A new collaborative model for a holistic and sustainable metropolitan planning

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Abstract. The purpose of our contribution is to provide insight into an innovative, shared and transferable model to assist the evolution and sustainable planning of an urban-industrial metropolitan area through a bottom-up involvement of the industrial community and local stakeholders. The presence of industrial urban districts has become a typical feature in Italy as a result of urban spreading. The presence of SMEs in urban ecosystems is a new fundamental opportunity for the design and planning of spaces as well as for the planning of smart energy systems and life quality in the cities.
We tested this approach in Roveri, a historical industrial district in transition located within the urban boundary of Bologna. This paper describes the first results obtained with a number of tools and actions aimed at making the community and stakeholders conscious of the district's potential and to enable them to lead its development.

Keywords: SMEs, Metropolitan area, Energy efficiency, Circular economy, Holistic approach

Introduction

Until now, urban stakeholders have thought of industrial and urban areas as separate entities in terms of energy systems, transports and service planning and overall quality-of-life standards. As they become aware of the presence of urban manufacturing, with its socio-economic and environmental implications and emerging opportunities, an evolution of the spatial relationship between cities and industrial environments becomes necessary. This trend can be observed in Italy as well as in many other industrialized countries worldwide.
The relationship between current urban planning practices and the places where urban industries are growing today is largely based on the conflict between the city center and the industrial periphery.
Industries have become urban industries with the growth of urbanized areas over the last twenty years. This happened without planning an integration between the needs of the city center and those of this new industrial periphery that has no inhabitants but every day employs energy resources and handles a huge amount of people from the city center (and outside).
After a post-industrial trend in which European cities moved industries outside of the urban boundary, today industries - mainly SMEs - are located within the city, even more so because they occupy whole districts that were once "close to" the city and now are in physical continuity with the city.
Even if they are often referred to as a value, they are not perceived as a key component of the city. In Italy, the lack of experience in the district management of this kind of industrial settlements (in which hundreds of companies are located) makes it harder to bring together typical "urban needs" (based on citizen housing) and "industrial needs".
The management and planning of tomorrow's sustainable and smart cities imply the ability to adopt a strategic approach on energy use and production, to apply technologies for innovation, to use financial tools to achieve progress, but primarily to know the needs, consumptions, opportunities to apply innovation and achieve more sustainable goals.
Worldwide, it is recognized that buildings account for about 40 percent of total energy consumption and contribute a corresponding percentage to overall carbon emissions. As 41% of the European population lives in the cities (Eurostat, 2017), this influenced the attention to new urban policies, in favor of a culture of the efficiency for private and public buildings and in favor of policies for a more sustainable emission-free urban mobility.
The presence of hundreds of productive enterprises in the citizen ecosystem is not yet adequately perceived both as a problem and an opportunity and needs to be fully included in policies aimed at a new smart sustainable urban ecosystem development.
A correct and updated knowledge of the new urban ecosystem is crucial to support a new holistic "urban-industrial" community as a basis to develop a new smart urban planning system.
At the same time, it is essential that the industrial district community (that generally does not coincide with the boundaries of an urban neighborhood), even without a manager, becomes visible to itself and to the nearby urban environments.
We applied the experience to a real Bologna historical district, Roveri, a mixed industrial area that covers an area of about 2 square kilometers, where we developed tools and methods that could be transferred to many other metropolitan environments.

The industrial-urban ecosystems

A new smart and sustainable urban planning must be based on an effective urban industry management focused on the environmental problems related to company activities and on the interactions arising from the constraints of adjusting industrial needs to an urban context and vice-versa. Today, urban planning in our cities mainly involves urban renewal, with an adaptation of urban planning methods to existing cities. Industrial regeneration inside cities represents an additional problem that cities, normally, are not ready to address and solve (Hatuka and Ben-Joseph, 2017). As technologies that permeate citizens' life continuously produce and utilize data, a sustainable planning needs information more than data, which can come from a smart data processing. Ours is the big data time, so we think we know everything and that there is already too much data available on everything. However, the knowledge required to plan smart cities and territories has special features that need specific data for quality, accuracy and mainly updating, since urban and industrial settlements have a high intrinsic dynamism and the information becomes quickly obsolescent. Moreover, the knowledge for sustainable planning also needs to

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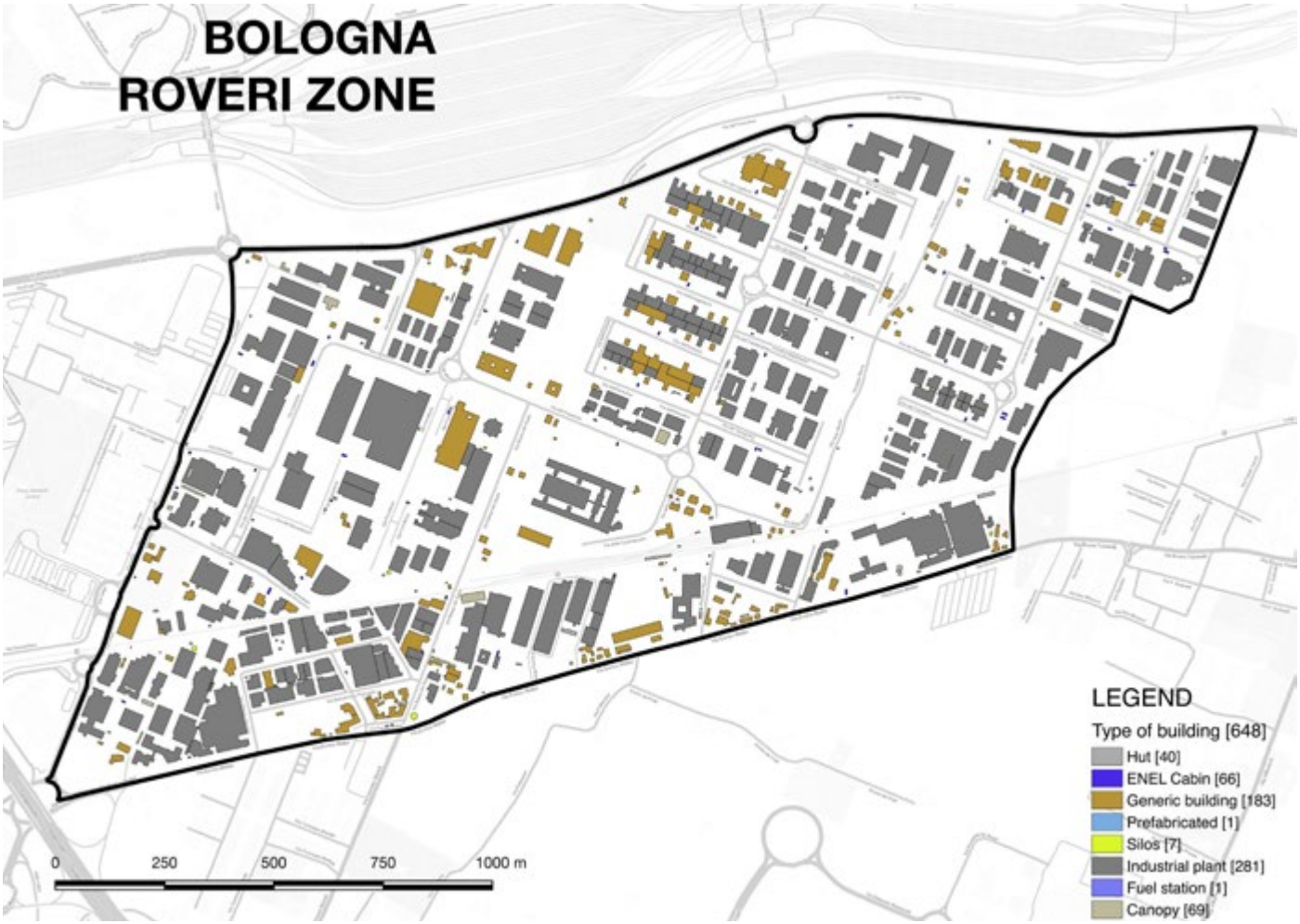

01 | Roveri district: buildings occurrence and type (from Bologna Municipal Cartography)

be based on confidential information that refers to the inhabitants' behavior, lifestyles, as well as on industrial subjects' activity and resources. Therefore, it is difficult to find useful data for good planning, and this data needs to be refashioned frequently - and in many cases it is not currently available. The principle "know well to manage well" and the need to open up the city to its industrial soul has led us to imagine a dynamic and holistic knowledge system that can derive data dynamically from many different sources and, by relating and combining them, produce useful information. This tool (that can be regarded more as a system than a tool) will create the basis of an ongoing process in which technology helps the community to know itself, to make it recognizable to the outside and to its stakeholders, and to allow the community to become aware of its possibility to improve both the quality of the life and production by acting as a whole in sustainable strategies for energy, services, events, to be used and shared . Moreover, the system was planned to be alive: it can grow with new data through technology (interoperability approach), agreements with public and private entities that produce, update and use processed data, and finally through input from the community that the system depicts. This paper discusses the first results of our work that was carried out on real data in real environments. This dynamic approach is also possible because the activity is part of a greater project, "Roveri Smart Village", shared between public and private partners; the purpose is to set up a system based on methods and tools, to support the dynamic transition towards the sustainable smart district of an old industrial area of Bologna by keeping and emphasizing its industrial nature. Against this institutional background, public and private agreements on data access, use and updating have been scheduled. As the activity was started to provide answers to real

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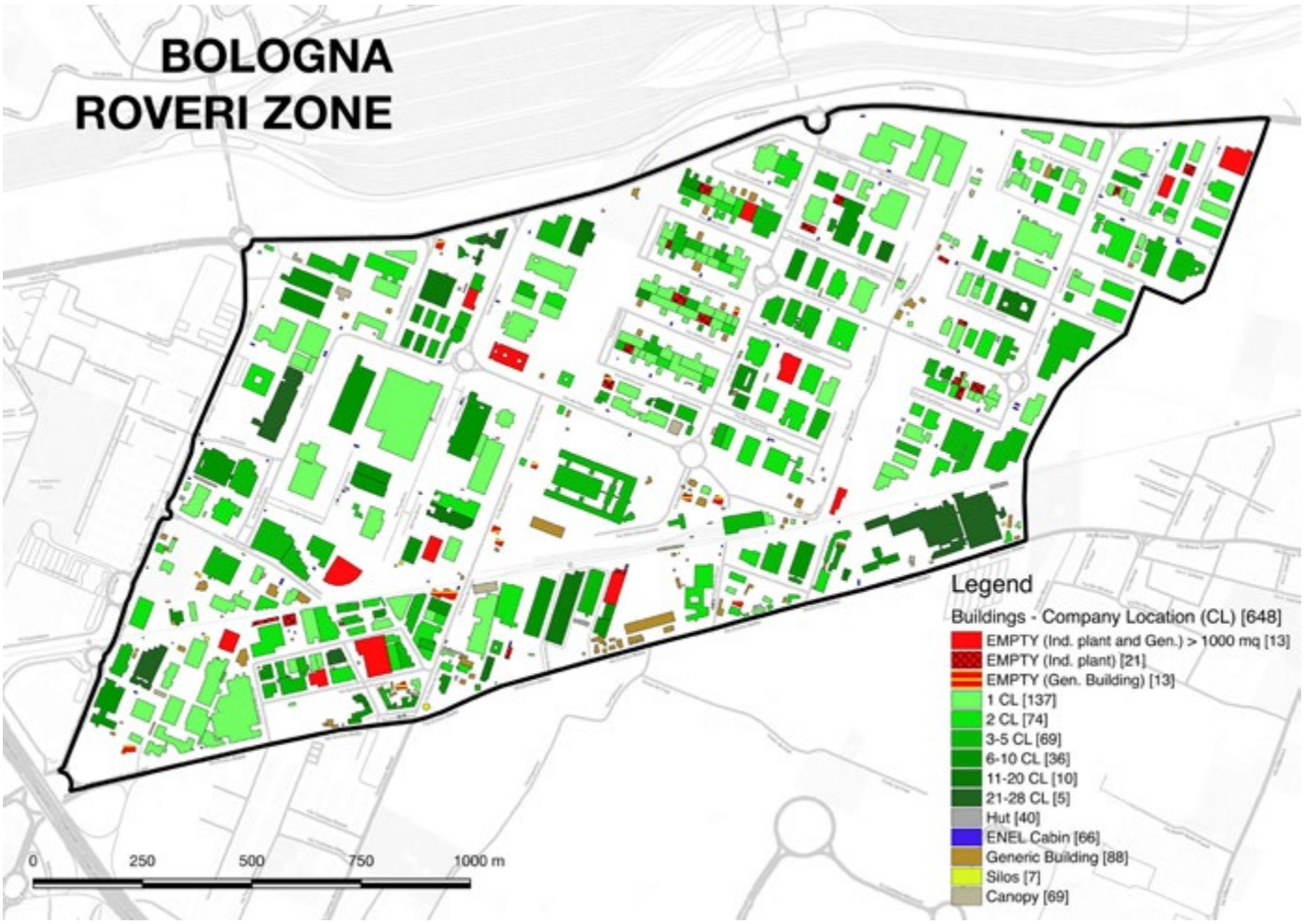

02 | Activities and companies occurrence in the buildings

questions coming both from a community (mainly entrepreneurs) and planners, the first results depict the informative infrastructure for future improvements on energy efficiency, circular economy, sustainable viability topics. But first, some crucial data is needed: what are the companies in Roveri today, and how many are they? What has been the effect of economic crisis on companies? How have they changed over time?

A geographical model to plan strategies for an industrial urban area

To date, we have completed the first tool of the Roveri holistic knowledge system (Roveri Smart Map) that aims to assess and describe the current presence of industries in the district.
We chose geo-data (and methods to relate these) that could allow us and future users to gain results, to update such results repetitively and to grow by using new information mainly referred to productive units (and buildings). Also, the possibility to export our results to other locations guided the data model approach. The majority of data used were made available to the Authors under the institutional agreements of the Roveri Smart Village Project.
The Roveri industrial district is still characterized by its industrial buildings dating back to the 1970s, within the latest industrial planning act approved by the municipality of Bologna; while the activities have changed many times over the years, the built pattern of the area is unchanged.
So, we refer all data and information to the polygons-buildings that design the fabric of this industrial area. With this assumption, we based the data model on these buildings on the geometries

coming from the cartographic database of the Municipality of Bologna (UTM32-ETRS89).
Polygons-buildings are in the original dataset, described by attributes such as univocal code, addresses (street name field, civic number) and main use (text fields). Other attributes are presented in separate shape-files, linkable to the buildings' code, such as streets (line features, with their name attributes), and civic numbers (point features). In a separate file, point features are linkable to data from the municipal technical land register, shown as polygon features that intersect building polygon features (Fig 1).
On the other hand, in order to know which kind of industrial activities was carried out inside these buildings, data on companies were derived from the Chamber of Commerce's dataset updated to May 2017, made available for the project and limited to the Roveri district area by the Metropolitan City of Bologna. These data contain information on all kinds of business companies in Roveri, each classified by name, address (street name and civic number), company's settlement numbers, activity startup and closing date (if applicable) (since 1960), VAT number, ATECO code, identifying the activity standardized category. Such data are not georeferred but contain geometric information that we highlighted through topological procedures. As the relationship between building geometries and companies/activities was not unique, the data were not logically coherent, and many times some pieces of information were lacking (i.e. no company results in a building recognized as an industrial one), sometimes it was duplicated, sometimes it was "combined" (i.e. more than one civic address refer to one company with many different settlements), etc.
Moreover, since logical inconsistencies on street names, civic number formats or company names are frequently the result of data integration, further activity of alignment of data content is essential. A Geographic Information System (GIS) was indispensable to achieve these results; to this end, different software programs were used. Filemaker Pro software was chosen to create a specific application to perform this task. An open-source GIS software, QGIS, was used to create the smart-map with which all thematic geographic relationships were made.
Many data were recovered or selected by means of geocoding procedures that allowed to include and integrate all compound data, referring to the open digital cartography OpenStreetMap® (OSM) licensed under the Open Data Commons Open Database License (ODbL) by the OpenStreetMap Foundation (OSMF).

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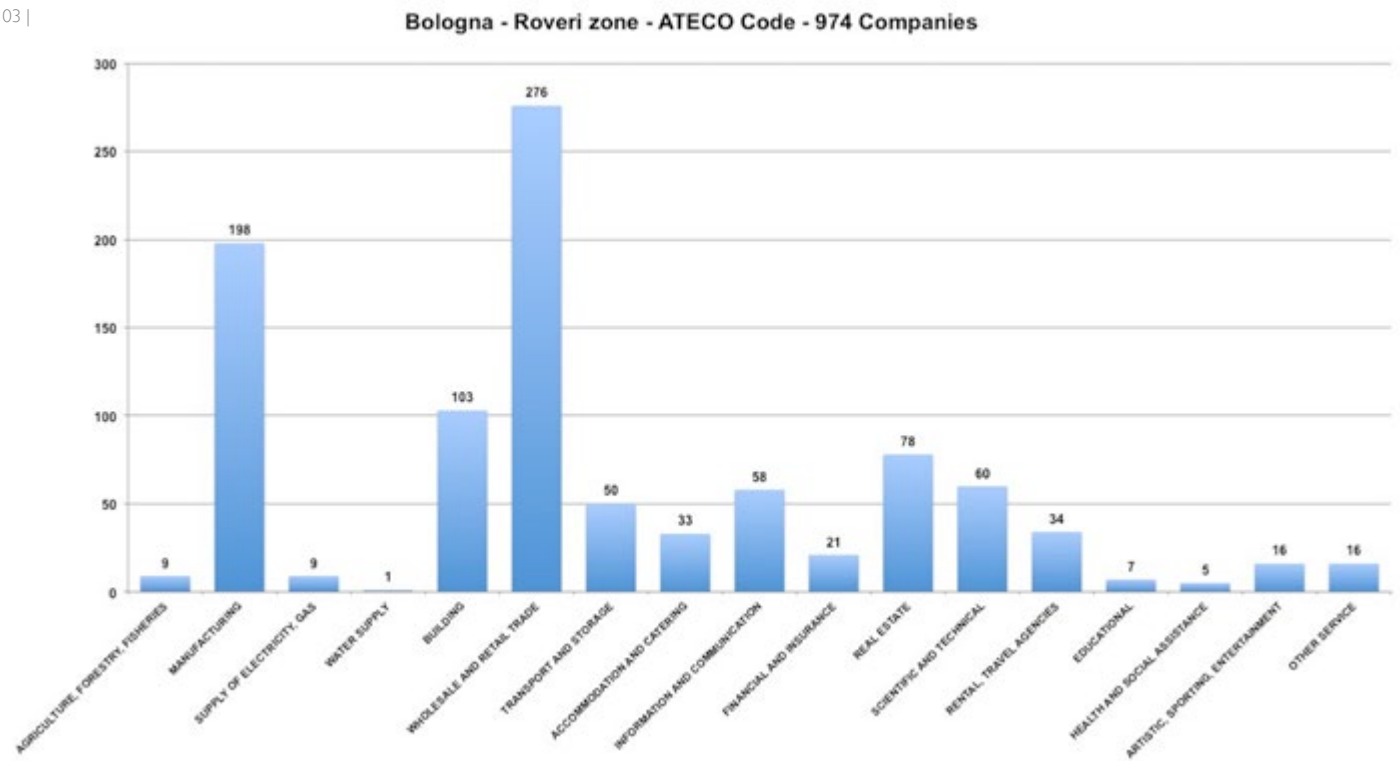

03 | Current activities/companies in Roveri area, classified on ATECO codes

OSM data, although with different archiving formats, libraries (SQLite), coordinates and projection systems (GC-WGS84), are very consistent and have a geometrical congruence to the Municipal features. In addition, Google Maps was used for the web smart-map edition. The geocoding of addresses was implemented through a GIS application, created within the database itself, which reads addresses and converts them, through Google Maps libraries, into two numeric fields, latitude and longitude in decimal degrees, so that eventually they are displayed on a map to see any errors and positions outside of the study area.
Homogenous data were obtained to correlate them and search for errors and duplications through repeatable procedures, created specifically for the management of these different types of data.
Additional tests were also done, not only for errors or failures but also to make company addresses homogeneous with the addresses of the cartographic buildings. Some tests were carried out with field surveys and control via Google Street View, flanking it with the cartography of buildings directly on a special Webgis application. At this stage of data processing, 648 building-polygons were identified, corresponding to 2521 records from the Chamber of Commerce, each describing a real activity in the Roveri district. But still, it is not possible to make a distinction between active businesses and ceased businesses.
To discriminate in a repeatable way the present industrial activity from the past one, and to identify vacant buildings, other complex spatial and logical queries were arranged.
The final results showed 1121 addresses of current activities occupying 331 buildings and related to 974 active companies. Among these, 13 buildings (1 of which is residential) covering an area of over 1000 square meters are empty; 34 buildings of less than 1000 square meters are also vacant, 13 of which are not industrial. The accuracy and complexity of this work allows to appraise the number of activities performed inside the same building and to classify buildings also on this basis (Fig. 2).
In the final smart map for Roveri, every building is linked to its address, type, name, and number of activities or company; each activity (or company) is described through its name, VAT number, ATECO code, startup (or ending) date.

Conclusions

The analysis of activities based on the ATECO code and on the startup and ending of these activities has a great value in order to plan strategies for this industrial area. These data show that despite a great dynamism in the companies represented during the latest years, the manufacturing sector is still the most present (Fig. 3). Moreover, the resulting outline shows how activities are changing in response to the last economic crisis, and how the closeness of the city, together with the decrease in real estate values, has influenced the introduction of new brands and new company models. Data highlight the industrial district dynamism and polymorphism that occur, still now, without any private or public management.
This information is crucial, within the knowledge society, for the planning of smart cities where industrial environments are present, and to plan and manage environmental and energy performances of these areas. We tried to create not only a knowledge tool, but rather a system that can be used to enter, extract and update information on the life of urban industrial settlements. The final aim is to learn how to plan, including multidisciplinary knowledge and citizen involvement, and to allow not only spatial reasoning but also the evaluation of various scenarios and alternatives for territorial intelligence governance (Laurini, 2017).
The Roveri Smart Village Project, which includes the above-described activities, involves researchers, entrepreneurs, and public administration, which represent the necessary condition to concretely implement it. The activity is ongoing to fix tools as living and replicable knowledge systems. The results described in this paper offer local stakeholders the opportunity to know substantial traits of the urban industrial setting that otherwise would not be available. Also, the smart map aims to give visibility and relevance to hundreds of individual companies that are often not sufficiently represented by trade associations. The Roveri community's awareness request was expressed by the active listening approach adopted by the Authors with the purpose of creating a community feeling without any strong management of the community. The Roveri community is very interested in the Project and in the tools presented in this work, which are perceived as a real way to know itself and to make itself visible outside of its boundaries and to the whole city.
Therefore, we will accompany them to use and improve these tools with the addition of additional data that only can be provided by those who live (or work) in the district: security, calamities, traffic, events, job offers, real estate news, etc. At the same time, the results discussed in this paper will lay down the basis to support their broader application in the fields of SME energy consumptions, energy efficiency, circular economy and industrial symbiosis. This chance is coming from European funded projects that the Authors will apply to this district as project demonstration area.
The approach, the procedures and the tool system are suitable to be transferred to other industrial-urban environments, and to be applied on a wider scale to value and monitor the trends of industrial presence, real estate value, etc.
Many of the activities described in this paper were carried out by the Roveri Smart Village management board (following a decision of the Municipality of Bologna) of which Authors are the instituting subjects.

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The activities described in this paper offer local stakeholders the opportunity to know the substantial traits of an urban industrial setting that otherwise would not be available. The presence of industrial settlements in the urban texture remains insufficiently studied, even though it occurs very commonly in Italy and particularly in the Emilia-Romagna Region.
Knowledge is a key factor to plan and manage environmental performances in these areas. The Roveri Smart Village Project, which includes the results described in this paper, involves researchers, entrepreneurs and public administration at various levels which represent the necessary condition to achieve concrete goals. The tools presented by the Authors have been developed for integrating the existing GI-instruments to be easily and free usable into the planning tools of local stakeholders.

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General Manager CONFINDUSTRIA EMILIA

This paper describes an initiative that will develop methods and tools that can be usefully used to support some institutional competences within our Organization. The smart map described in the paper, among other things, was designed with the perspective of becoming a reference instrument for energy efficiency and circular economy scenarios, and more in general to support a new planning for the sustainable development of an existing industrial area in transition.
In collaboration with ENEA, we promoted the Roveri Smart Village project, which includes this activity, since its early stages, precisely because we believe that a transversal action of knowledge and applications shared with research institutions, entrepreneurs and administrators can give a new and fundamental contribution to business innovation practices, with the goal of improving the quality and attractiveness of the production that we are interested in providing to our companies.

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