Oeste smart region. An intermunicipal integrated analytical territorial intelligence platform

Oeste smart region. Una plataforma intermunicipal integrada de inteligencia analítica territorial

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Abstract

Smart regions are described as an instrument to achieve sustainable planning at the regional level, promoting knowledge-based development through continuous learning as an integral part of the development of regional resources that solves challenges through the knowledgeable application of new technologies, the organization of processes and reasonable and future-proof decision-making. With this work we intend to present a territorial intelligence platform, in particular the spatial data infrastructure that supports it. Based on the potential of multiple sources and formats of data available (Big Data), from the systems of twelve Portuguese municipalities. Along with the Internet of Things and collective intelligence the developed model, sets out as an ambition to take advantage of the potential of data science and artificial intelligence, to promote a regional model of governance based on the management of information capable of leveraging the creation of a territorial intelligence center constituting a new paradigm of territorial planning and management based on facts.

Resumen

Las regiones inteligentes se describen como un instrumento para lograr una planificación sostenible a nivel regional, promoviendo el desarrollo basado en el conocimiento a través del aprendizaje continuo como parte integral del desarrollo de los recursos regionales que resuelve los desafíos a través de la aplicación con conocimiento de las nuevas tecnologías, la organización de procesos y toma de decisiones razonables y preparadas para el futuro. Con este trabajo pretendemos presentar una plataforma de inteligencia territorial, en particular la infraestructura de datos espaciales que la soporta. Basado en el potencial de múltiples fuentes y formatos de datos disponibles (Big Data), de los sistemas de doce municipios portugueses. Junto con el Internet de las Cosas y la inteligencia colectiva, el modelo desarrollado se plantea como una ambición de aprovechar el potencial de la ciencia de datos y la inteligencia artificial, para impulsar un modelo regional de gobernanza basado en la gestión de la información capaz de impulsar la creación de un centro de inteligencia territorial que constituye un nuevo paradigma de planificación y gestión territorial basada en hechos.

Keywords: Smart regions, Territorial analytics, Data-driven public policies, Spatial Data Infrastructures, Platform

Palabras clave: Regiones inteligentes, Análisis territorial, Políticas públicas basadas en datos, Infraestructuras de Datos Espaciales, Plataforma

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1. INTRODUCTION

There is no agreed definition of what a region is (Vukovic & Kochetkov, 2017). Matern et al., (2020) argued that it is important to comprehensively understand what a region is, prior to a study of smart regions. The problem of defining a region is associated with its multifaceted nature (Vukovic & Kochetkov, 2017). An early definition by Hartshorne (1979) stated that it is "an area of specific location which is in some way distinct from other areas, and which extends as far as that distinction extends." Although it was referred to as "a cohesive area that is homogeneous in selected definitional criteria and is distinguished from neighbouring areas or regions by those criteria." by Encyclopedia Britannica. Mazza & Mavri, (2019) captured the essence of a region relevant to this study as "an association of regions or cities with different growth rates, with different spatial development and physical - technological infrastructure, and with different citizen needs."

The term smart regions, on the other hand, is synonymous with smart territory and smart area. Smart regions are described as a tool for achieving sustainable planning at the regional level, promoting knowledge-based development through continuous learning of human resources as an integral part of regional resource development (Sutriadi, 2018). Kodym & Unucka, (2018) viewed it simply as a region that employs modern technology to save time and money for the people living in it and Bauer et al. (2019) understood the concept as a region that solves tasks and challenges through the wise application of new technologies, the organization of processes, or making wise and future-proof decisions. The common thread in all definitions is that smart regions adopt various technologies to achieve a better quality of life and environment.

Moreover, knowledge of smart regions is largely shaped by smart city debates and current research on smart regions is heavily influenced by an economic perspective with an emphasis on growth, innovation, and policy strategies (Matern et al. 2020). Thus, agrees with Shearmur et al. (2017), who stressed that smart regions are "the result of dynamics in different economic sectors". Therefore, a working definition of a smart region adopted by this study is a territory comprising multiple smaller contiguous territories that together build smart systems to achieve a better quality of life for its residents, while striving for environmental and economic sustainability.

Although in recent years the notion of smart region is still ambiguous, the increase in the amount of literature on smart regions, strategies to promote digitalization methods within the political and administrative boundaries of cities has been noticeable (Breuer, Walravens, & Ballon, 2014; Caragliu et al., 2011; Cocchia, 2014; Vanolo, 2013). We can thus also address the notion of smart city since it follows the same ideal, as it comprises different approaches on how to encourage urban efficiency, technological innovation, and quality of life, but lacking a clear definition of what a smart city actually entails. Almost all smart city strategies deal with information and communication technologies (ICT) and how they can help reorganize urban life more efficiently. In the context of urban planning, Giffinger et al. (2007, p. 10) characterize the smart city as a "certain ability of a city" to qualify as "smart." In their study of medium-sized European smart cities, they identify six constituent characteristics of such cities: a smart economy, smart people, smart governance, smart mobility, a smart environment, and smart living. Since the notion of smart cities comprises different approaches on how to encourage urban efficiency, technological innovation, and quality of life, lacking a clear definition of what a smart city actually entails.

From a more critical perspective, by Greenfield (2013), Kitchin (2014), Sassen (2012), Sennett (2012), Shearmur et al. (2017), Söderström, Paasche and Klauser (2014), Söderström (2014), Vanolo (2013) and Viitanen and Kingston (2014) among others, who call for greater reflection on the production and use of big data and argue for a less positivist and more technocratic discourse. When questioning the role of multinational corporations in providing technological infrastructure for urban governance, attention is focused on the problem of monopolization and centralization of information and services. Debating technological determinism helps highlight power disparities and the societal as well as ecological consequences of ICT systems (Hodson & Marvin, 2017).

Soon, the concept of smart and sustainable cities claims to be an integrated response to rapid urbanization and the integration of ICT into city planning processes (Bibri & Krogstie, 2017; Höjer & Wangel, 2015). It is then an innovative city that uses ICT and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while being attentive to the needs of present and future generations with regard to economic, social, environmental, and cultural aspects (ITU, 2015). In this way, it increases the involvement of citizens and their quality of life as the main aspect of smart and sustainable strategies and integrates a variety of stakeholders. However, its opinion is more normative than analytical and focuses only on cities rather than thinking of urban and rural areas as being interconnected - even more so in the backdrop of digitalization.

Thus, there is a need for smart regions to not only refer to the territorial level and not be limited to rural regions. The authors argue for an understanding of smart regions that include urban and rural territories whose characteristics are increasingly complementary (Mölders, Othengrafen, Stock, & Zibell, 2016, p. 55). Increasingly, aspects of the 'urban fabric' are manifesting themselves in rural areas, finding expression in infrastructure that improves the accessibility (highways, bypass roads, etc.) and connectivity (ICT) of rural areas, profoundly transforming social interactions. Super-regional cooperation serves to avoid boundaries between urban and rural, for this is to prevent peripheral rural spaces from becoming disadvantaged and to ensure equal living conditions (Beirat für Raumentwicklung, 2017, p. 2).

However, most planning processes still treat urban and rural areas as separate. This dichotomy contradicts an integrated approach to regional development, "resulting in a lack of awareness of urban-rural relations and non-cooperation between urban and rural actors" (Calabrò & Cassalia, 2018, p. 574). Smart regions are shaped by informal processes of cooperation and governance that establish a "system of integrated action" (Garcia-Ayllon & Miralles, 2015, p. 4). The combination of different planning instruments and modes of governance (e.g., restricting settlement activities, protecting open spaces etc.), and debates about how a smart region should develop and how this could be achieved, and come to play an important role as well (Mölders et al., 2016, p. 56).

Given that more and more city dwellers are buying goods dedicated to country life, subscribing to vegetable delivery services, and engaging in urban gardening, Nikolaidou et al. (2016) speak of a growing rurality in urban regions. In contrast, Lefebvre (2003, p. 14) emphasizes the urban influence on the rural. Increasingly, aspects of the "urban fabric" are manifesting themselves in rural areas, finding expression in infrastructure that improves accessibility (highways, bypass roads, etc.) and connectivity (ICT) of rural areas, profoundly transforming social interactions.

Therefore, smart regions can be illustrated with the example of Helsinki Smart Region (https://helsinkismart.fi/), as it explicitly uses the term "smart region" to describe the concept of development in the Helsinki-Uusimaa region. This smart region has been created through application processes where the implemented dimension is represented by pilot projects such as driverless electric buses, on-demand public transport models, projects that make socially excluded groups digitally active citizens or co-working spaces that are implemented in the Helsinki metropolitan area. All these activities are part of a smart region strategy approved in 2014 by the Helsinki-Uusimaa Regional Council, which is responsible for regional planning and promoting regional interests and illustrate the analytical level of implementation within the smart region definition. This Helsinki Smart Region strategy is then directly linked to the Europe 2020 strategy and financial policies and instruments, as well as national and regional policies and funding.

1.1. Oeste Smart Region

Following the presented vision of what is a smart region, in this work we present the Oeste Smart Region as a regional integrated analytical intelligence platform for the Intermunicipal Community of Oeste (CIM OESTE) (see Figure 1).

The ambition is to make available to CIM Oeste, the first Portuguese integrated analytical platform of territorial intelligence that will offer capacity for collecting, storing, processing, and analysing data from municipalities (bottom-up) and external sources (top-down), changing the paradigm in municipalities planning and management.

The Oeste Smart Region project is a collaborative pilot project for the co-creation of an innovative solution to be implemented at a regional level taking further the concepts, methodologies, and solutions of Smart Cities, namely by adopting an open data policy and by promoting the dual digital and green transition which implies a structural change and the creation of the region as a platform concept for the integrated and real-time planning and management of inherent public competences.

The regional platform involved 12 municipalities (see Figure 1) in a collaborative pilot project for the co-creation of an innovative solution that changed the paradigm of planning and management decision making at regional level. The platform is being implemented having as its foundation a regional spatial data infrastructure that dynamically connects the twelve municipalities local spatial data infrastructures in a bottom-up data integration approach augmented by a top-down external data collection.

The new information products and services that Oeste Smart Region will make available, bring significant benefits to the design, execution, and monitoring of public policies, both at planning and operational level, allowing increased efficiency of resources usage altogether with a much higher degree of certainty in the achieved results.

This digital transformation with a focus on information is today a lever for changing the

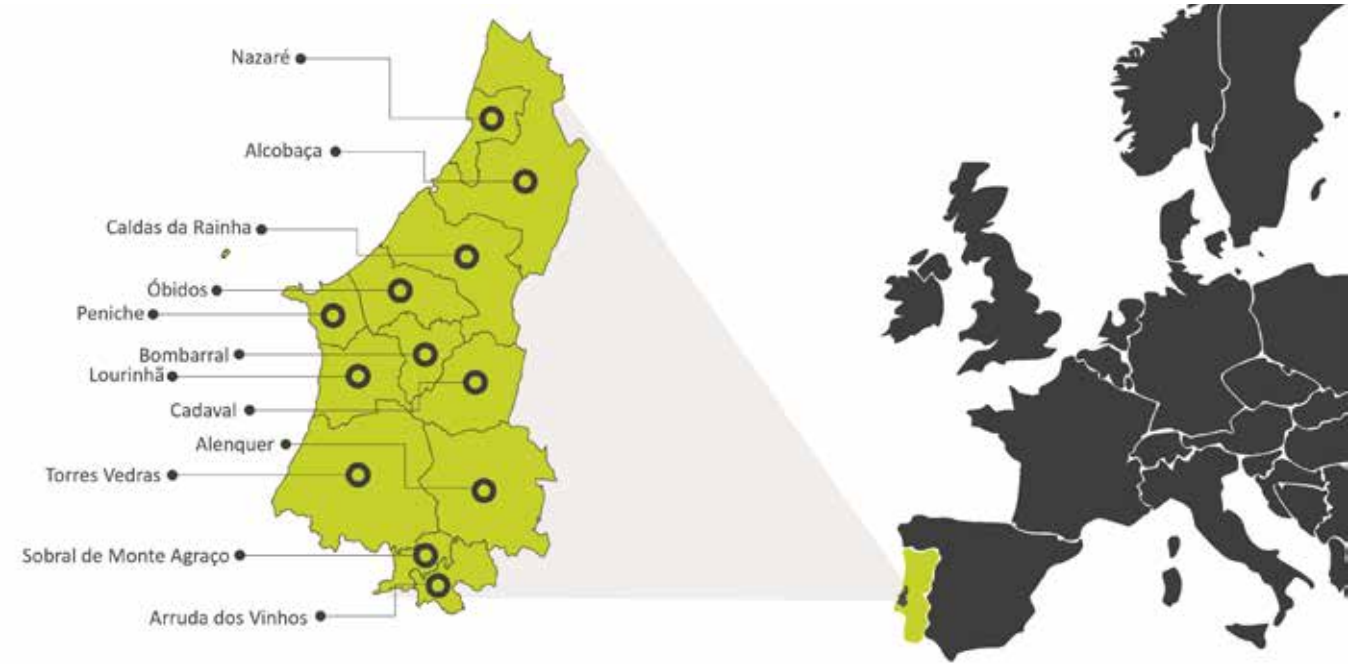

Figure 1. CIM Oeste municipalities

management model of cities and regions, in the conviction that what is best known is managed better, being a transversal matter to all strategic domains of territorial governance, from the economy to social inclusion, from the environment to urban regeneration, from risk management and prevention to urban-rural integration. This transformation process stems, to a large extent, from four major changes that are coming together and suddenly providing the ability of regions to become smarter than before – people, data, infrastructure, and technology – which can interact in more fluid and efficient ways than ever before.

Oeste Smart Region is a connected, decision-making space using information technologies to optimize services and infrastructure, reduce costs, increase security, attract investment, be sustainable and improve the quality of life of those who live, work or visit it.

With this platform the Oeste region has the ambition of:

- Dramatically increase the pace at which its sustainability and resilience grow
- Improving the way on: (i) how it involves society, (ii) how it uses collaborative leadership methods, (iii) how it works across disciplinary areas and systems, and (iv) how it uses data and integrated technologies
- Transforming services and improve the quality of life

With this project Oeste region will become an intelligent region which can promote not only information, but also a true sharing economy, which guarantees useful data and services to people, companies, and municipalities, for decision-making in real time.

2. MATERIALS AND METHODS

The Smart Region platform was based on the concept of the city as a platform, with their rational extended for a region, in this case for the 12 municipalities that integrate Oeste Region.

The concept of the regional platform is divided into 3 layers: 1) Data governance; 2) Analytics; and 3) Target (see Figure 2). In the first layer (Data governance), data is collected from sensors (e.g., air quality, weather, traffic counting); by people (e.g., social media, web applications); and from different systems (e.g., transactional systems from companies or cities) and stored in a data lake. In the analytics layer this data can be processed and modelled through descriptive, predictive, and prescriptive analytics and also made available in an open data portal searchable by a data catalogue. All developments made in the analytics layer have specific targets and objectives, namely: 1) for Government to plan and manage the region; 2) for Academia that through the data available can produce research, increasing the knowledge about the region; 3) for Companies that can take advantage of the platform to create new products and services, increasing economic development of the region; and 4) for Citizens providing information and services that can be used by people who lives, works and visit the region.

The Smart Region platform incorporates mainly data coming from the 12 municipalities (bottom-up data) and from external sources (top-down data). Considering municipalities data (the bottom-up data) was referring to: 1) environments; 2) cartography; 3) equipment's;

4) local development; 5) heritage; 6) infrastructures; 7) mobility; 8) territorial management instruments; and 9) Wi-fi. Regarding the external data (the top-down data), their origin came from several entities that provided data on: 1) ATM transactions; 2) companies data (sales, employment); 3) public transportation ticketing; 4) traffic jams and alerts; 5) waste management; 6) carbon neutrality; 7) KPIs of funding projects; 8) gender equality indicators; and 9) education statistics.

For the integration of the bottom-up and top-down data two different approaches have been carried out. In the case of the bottom-up data the rational for the integration was the direct connection to the data sources (i.e., the information system of each municipality). The ambition in this platform is that the integrated data was not duplicated, but instead the data that is managed by each municipality. This aspect allowed the non-use of duplicated data as well guarantee that the data available in the platform is more accurate and updated as possible, reflecting any changes that are made in the source by the municipality technicians.

Regarding the top-down data several strategies were carried out, depending on the way data from external providers was made available. Independently from the way that external data was made available, the rational for their integration was having always in mind to try to have as much as possible automatic procedures to maintain the data of the platform always updated. In Figure 3 is presented the Smart Region platform architecture.

2.1. Bottom-up data integration

To connect the Smart Region platform to the municipalities, a first assessment was made in each one, to verify how the data was stored and structured, taking into consideration the strong geographic component of the data produced and maintained. After the initial assessment three distinct situations were found: (1) municipalities with geographic information stored in system files; (2) municipalities with the geographic information stored in database but managed by an external entity; and (3) municipalities with the geographic information stored in a database managed by the municipality. Based on the assessment for (1) a database for each municipality was created that still worked with a file system in the management of its geographic information for (2) an open database was created, to allow autonomy in geographic information management, for (3), the platform was linked directly to those databases through, web services.

2.2. Top-down data integration

The integration of the top-down data was made following different strategies, depending on how the

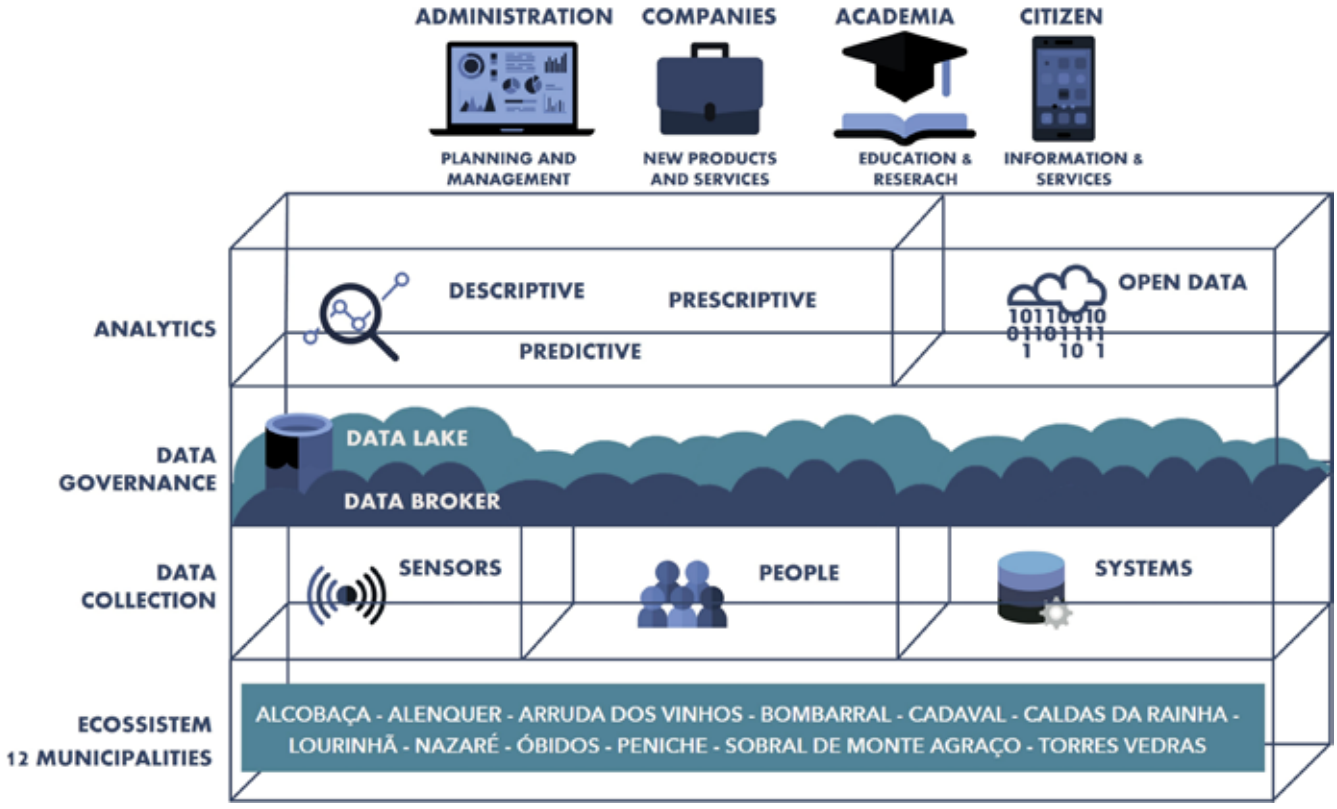

Figure 2. Region as a platform concept implemented in Smart Region analytical platform

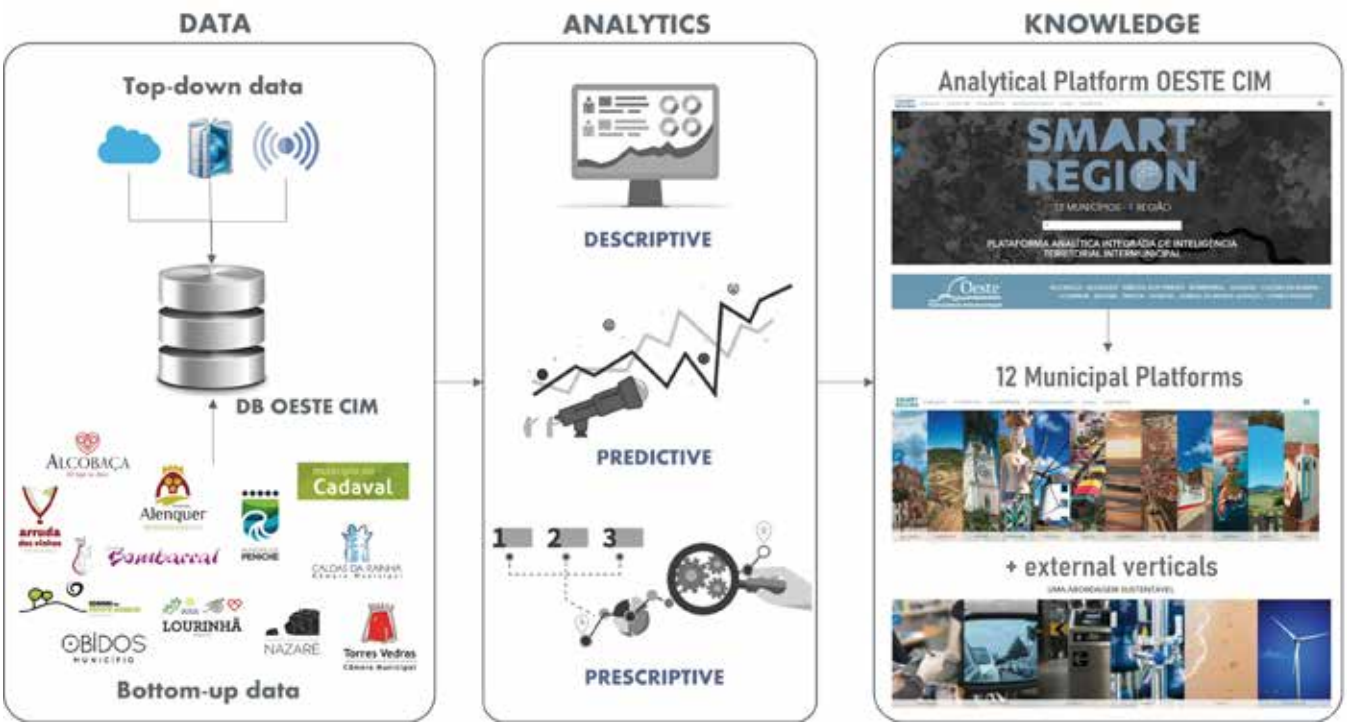

Figure 3. Smart Region analytical platform Architecture

data was made available by the different data providers. Indeed, as mentioned previously the ambition of the platform is to integrate external datasets in the most automatic way possible, to guarantee a minimum effort in the future update of the information. Below is described the methodology adopted for each vertical and their integration in the Smart Region platform.

ATM transactions: data was provided by SIBS Analytics about weekly and monthly ATM transactions in the 12 municipalities of Oeste region. Data is made available through the delivery of a file in a folder stored in a server, with the transactions of last week and last month. It was created an automatic procedure that runs every week to detect a new file and store the data in two tables of a database: one for the weekly transactions and another for the monthly transactions.

Companies data: this data was delivered in .xlsx format and stored in the Smart Region database: 1) information and location of companies; 2) business volume (import, export and number of employees); 3) location of establishments. The available data is relative to years 2016 to 2021.

Bus ticketing: data was provided by the company responsible to make the integration of bus operators data with the information system of CIM Oeste. Data provided considers: 1) ticket sales; 2) monthly ticket sales; and 3) validation of monthly tickets that are available in an external database. Data refers to years 2019 to current time.

Traffic jams and alerts: CIM Oeste celebrated a protocol with Waze for Cities program. This program provides for the assignment of traffic alerts data collected by Waze app users and traffic jams provided by the same application. This data is being collected and stored in the Smart Region database. Data refers to years 2019 to current time.

Waste management: waste management data is being provided by the company that is responsible for waste collection in CIM Oeste municipalities. The data provided refers to the monthly amount of mixed and recycled waste collected in each municipality from the years 2019 to 2021. This data is provided in .xlsx format.

Regarding carbon neutrality, KPIs of funding projects, gender equality indicators, and education statistics, this data is not yet ready for integration, but will be provided in spreadsheets, that will be integrated in Smart Region platform.

2.3. Visualization

Data is made available in the platform in several ways, namely through GIS web applications and embedded dashboards. Data from municipalities and the several verticals is available considering the 12 municipalities, and each municipality has its own portal with the representative data.

On each of the portals, a more static and dedicated dashboard with summarized information was also

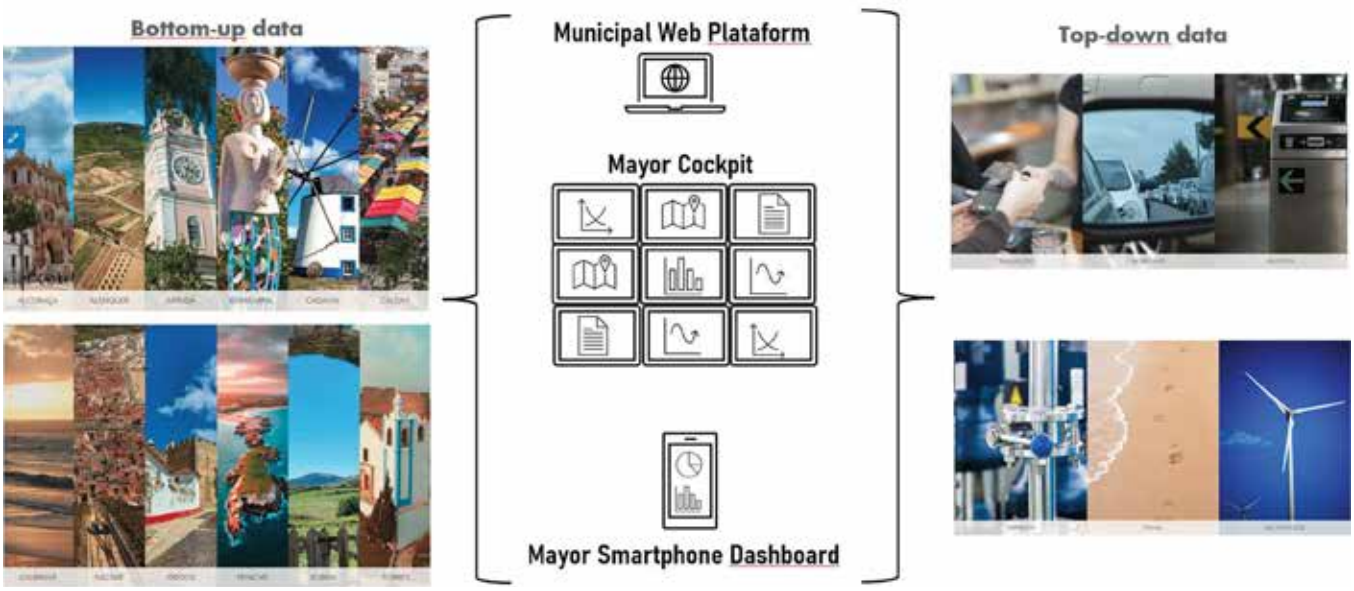

Figure 4. Bottom-up and top-down data visualization in Smart Region platform

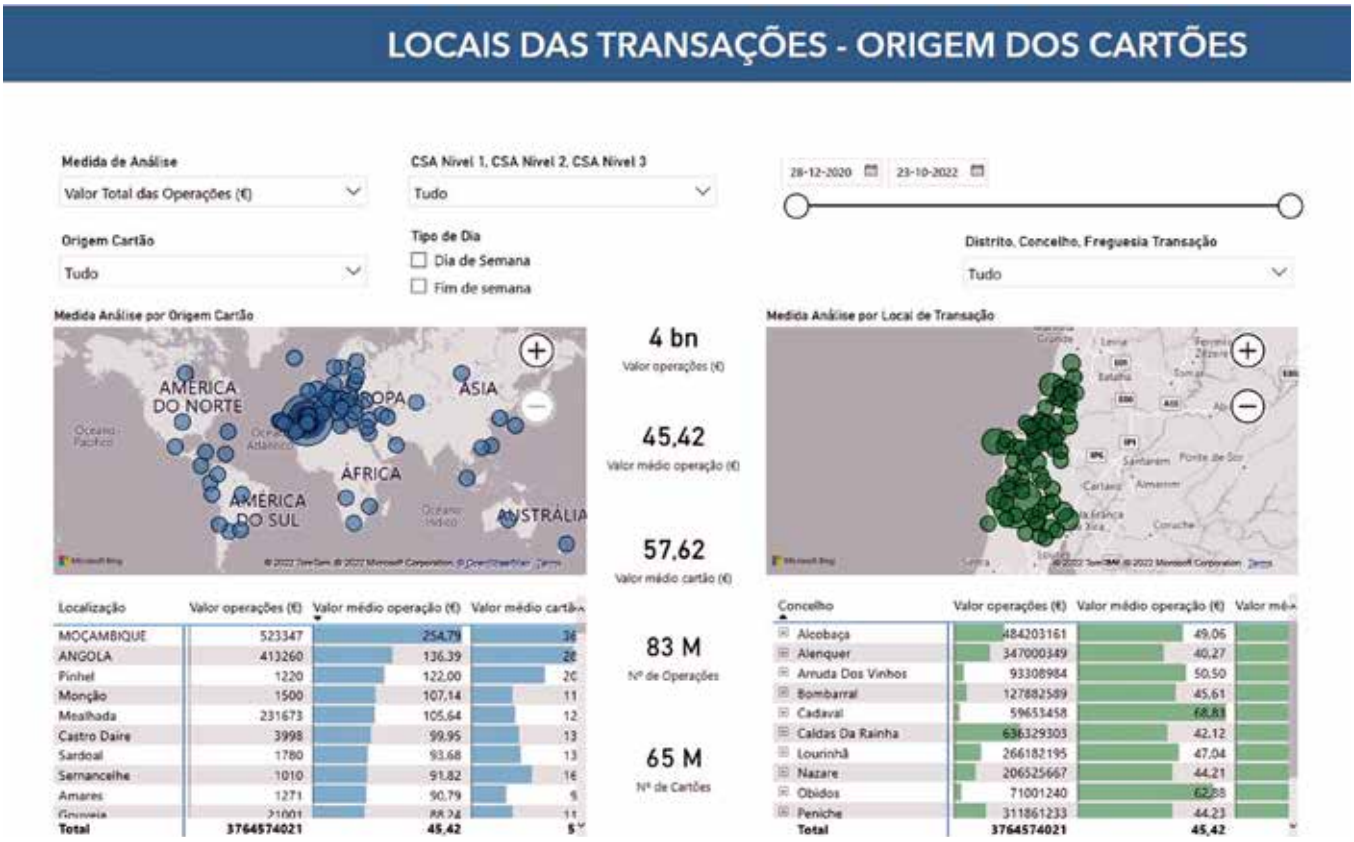

Figure 5. ATM transactions information at CIM Oeste level – Transactions location and debit/credit cards origin

implemented for the city's mayors – the Mayor Cockpit. The developed Mayors Cockpit provides information on ATM transactions, companies, bus ticketing, alerts and traffic jams and waste management. Although the goal is to have a tailormade dedicated information dashboards for the more relevant verticals of each municipality (see Figure 4).

3. RESULTS

Following the established ambition and adopting the above referred methodology it was possible to create a platform that can deliver its value at different territorial levels and for different stakeholders.

On one hand and taking advantage of a hybrid

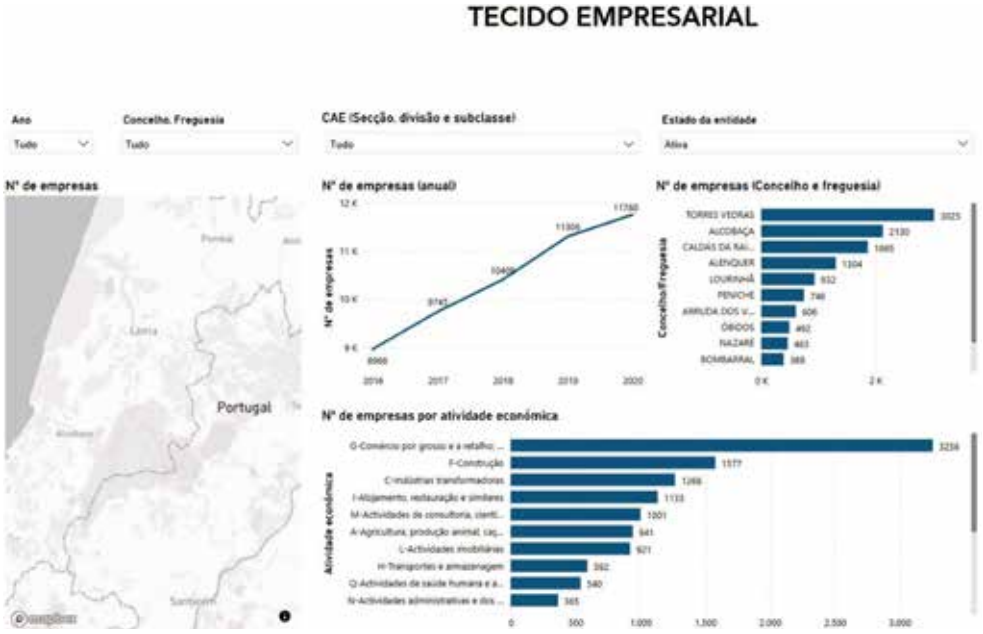

Figure 6. Companies data dashboard at CIM Oeste level that considers the location and number of companies. This information can be filtered by year and by code of economic activity

combination of geographical information science and business intelligence, the platform allows the delivery information portals at regional, municipal and parish level. On the other hand, it allows for the delivery of information for different users/purposes, such as policy makers (mayors), technical services and the citizen in general.

Figure 7. Web application embedded in Smart Region platform with real time data on road traffic alerts

Figure 8. Web application embedded in Smart Region platform regarding information on the Adaptation to Climate Change Intermunicipal Plan of Oeste Region

3.1. CIM Oeste information

At CIM Oeste level several dashboards were developed for each considered vertical. As an example, in Figure 5 is presented a report with information regarding ATM transactions information, namely transactions location and origin location of debit/credit cards that were used to make the transactions.

Figure 6 represents a dashboard embedded in the Smart Region platform with data about companies at CIM Oeste level.

In Figure 7 and Figure 8 are presented two web applications embedded in the Smart Region platform, considering respectively the real time feed of traffic alerts and the Adaptation to Climate Change Intermunicipal Plan of Oeste Region.

3.2. Municipalities information

Applications were also made for the municipalities of Oeste Region. In Figure 9 is presented a web application with the location of sports and educational facilities and pedestrian tracks for Alenquer municipality.

As the data provided was available at CIM Oeste level, the data from each vertical and represented for each municipality was based on the CIM Oeste data filtered by municipality. In Figure 10 is presented the monthly tickets validation dashboard, that was filtered based on the data

Figure 9. Web application with the location of sports and educational facilities along with pedestrian tracks in Alenquer municipality

Figure 10. Monthly tickets validation in Alenquer municipality

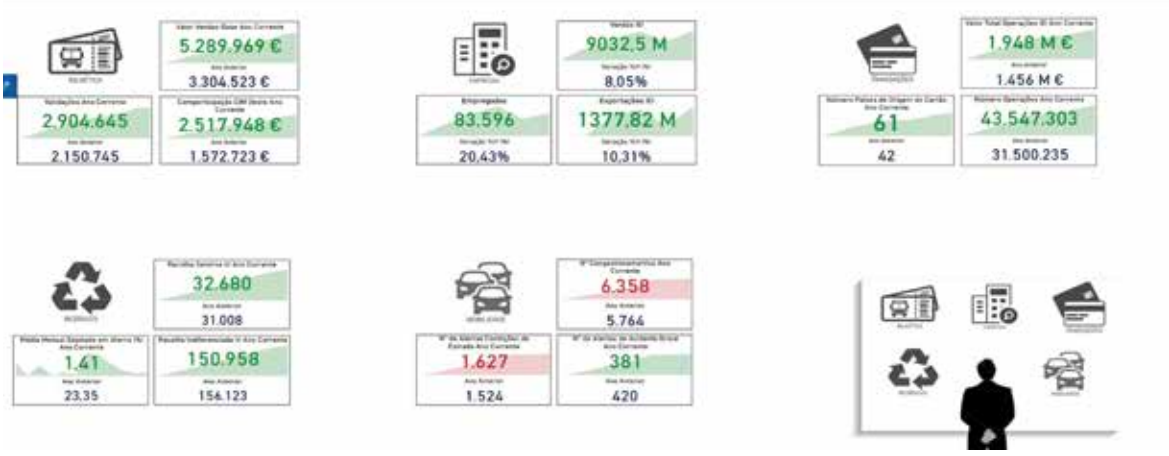

Figure 11. Alenquer Mayors Cockpit

available at CIM Oeste level.

The Mayors Cockpit for each municipality allow to each mayor have the most important figures of the main verticals addressed in the platform (see Figure 11). Clicking on the icon of each vertical the mayor can access more detailed information, namely the time evolution of the variation for example of the selective waste collection, mixed waste collection, waste energetic valorization, and waste that was deposited in landfill (see Figure 12).

4. CONCLUSION

The project supported the creation of a new paradigm of public policies, that supports all their cycle (i.e., Scheduling, Formulation, Implementation and Assessment) in which the interventions planned and implemented by the municipalities are data-driven, with great granularity and generating efficiency in the use of resources. This new approach will contribute to

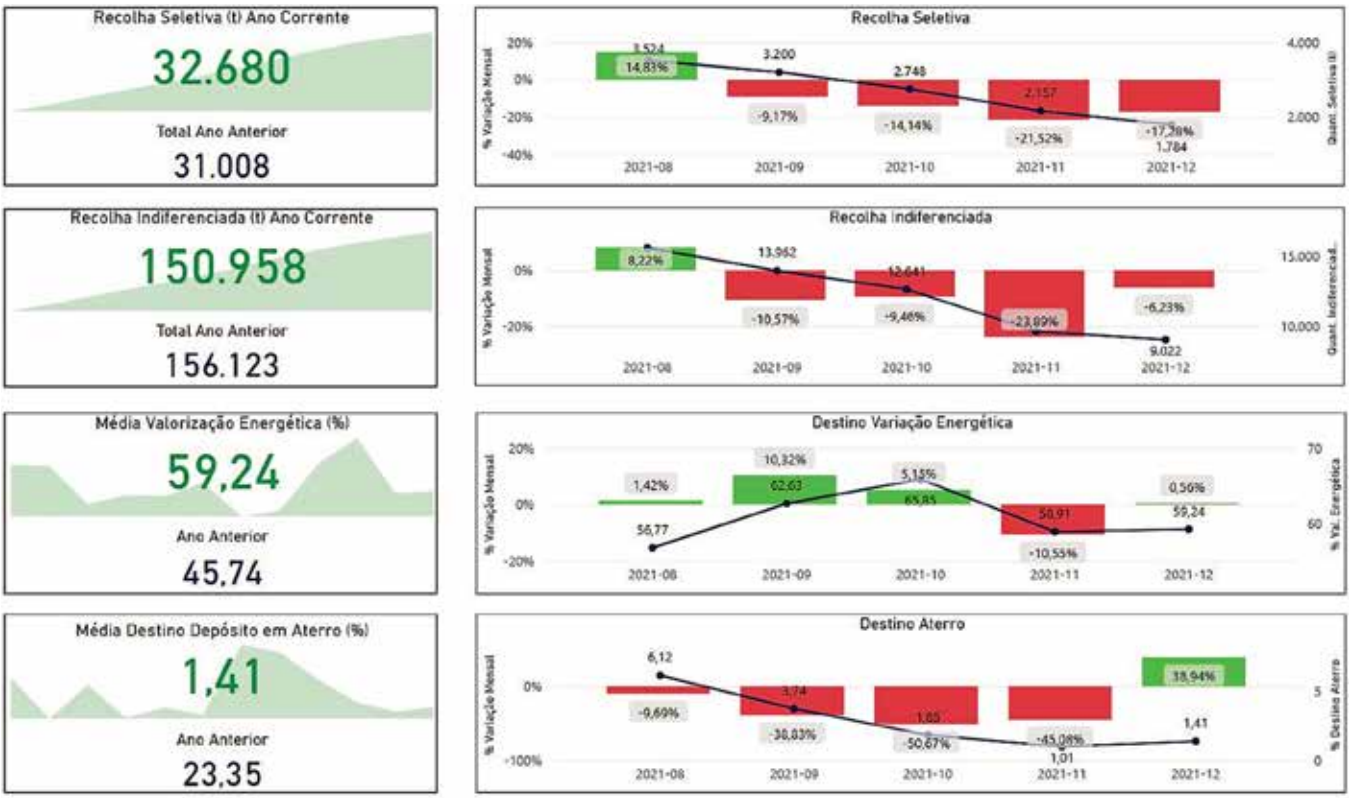

Figure 12. Waste management detailed information available in Mayors Cockpit of Alenquer municipality

a better application of public resources, and ensuring greater sustainability in decision making, creating a new paradigm in the creation of public value.

Additionally, it was possible to create applications for internal use by municipalities and external use for citizens, as well as to provide information to companies in the region (e.g., equipment and infrastructure) that will allow the design of new products and services, thus leveraging the region's economy. Finally, it also relevant to refer the opportunity to feed research by the academy with the data provided by the platform, increasing knowledge about the region.

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