Urban Artefacts and Their Social Roles: Towards an Ontology of Social Practices

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Abstract

Cities can be seen as systems of urban artefacts interacting with human activities. Since cities in this sense need to be organized and coordinated, convergences and divergences between the "planned" and the "lived" city have always been of paramount interest in urban planning. The increasing amount of geo big data and the growing impact of Internet of Things (IoT) in contemporary smart city is pushing toward a re-conceptualization of urban systems taking into consideration the complexity of human behaviors. This work contributes to this view by proposing an ontological analysis of urban artefacts and their roles, focusing in particular on the difference between social roles and functional roles through the prism of social practices.

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1 Introduction

From a human geography perspective, the notions of *space* and *place* have been considered as the opposite extremes of a continuum which goes from the ideal geometrical abstraction of space to the experiential world of place [5]. Understanding human conceptualization of place entails referring to the meanings which people commonly associate with their spatial experiences [19]. With the emergence of volunteered geographic information and geo-social media, such meanings are encoded in a growing amount of geo-referenced data collected by people who have a non-expert viewpoint on possible place uses [8]. As a consequence, a very important practical concern of Geographic Information System (GIS) and urban planning is to make explicit, for the purpose of mutual understanding and interoperability, people's assumptions about their everyday spatial experiences.

This paper considers a special class of artefacts, *urban artefacts*, designed and built for urban use. We take the view that a city can be seen as a system of urban artefacts, which may play distinct roles when taking part in social practices. Our focus is thus on the interaction between artefacts and their social uses. Different kinds of places will be defined, throughout the paper, as socially constructed concepts that emerge from the interaction between urban artefacts and collective human practices. We introduce here the concepts of social and functional places. It is crucial to consider them as different from the more common

sense idea of place as geographical space: they are treated as social concepts, particularly, as social roles[1].

The notion of Urban Artefacts is grounded in the DOLCE foundational ontology[2][12, 3]. DOLCE focuses on *particulars*, which differ from *universals* since they cannot be instantiated (i.e. "my car" vs. "car"), and are subdivided in endurants, perdurants, qualities and abstract entities. DOLCE has been explicitly engineered to capture human common sense meanings with a definite cognitive bias, and provides crucial notions to describe socio-technical systems. In the light of this, we consider DOLCE as the most suitable reference framework to ground a representation of social geographical knowledge. The relevant portion of DOLCE employed in the present analysis is reported in Figure 1, which shows how the various notions introduced in this paper are grounded in the DOLCE ontology.

The paper is organized as follows: first, we will provide a general definition of artefact as it has been discussed in the field of formal ontology so far. Then, we will apply the definition of artefact to represent the built environment, introducing the notion of urban artefacts and the needed distinction between their social and planned views. On the one hand, physical qualities resulting from planner design choices are used to classify urban types. On the other hand, the highly dynamic interaction between the built environment and human collective behaviour will be framed using roles theory; particularly, roles played by urban artefacts are considered as depending on their participation in social practices with human agents. Finally, we will exemplify these cases in a real context. We will present expected and unexpected 'meanings' attributed to Piazza del Mercato in Naples (Italy), where roles that an urban artefact plays may diverge from its own ontological status. The scenario shows how to ontologically distinguish different perspectives providing room for the creation of a map of urban artefacts and their multiple roles in an urban environment.

2 Urban artefacts

The goal of this section is to apply the notion of artefact to the field of urban modeling. Here we take the view that a city can be seen as a system including (urban) artefacts of various kinds that may participate to agents' activities by playing multiple roles, possibly at the same time. Our focus is thus on the study of artefacts and their social uses. As we will see in the next section, this leads us to introduce the notion of *mode of deployment* – an idea developed in engineering design for functional studies – into the field of urban studies.

2.1 From Artefacts to Urban Artefacts

The notion of urban artefact that we develop starts from the characterization of ontological artefacts in [4] and artefactual objects in [9]. These approaches discuss broad notions.

In Borgo and Vieu [4] artefacts are modeled as the result of an intentional act of some agents (the artefact's creators) which, by creating a new entity, determine its constitution, capacity, attributed capacity and (implicitly) identity criteria. In their view, an intentional selection *and* capacity attribution is a mental event (possibly associated with physical actions)

[1] At the same time, we do not deny the existence of another ontological level – corresponding to places intended as geographical spaces rather than concepts. However, for the purpose of the current work, in order to be able to distinguish between expected and unexpected – or planned and unplanned – uses of the city, we will only focus on the concepts of social and functional place: two different roles that urban artefacts may play.

[2] `http://www.loa.istc.cnr.it/old/DOLCE.html`

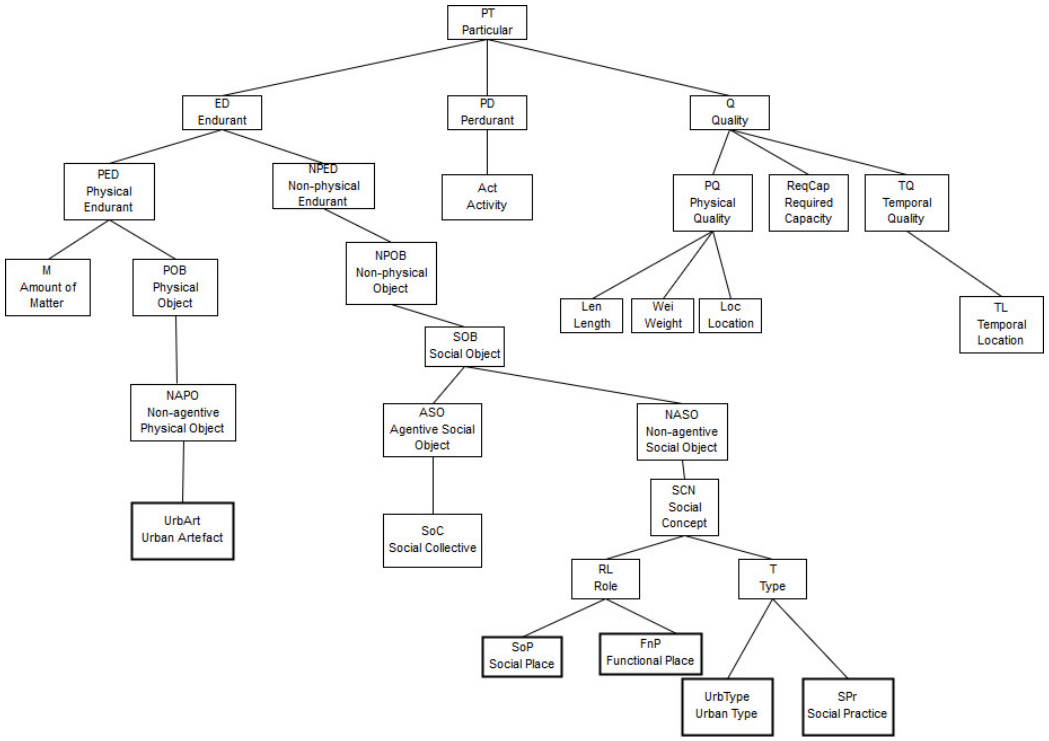

Figure 1 General taxonomy in DOLCE.

that *creates* an artefact: when an agent chooses a pebble as her paperweight, an artefact is immediately created, since an intentional selection and capacity attribution (namely, to behave as a paperweight) have taken place. When the artefact, due to inappropriate attribution or to usage, does not manifest the capacities attributed to it, it is said to be malfunctioning.[3] This view of artefacts has been expanded to account for *technical artefacts* in [1, 2, 10]. In particular, in [2] the authors have analysed different understandings of technical artefacts, isolating, among others, the notion of *technological artefact*.

Guarino [9] introduced the category of *artefactual object* to capture the view of artefact as an entity that realises a given design. This way, artefactual objects are not the result of a direct intentional selection, since the artefactual status is due to the relationship between the object and the design specification. So, the connection between an object and its artefactual status becomes independent of any specific agent act, while the historical property of *being an artefact* is considered as *anti-rigid*, in the sense that it is accidental for all its instances. A naturally fallen tree may be used as a chair (playing therefore an *artefactual role*), but it is not an artefactual object unless it satisfies some chair design. In short, this leads to assume that no artefactual entity is created when certain qualities of the fallen tree are intentionally selected in order to use it as a chair. Artefactual objects are entities whose essence lies not in some attributed capacity to fulfill a certain function, but rather in the match between the object's features and a design specification. Therefore a distinction is needed: to be an instance of an artefactual type, an object is required to match a design, while to be an

[3] This means that artefacts may be disconnected from their actual use. Note that an object stably used to perform some activity is not an artefact until it is identified by its user as the 'tool' for such an activity. In the paperweight example, the user and the creator are the same agent but this is not true in general.

instance of an artefactual role it is enough to be used in a way that is the expected way of use of some artefactual type. Recalling our previous example, in this view the pebble used as a paperweight is not an artefactual object, but only plays an artefactual role unless there is a specific design that is satisfied by that pebble.

Considering urban artefacts, these normally originate from an act of rational design and intentional construction. They fit, therefore, the specific notion of technological artefact defined in [2][4], but they can also be considered as artefactual objects according to [9], since it makes sense to assume for them that a design specification exists.

2.2 Grounding Urban Artefacts in DOLCE

We conceive an urban artefact as a component of an urban system which is formed by physical objects and/or amounts of matter[5], shaped or somehow organized in order to satisfy some design specifications.

Such specifications may deal with different kinds of information, including:

- *Design constraints* concerning the physical structure of the urban artefact and its physical qualities;
- Intended *use scenarios* in terms of *modes of deployment*, i.e., how an urban artefact is supposed to be used or exploited;
- *Normative constraints* concerning forbidden uses or explicit use rights allowed to specific classes of users. For instance, a park may include a playground where children may play, or where only children may play, and a green area where to keep off the grass.[6]

We shall assume that a design specification characterizes an urban type (*UrbType*), which is a category of urban artefacts characterized by a *prototypical* design of architectural and urban interest, which *a-priori* identifies specific physical qualities. Once an artefact is a member of the *UrbType* category it remains so for all its life, i.e., until some disruptive change occurs like the destruction of the physical object that composes the artefact or the modification of one of its core characteristics. In both cases, the original artefact ceases to exist while a new one may appear. It is also possible to have co-located artefacts constituted by the very same physical object. While being an urban artefact of some type (e.g. school type), the same building could belong to another type as well (e.g. polling station type).

Of course, design specifications can be described at different levels of detail: in general each specification is associated to an *urban type*, which may be further specialized in several variations. In principle, once a design is completely specified it may be *realized* by multiple physical objects (say, multiple buildings with the same design), but often urban artifacts are realized just once. According to DOLCE, design specifications are classified as *descriptions*, which are a kind of abstract entities, while urban artefacts are classified as *physical objects*, and more exactly as *non-agentive physical objects* (NAPO), at least in the typical case.[7] In turn, physical objects are a subclass of *endurants* (entities that persist in time by keeping all

[4] A technological artefact a is a physical object which is, firstly, created by the carrying out by an agent (or group of agents) of a make plan for a physical object with a physical description id, and for which, secondly, a use plan exists.

[5] For instance, it can be a fountain including the water thatu springs from it.

[6] Note that design constraints may in turn result from the obligation to satisfy certain normative constraints that reflect, for instance, quality or safety requirements. Such normative constraints are however very different from those concerning forbidden or allowed use of the artefact.

[7] An urban artefact can also be formed by agentive (APO) physical objects such as robotic systems broadly understood (e.g. traffic control systems). This case is going to become more relevant with the Internet of Things paradigm.

their parts present at each time), and are distinguished from *amounts of matter* (M) since their identity depends on a specific structure, and not just on the parts they are composed of. Like physical objects, all urban artefacts have a spatial location, which is a geo-referenced quality, since its quality space is associated with a geographic coordinate system (GCS).

However, if we aim to model finer changes in the evolution of the city, and in particular changes caused by social practices, this view needs to be enriched with a more flexible classification, where an object of urban interest can change its status depending on the context.

An interesting example of an urban artefact is Piazza del Mercato in Naples. It is formed by some NAPO elements (buildings facades, paved floor, lights, benches and other urban decorations) whose qualities and physical structure satisfy the generic characteristics associated to the concept *square*, and the specific ones described in the design specification according to which *that* urban artefact was originally realized.[8] An urban artefact, which is often a system of both artefacts and natural objects (buildings, benches and trees), can be seen at different levels of granularity: sometimes the square is the focus, in other cases the focus is the neighbourhood of which the square is just a component. In the latter case, the benches or the trees in the square may not be considered as elements of the larger urban artefact just because, at a coarser granularity, the square may be considered as atomic.[9] e is no design specification for it: it just plays the role of a chair.

3 Urban artefacts roles

In real scenarios, the intended use of an urban artefact (described in its design specifications) may not correspond to its actual use in social practices. To model this mismatch, due to the multiple and unexpected ways in which urban artefacts can be used, we introduce the distinction between *urban types* (*UrbType*) and *urban artefact roles*. Urban artefacts, which are instances of urban types, may play several social roles. For example, a *school* can be used as *meetingpoint* during a demonstration. Does this change of use imply a change of identity of the school type?

We believe not. For this reason, we will model uses of artefacts in terms of roles theory. Both types and roles are recognizable by a society or a group of agents, but, according to [13], the former are *rigid* properties (`R`), while the latter are *anti-rigid* (`AR`) and *founded* (`FD`).

Concerning the *way* these social roles emerge from social practices, an important distinction is to be done between the *institutional* roles associated to urban artefacts by their designers, and the *non-institutional* roles that may be actually played. The former are the result of a design choice made at the time the urban artefact is planned, and typically have a functional nature (for instance, the function of Piazza del Mercato might originally have been that of a *market place*); the latter are just related to the fact that an urban artefact may actually be used in a way different from that originally planned. Note that several social roles, especially in an urban scenario, may be played both in an institutional and a non-institutional way: for instance, the same role of market place may be an institutional role for an urban artefact of a certain type (a square) and non-institutional role for an urban artefact of a different type (a church). On the other hand, certain social roles can only

[8] Note that not every square is an urban artefact, since some squares may not have been designed.

[9] The rules that determine which types of physical objects are components of an artefact are not discussed in this paper. Some of these rules combine different aspects like size, function and spatial disposition. Their discussion requires to refer to a set of urban artefact types, but the characterization of such a type is itself an open topic in the literature.

be played in one way, either institutionally or non-institutionally. For instance, the role of *president* is always institutional.

With these categories we can distinguish situations in which the roles played by an urban artefact are compatible with its type from those in which they are not. This is a necessary step to be able to model mismatches between the 'planned' and the 'lived' city or simply to separate the compliant and the non-compliant aspects of an emergent social pattern in which an urban artefact participates.

Local knowledge expressed by emergent social patterns is crucial to represent the concept of places as recognized by people who live them.

As a consequence, multiple perspectives on urban artefacts are needed: on the one hand, the designer's perspective, which is based on explicitly stated uses and modes of deployment; the local authority perspective, based on explicitly stated normative constraints, and the users' perspective based on how the artefact actually contributes to the activities of the inhabitants.

The user's perspectives may agree with the institutional role of an urban artefact in two cases, namely, when the users' activities are in agreement with the modes of deployment established by the designer; or when the artefact itself is "re-created" via the recognition, e.g., by the city authority, that the users' uses are thereafter allowed, i.e., considered as "institutional". Of course, this latter step may require that the design is rewritten at least in part. The conditions under which this change determines the change of identity of the urban artefact may be subtle. One would like to say that this surely happens when the urban artefact is structurally and functionally modified by changing its topmost type, e.g. when a church is transformed into a hospital.[10] Yet, even these changes do not determine a change of identity when they are assumed to be temporary, like when a church is transformed into a military hospital during a war. We distinguish two types of roles (see Fig. 1):

- the functional place role (FnP) which is compliant with a specific urban type and it can be considered as an institutional role;
- the social place role (SoP) which is related with unexpected uses of the artefact and it can be thought of a non institutional role.

Roles do not depend on an *a-priori* design or mode of deployment but only on the collective use of the artefact at some point in time. The same artefact can play multiple roles at the same time, it can start and stop to play a role several times in its life, and several artefacts (perhaps differing in type) can play the same role. In the case of a school during the demonstration, we can say that the artefact's identity remains unchanged, it still is a school, but the artefact plays the role of being a meeting point during that day.

It is crucial to recognize the variety of roles that an urban artefact can play depending on actual uses. Social practices, being recurrent activities, define the way in which an urban artefact is actually used: they can be compliant or not with the uses foreseen by the urban type. This observation is key to the difference between functional and social place, the urban artefactual roles modeling the expected (functional) uses of an Urban Artefact and the actual (social) uses which can be unexpected.

To define the roles and to use them to classify urban artefacts, social practices have to be recognized, thus a definition of social practices needs to be introduced.

[10] Here we assume that church and hospital are general urban types and that there is no higher type (in particular, building would not be a type).

3.1 Defining Social Practices

In a society there are established and accepted behavioral patterns which characterize traits of human organizations. We find this especially in complex social organizations like cities. Inspired by the social geography field of study [18, 11], we claim that the actual meaning attributed to an urban artefact depends on social practices. The notion of social practice has been object of several studies, mostly in sociology [6, 15] and social geography [18], but never clearly formalized, with the exception of Tuomela [20], who proposed a complete formal representation of social practices, albeit with a strong bias on groups intentionality and a low level of awareness of their spatial aspects.

In the following, we propose an interpretation of social practices (SPr) based on the DOLCE ontology (see Fig. 1), which we shall use to define the social role an urban artefact plays depending on certain urban acts (UrbAct). Through the notion of social practice we can move our focus from individual to collective behavior. As stated in [7] the basic domain of study to interpret social structures is *neither the experience of individual actor, nor the existence of any form of societal totality, but social practices ordered across time and space.* A social practice models the way performed activities are situated in time and space and organized in a skilled and knowledgable fashion by groups of human agents [7], collected here in the DOLCE's category of *social collective* (SoC). To capture these intuitions, we shall use a primitive predicate $Rec(spr, y, t)$ standing for 'a social practice spr is recognized by the social collective y at time t. We have:

$$UrbAct(x) \rightarrow PD(x) \wedge \exists y(PC(y, x) \wedge UrbArt(y)); \tag{1}$$

$$Rec(spr, y, t) \rightarrow SPr(spr) \wedge SoC(y) \wedge Time(t); \tag{2}$$

$$SoC(y) \rightarrow ASO(y); \tag{3}$$

$$SPr(spr) \rightarrow \exists x, t, y\,(CF(x, spr, t) \wedge Act(x) \wedge SoC(y) \wedge Rec(sty, y, t)); \tag{4}$$

$$Act(x) \wedge Spr(y) \wedge CF(x, y, t) \wedge PC(z, x) \wedge DF(y, w) \wedge SoP(w) \rightarrow CF(z, w, t) \tag{5}$$

In the formulas above, which use the primitives introduced in [12] and [13], $PD(x)$ stands for 'x is a perdurant', $PC(x, y)$ for 'x participates to y', $DF(x, y)$ for 'concept x defines role y' and $CF(x, y, t)$ for 'x is classified by the concept y at time t'. Axiom (4) says that every social practice is a concept that classifies some activity taking place in a given space, so this means we are focusing on *urban* social practices. Also, a social practice requires the existence of a social collective that recognizes it, so we can say that it is specifically dependent on a social collective. To be recognized by a social collective we shall also assume that the social practice is a recurrent activity[11]. For example, the *urban* social practice of having dinner at a particular place is not recognized in the same way by everyone: different groups would characterize it as constrained by different temporal or spatial conditions as well as action patterns depending on how that practice is usually performed in that social and cultural system. Therefore, we can say that there are many possible types of the social practice of having dinner at that place (say, for certain special occasions, or as a regular habit every week), each recognized by one or more social groups.

We can also have distinct social practices emerging from different spatial patterns. For example, in the last decades large shopping malls have been considered as places of entertainment as a result of a change in urban lifestyles in the so-called post-modernist

[11] This assumption means that an activity type, to be a social practice, has to be iterated several time by the members of the same social collective. Such constrain is not included in our formalization yet.

society [21]. The practice of entertainment counts as a new type of practice specifically located in a particular space. It follows that social practices are conceptualized differently depending on temporal and spatial locations. On the contrary, we may consider an emerging activity type as a social practice only relatively to the fact that the activities are recognized by a social collective. Finally, Axiom (5) states that the social place role defined by a given social practice classifies the urban artefact(s) which is used in the associated social practice activities.

3.2 How social practices define urban places

As we have seen, urban artefacts may play institutional or non-institutional roles. Institutional roles are those that are played in compliance with the intended function of the urban artefact. Playing such institutional role may be recognized as a recurrent activity by a certain social collective, so that a social practice emerges. Whenever such a social practice exists, we can say that the urban artefact marks an *institutional place*.

For instance, urban artefacts of type *school* are designed for teaching activities. Teaching is an intended use typically included in the design specifications for this type of artefact. When the artefact plays its institutional role, this is also a recurrent activity of the social collective of educators, so that a social practice emerges from such recurrent collective behaviour. When this holds, we can say that the school is a *teaching place* – more exactly, an *institutional teaching place*. From a different perspective, the same school can be seen as an *institutional learning place*, given the social practice of learning recognized by the social collective of students. In conclusion, we shall say that *being an institutional place* is an emergent and dynamic property of an urban artefact that depends on the iteration of some collective behavior, which can be ascribed to an urban artefact since such collective behavior is compliant with its planned use. So, being institutionally intended to be used for a certain purpose is not enough for an artefact to mark an institutional place.

Classifying schools as *teaching places* is rather natural, but the teaching collective behavior might be manifested also outside schools, e.g., in hotels, bookstores, factories and parks, which are not sub-types of school. Likewise, we may use a school just as a meeting place or as a place for recreational activities.

These unforeseen uses of an urban artefact are quite common: a square may be used for praying, a church may be turned into an hospital, a school yard may be used for sports tournaments. All these uses involve playing *non-institutional* roles, in a way that is not compliant with the uses foreseen in the urban artefact's design specifications. In these cases, the urban artefacts marks a *non-institutional* place.

So, we shall define a non-institutional place as a place marked by an urban artefact participating in social practices, recognized from a recurrent activity, such that the artefact is not used in compliance with its designed uses. Non-institutional places are often called *social places*, so in the following we shall use both terms interchangeably.

Note that, differently from an urban artefact, social place and institutional places are not generally recognizable *per se*. They are recognized as such only by the members of a social collective since these share the knowledge of (and may also participate to) that social practice. Indeed, the so-called *local* knowledge, related to urban places, is shared in specific communities and is generally the most difficult knowledge to gather, since it is not the subject of standard geography classifications. At the same time, awareness of the different groups which use an urban artefact in distinct ways is essential to identify the actual stakeholders. Our approach to conceptualize social place is theoretically grounded in social geography theories [11, 16, 14, 18], where it is claimed that the *social content* of the city is the basis for

reading it. The study of social content focuses on the social structures, generated by collective behaviors, in connection with the forms of the city where they appear [17]. Differently from institutional places, where the social practice is compliant with the planned uses, the essence of a social place is of being related to unexpected social practices in which urban artefacts participate. By using this notion, we can exploit the local knowledge about the lived city expressed by different social collectives to describe the urban social environment.

To show some implications of this modeling choice, a real example is discussed in the following section.

4 Piazza del Mercato, Naples – A real context example

Piazza del Mercato is a square in Naples which represents an interesting as well as rather complex example of the differences between typologies and typicalities characterizing urban artefacts. In the framework developed above, a typology refers to $UrbType$ while typicalities are expressed by the performed social practices. These types and practices determine the social places and the institutional places marked by urban artefacts.

Several urban regeneration plans of Piazza del Mercato have been discussed in the last decade and the process is far from being over. Since it is not possible to illustrate here all the aspects related to this area, we will focus on two situations that exemplify how to use the framework for the representation of the urban environment. Note that each situation presents different processes which in turn provide multiple perspectives of Piazza del Mercato.

4.1 First situation

Piazza del Mercato in Naples (pdm) is an urban artefact classified by the urban type *square* and constituted by a number of non-agentive physical objects such as fountains and lampposts, and with specific physical qualities, e.g., location, size and delimitations, and normative constraints like the no-parking restriction over the whole area.

$$UrbArt(pdm) \tag{6}$$

Although parking was not allowed, pdm has been used as a parking area until 2006, when fences and a CCTV system were installed. This is an example of an urban artefact that was not designed to be a parking area, but a typicality of its use is related to the social practice of parking. As long as the social practice existed, pdm was classified by the local social community as a *parking place*.

This social practice conceptualizes a recurrent activity of parking that was performed in pdm. The activity was recognized specifically by users that participate in that use of pdm. Also, in pdm's design specifications it was (and currently is) required not to use the area for parking. Therefore, *being a parking place* was a non-institutional role of pdm, being in contrast with the normative constraints of its design specifications. A social place therefore emerged.

Given the following conditions:

$$Act(parkingInPdM); \tag{7}$$
$$ActIn(parkingInPdM, pdm, 2005); \tag{8}$$
$$Spr(pdm_{parking}); \tag{9}$$
$$CF(parkingInPdM, pdm_{parking}, 2005); \tag{10}$$
$$SoP(parkingPlace); \tag{11}$$
$$DF(pdm_{parking}, parkingPlace) \tag{12}$$

Figure 2 The image shows Piazza del Mercato, in Naples, where a group of muslims are praying and a football field with mobile goalposts is drawn.

We can now infer that *pdm* is classified by the social place role *parkingPlace*:

$$CF(pdm, parkingPlace, 2005) \tag{13}$$

4.2 Second situation

After 2006 the parking practice was eliminated and new social practices emerged. As we can see in Figure 2, *pdm* became a place where Muslims meet to pray and young people to play football. These are unexpected uses of the square that are not specifically ascribed to its type nor identifiable through design specifications. However, the knowledge Muslims or young people have about *pdm* is related to their experiences of *pdm*. Let us say that Muslims meet in *pdm* to pray on Friday morning and youngsters play football on Sunday.

Only from the activities that members of the two social collectives (recurrently) perform we can identify the two non-institutional roles played by *pdm*: *being a praying place* and *being a football place*.

$$SPr(pdm_{praying}); \tag{14}$$
$$Act(prayingInPdM); \tag{15}$$
$$SoC(muslims); \tag{16}$$
$$CF(prayingInPdM, pdm_{praying}, fridays\text{-}in\text{-}2017); \tag{17}$$
$$Rec(pdm_{praying}, muslims, fridays\text{-}in\text{-}2017); \tag{18}$$
$$SoP(prayingPlace); \tag{19}$$
$$SPr(pdm_{playingFootball}); \tag{20}$$
$$Act(playingFootballInPdM); \tag{21}$$
$$SoC(youngPeople); \tag{22}$$
$$CF(playingFootballInPdM, pdm_{playingFootball}, sundays\text{-}in\text{-}2017); \tag{23}$$
$$Rec(pdm_{playingFootball}, youngPeople, sundays\text{-}in\text{-}2017); \tag{24}$$
$$SoP(footballPlace)\,. \tag{25}$$

Therefore we conclude:

$$CF(pdm, prayingPlace, fridays\text{-}in\text{-}2017); \tag{26}$$
$$CF(pdm, footballPlace, sundays\text{-}in\text{-}2017)\,. \tag{27}$$

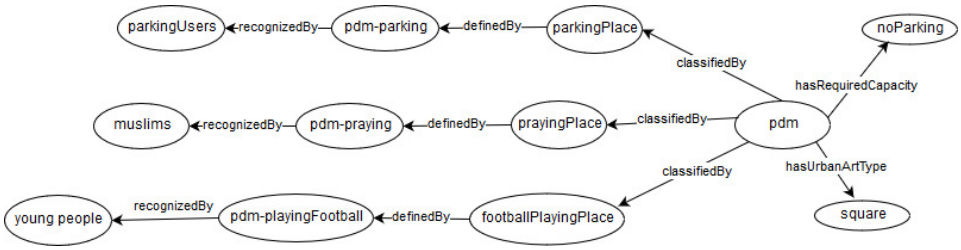

Figure 3 The figure shows some of the instances (in ellipses) and their relations that can be used to represent the situations characterizing Piazza del Mercato. It can be seen that the urban artefact *pdm* is classified by different social places; this is expression of the multiple social collective's point of views which experience *pdm* through different social practices.

4.3 Final remarks

Piazza del Mercato in Naples has been used to exemplify possible implementations of our framework. Some final remarks are needed:

- urban artefacts cannot be classified exclusively on the basis of their designed uses, since they are changeable depending on how people actually experience them;
- social and functional places, as defined in this paper, are emergent roles (properties);
- places, as understood here, are expression of different social collectives' perspectives;
- we believe that the conceptual system we developed helps to better identify the stakeholders of an area and to establish how a new design may impact them;

Given these observations Piazza del Mercato, which here we studied only in minimal part, seems to be better represented in its complexity via a role theory. In Figure 3 we sketch how the notion of social place can support the recognition of different stakeholders through the analysis of social collectives. Also, taking into consideration social practices to define an urban artefact's roles allows an evaluation of the compliance between actual and required uses.

5 Future work and Conclusions

The social use of urban artefacts and their type are two interacting aspects of the built environment. The way urban artefacts are designed strongly influences the way we use them, and forces the construction of specific social contents related to recognized collective behaviours. Cities, indeed, can be interpreted as the result of the political, economical and social organization of contemporary societies.

However, the emergent semantics of an urban artefact's social roles goes far beyond the one addressed by a specific type. Also, making explicit the social characterization of the urban areas is the grounding for a better contextualization and evaluation of the way these are planned and how they can be changed.

The formal framework described in the previous sections defines only a static representation of the urban environment. It answers the following question: How can ontological analysis help modeling the *social content* [17] of the build environment besides its planned characterization?

Clearly, the dynamics of the existing mutual interaction between the social roles and the urban types needs further analysis and specifications. Even if it is not the focus of this contribution, being able to represent dynamic processes that arise from this mutual interaction is crucial to support decision making in the definition of re-design patterns that want to be more contextualized in the social dimension of an area.

In a typical design studio scenario, groups of professionals such as architects, urban planners and landscape architects generally start their work with site visits and intense analysis to deeply describe the current state of an area. This work is all on the shoulders of these professionals which use both qualitative and quantitative methods. Involving citizens via a participatory process to collectively build a *social* knowledge base about an area is generally considered too expensive. Nowadays, with the growing availability of geo-based mobile tools it has become much easier to collect data via crowdsourcing [12], and with the Internet of Things (IoT) paradigm every physical object in the city can potentially have a digital identity and sense the environment around itself as well as interact with the others.

Recording the dynamics of place uses and the way they are recognized by different social collectives will allow a better understanding of design choices and evaluations. Grounding the wealth of data collected through crowdsourcing, geosocial media, and the IoT in our framework, can be extremely useful – especially in the first phase of participatory urban planning, in order to identify the relevant stakeholders and critical areas.

References

1 Stefano Borgo, Massimiliano Carrara, Pawel Garbacz, and E. Pieter Vermaas. A formal ontological perspective on the behaviors and functions of technical artifacts. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 23:3–21, 2009.

2 Stefano Borgo, Maarten Franssen, Pawel Garbacz, Yoshinobu Kitamura, Riichiro Mizoguchi, and E. Pieter Vermaas. Technical artifacts: An integrated perspective. *Applied Ontology*, 9:217–235, 2014.

3 Stefano Borgo and Claudio Masolo. Ontological Foundations of DOLCE. In Roberto Poli, Michael Healy, and Achilles Kameas, editors, *Theory and Applications of Ontology: Computer Applications*, chapter 13, pages 279–295. Springer, 2010.

4 Stefano Borgo and Laure Vieu. Artefacts in formal ontology. In *Handbook of phylosophy of technology and engineering sciences*, volume 9, pages 273–307. 2009.

5 Helen Couclelis. Location, place, region, and space. *Geography's inner worlds*, 2:15–233, 1992.

6 Anthony Giddens. *Central problems in social theory: Action, structure, and contradiction in social analysis*, volume 241. Univ of California Press, 1979.

7 Anthony Giddens. *The constitution of society: Outline of the theory of structuration*. Univ of California Press, 1984.

8 Michael F. Goodchild. Formalizing place in geographic information systems. In *Communities, Neighborhoods, and Health*, pages 21–33. Springer, 2011.

9 Nicola Guarino. Artefactual systems, missing components and replaceability. In *Artefact Kinds: Ontology and the Human-Made World*, pages 1–11. Springer International Publishing Switzerland, 2014.

10 Gilles Kassel. A formal ontology of artefacts. *Applied Ontology*, 5:223–246, 2010.

11 Henri Lefebvre. *The production of space*, volume 142. Oxford Blackwell, 1991.

12 C. Masolo, S. Borgo, A. Gangemi, N. Guarino, A. Oltramari, and L. Schneider. Dolce: a descriptive ontology for linguistic and cognitive engineering. *WonderWeb Project, Deliverable D17 v2.1*, pages 1–38, 2003.

13 Claudio Masolo, Laure Vieu, Emanuele Bottazzi, Carola Catenacci, Roberta Ferrario, Aldo Gangemi, and Nicola Guarino. Social roles and their descriptions. In *KR*, pages 267–277, 2004.

[12] This kind of information is generally known as Volunteered Geographic Information.

14 Doreen Massey. *For space*. Sage, 2005.

15 Andreas Reckwitz. Toward a theory of social practices a development in culturalist theorizing. *European journal of social theory*, 5(2):243–263, 2002.

16 Edward Relph. *Place and placelessness*, volume 67. Pion London, 1976.

17 Aldo Rossi. *The architecture of the city*. The MIT Press, 1984.

18 Edward W. Soja. *Postmodern geographies: The reassertion of space in critical social theory*. Verso, 1989.

19 Yi-Fu Tuan. *Space and place: humanistic perspective*. Springer, 1979.

20 Raimo Tuomela. *The philosophy of social practices: A collective acceptance view*. Cambridge University Press, 2002.

21 Sharon Zukin. Urban lifestyles: diversity and standardisation in spaces of consumption. *Urban studies*, 35(5-6):825–839, 1998.