34] explains the connection among the three theories:

“[...] a theory of document acts supplementing the traditional Reinach-Austin-Searle theory of speech acts with an account of the ways in which, by doing things with documents [...] we are able to change the world by bringing into being new types of ownership relations, of legal accountability, of business organizations, and [...]”

The document acts theory, which is crucial to represent long-lasting duties, obligations, and responsibilities within a corporation, can be related to BFO through the *Document Acts (d-acts) Ontology* [56]. *D-acts Ontology* contains *Social Generically Dependent Continuants* (SGDCs). *D-acts* are kinds of SGDCs. SGDCs are kinds of *Generically Dependent Continuants* (GDCs), which are representative of social entities. GDCs, as we know, are kinds of BFO’s transcategorial entity.

D-acts Ontology incorporates the aforementioned kinds of acts presented in the *Document Acts Theory: social acts, declarations, and document acts*. A *social act*, as Reinach’s definition posed, is a process carried out by someone and directed toward another one, who perceives it; a *declaration* is a social act that brings about, transfers, or revokes a SGDCs; and a *document act* is a declaration made using a document in order to temporally extend the effects of the declaration.

Examples of the relation between document acts and SGDCs in *d-acts ontology* are as follows: (i) a document act can *create* a SGDC, for example, when John claims a piece of land; a document act can *transfer* a SGDC, for example, when John transfers his claim to Mary; and a document act can *revoke* a SGDC, for example, when a judge signs divorce papers filled in by a couple. In addition, *d-acts ontology* maintains specific roles and bearers: the creator of the document is called *document act template creator role*; the user of the document is called *declaration performer role*, and the target bearer of the SGDC is called *declaration target*. **Figure 7** presents the scheme of *d-acts ontology* and its relations to BFO.

A full example illustrates the operation of *d-acts ontology*: a fictitious case of recruitment in a corporation. A director signing and stamping an official memorandum to recruit a janitor is a *document act*; the official memorandum from the board of directors legally enables the recruitment process; a memorandum is the specified input of the document act of the director’s order to recruit the janitor; the human resources manager responsible for the recruitment process is the bearer of the *document act template creator role*; the director is the bearer of the

declaration performer role; a human resources employee responsible for the recruitment procedures is the *declaration target*, which becomes endowed with the right to perform procedures enabling the recruitment.

Finally, we present **Figure 8**, which is similar prior to **Figures 3** and **6**, containing the representation levels: the first level continues to represent the reality; the second level is now concretized in a d-acts Ontology model; the third level is a representation also concretized in BFO.

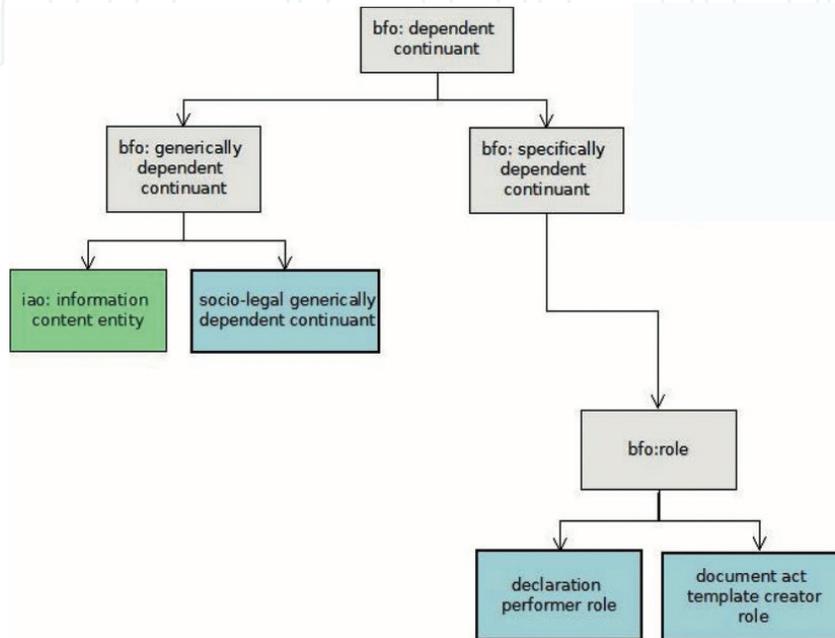


Figure 7. Classes of BFO (prefix :bfo), classes of IAO (prefix :iao) and classes of d-acts (without prefix) connected. Source: adapted from [57].

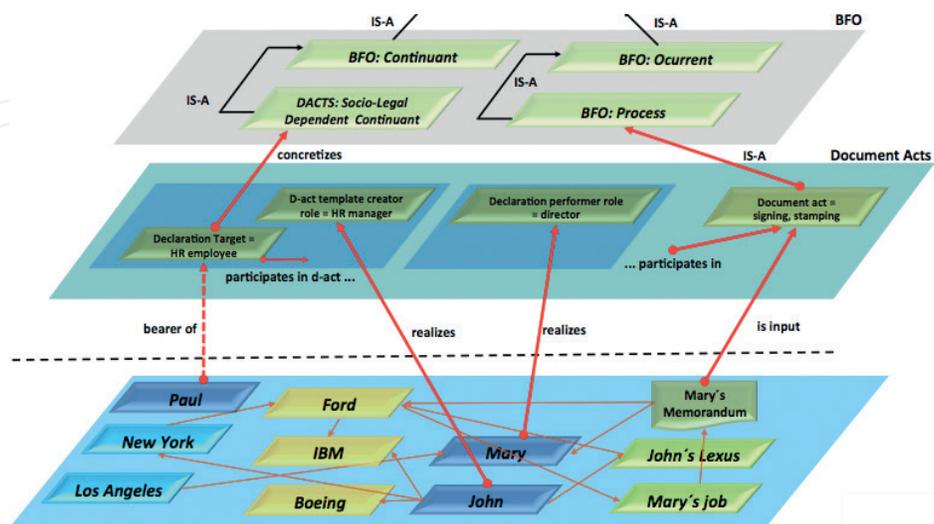


Figure 8. Levels from reality to d-acts and from d-acts to BFO. Source: [49].

5. Discussion

The normative dimension of analysis presented before (Section 4) seems to allow interesting possibilities for discussion, since processes, orders, tasks, nominations, obligations, recruitment and dismiss, as well as several other corporate-related activities occur through formal acts conveyed first, in the form of speech acts, and then recorded in the form of document acts. As our research is under way, at this moment we raise some speculations that admittedly need to be scientifically proved in future works. One speculation regards the relevance of corporative documents and respective document acts for charactering corporations and kinds of corporations.

We believe one can characterize the kind of corporation through both the documents that serve as inputs to document acts and the kinds of the very same document acts. We survey some theoretical evidences, coming from philosophers and researchers, for our premise that corporations are distinguished by documents they produce and use.

Brochhausen et al. [57] say that practices and resources regarded to both record production and record keeping reveal how one does organization within a corporation. The way one structure records imposes certain kinds of administration to workers and eventually creates indexes of how the corporation is managed. Indeed, “records are the information base of the modern state and of the modern organization” [57], since they are both the means and the results of a continuous process of notation, summarization, and information dissemination that aims to construct a depiction of what happens in the corporate environment.

Ledema [58] conjectures about the ubiquity of documents in our society through an ambitious theory called *documentality*, according to which “there is nothing social outside the text” [58]. Undoubtedly, a marriage or a contract that was not recorded would not exist as an (social) object, but a mountain can easily exist without being mapped. Since nothing social exists outside the text, society would be based on registration in documents, and this very act of registering is the condition for creating social objects. Thus, documents constitute the fundamental ingredient of the social world.

Ferraris [59] also places documents in an important position to explain society and social relations, for example, those ones produced and manipulated within a corporation. As the society became more and more complex, “the mnemonic powers of individuals have been extended prosthetically through documents in ways which have given rise to a variety of novel artifacts of social reality” [34].

So, we also say that one could identify the kind of corporation through the kinds of document acts performed. Consider a very typical document of a specific kind of corporation, for example, the *medical record* in the context of medical and healthcare units. A medical record can serve [59] to support patient care in the coordination of clinical processes, to allow better decision-making and for the creation of demographic surveys; to fulfill external obligations regarding health insurance plans, reimbursements, auditing, and accreditation; to support administration in planning, controlling, and quality management; and to allow scientific research and clinical education. Our speculation is that identifying the kinds of d-acts that

a medical record contains or generates may provide clues to formally distinguish the medical corporation from other ones. As we mention before, such idea has to be proved, what we expect to do in future works.

6. Final remarks

In this chapter, we proposed the preliminary foundations of an ontological-based architecture for organizing information and knowledge within corporations. We sought to clarify the ontological status of corporations, to understand the relations between corporate units, and to approach the duties within a corporation. We presented a background of formal theories required to understand the research and some of the main doctrines about the nature of corporations. Then, we analyzed the corporation through two dimensions we called descriptive and normative. The descriptive dimension deals with the structure of the corporation from the point of view of units and subunits, while the normative dimension deals with duties and obligations. We conducted our research using well-founded theories, for example, formal ontology, speech acts, and document acts. Finally, we offered a brief discussion focused on the normative aspects related to document and document acts.

As our final remarks, we would like to emphasize the connection among the levels of representation existing throughout our ontological analysis (Section 4). In **Figure 9**, we again display the level of reality along with two representation levels, namely, a level for partitions and the level for document acts. As one can realize, these two representation levels, additionally to describe the dimensions of analysis proposed, maintain co-relations that, once gathered, can offer a view of which would be an ontological-based information architecture to corporations. For purposes of formalization and application in the modern information systems, it is worth remembering that all representation levels described throughout the chapter can be mapped to BFO, a transcategorial formal top-level ontology.

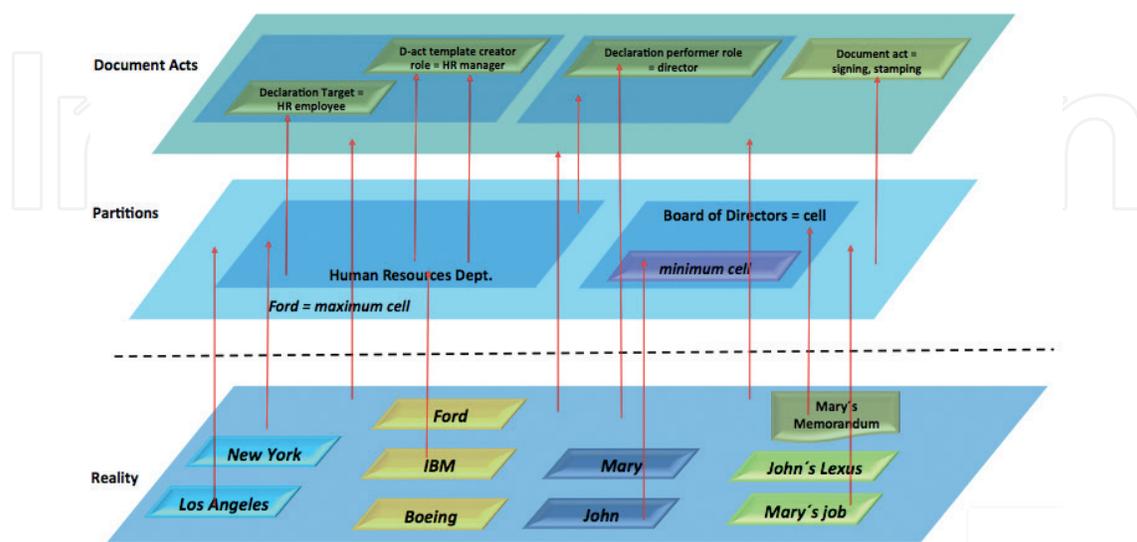


Figure 9. Descriptive and normative dimensions of the corporation. Source: [49].

As we have already mentioned, the relevance of such analysis rests on the need of a better understanding of corporations, as well as the advantages of a formal framework to be applied in information systems working in the context of Semantic Web. In future works, we intend to advance the discussion offered here and sketch an ontology-based model for medical organizations, along with semiformal definitions and hierarchy.

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