Data Spaces in the Republic of Croatia: Potential and Opportunities

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Abstract. *The digital era has steered in massive production and consumption of diverse data. These data are usually stored in isolated data silos, which can lead to drawbacks such as data spread across multiple silos and data inconsistency due to conflicting or outdated versions. Moving beyond this, the concept of data space offers a flexible, integrated environment, allowing various data types and sources to coexist, enhancing data sharing and processing. This shift is crucial for countries like Croatia to embrace the concept of data space, which can improve their digital transformation and data economy. Using data spaces in public services can enhance transparency, efficiency, and the delivery of high-quality services. For the economy, leveraging data space can benefit sectors like tourism, agriculture, and green energy, fostering growth and innovation.*

Keywords. data space, Croatia, public sector, economy, research

1 Introduction

Today, humanity produces and consumes large amounts of data. This data is fluid and constantly changing, pivotal in creating innovative products and services ranging from smart agriculture, personalized medicine, earth observation, or ecological research to outdoor and indoor navigation (Constantiou and Kallinikos, 2015). In the conventional paradigm, data is often stored in isolated silos. Such an organization is usually adapted to specific applications and a closed ecosystem of users. This can lead to several issues, such as data spread across multiple silos and data inconsistency due to conflicting or outdated versions. Besides that, users outside the ecosystem often face difficulties in locating and accessing such data, while individual data silos usually provide only one type of data (Manoochehri, 2013; Franklin et al., 2005).

In contrast to the traditional data silos that enforce strict schemas and centralized storage, data space (DS) provides an integrated, loosely coupled environment where data from various sources coexist and interact (Franklin et al., 2005; Otto, 2022). DSs are abstract concepts of middleware systems primarily designed for scalable and efficient data sharing, while data processing is also included in the latest evolution. They represent a collection of unstructured, semi-structured, and structured data and connections between them in catalogs accessible by web services (Otto, 2022). DSs provide integration of diverse data sources that include various data formats simultaneously, for example, text, audio and video files, blockchain, and relation or non-relation databases. They also reinforce richer metadata and semantic annotations, supporting new data sources while reducing data consolidation, which can result in significant cost savings (Kotsev et al., 2020; Otto, 2022).

Similar opportunities can be noted when DSs are integrated with artificial intelligence (AI). On the one hand, this integration enables more efficient use of data, allowing AI researchers access to different sources while not demanding centralized storage. Better data accessibility reduces the time and effort required for data preparation, reducing or eliminating data duplication. AI systems can also continuously learn and adapt using dynamic data from DSs (Zillner et al., 2021), while feature learning algorithms (Vlahek and Mongus, 2023) can extract knowledge from different data sources. On the other hand, AI algorithms can be used in DS optimization and functionality enhancement. For example, AI can help the user discover relevant data or enhance data quality by automation the dataset cleaning process with improved identification of inconsistencies and duplicates (Boukhers et al., 2023).

In this paper, we discussed the European Union's

data strategy along with the concept of data spaces. Furthermore, we explored the implications and opportunities that data spaces could offer for Croatia, focusing on three key sectors: public services, the economy, and the domains of research and science. By delving into these areas, we aim to shed light on the transformative potential that a well-implemented data strategy could have on enhancing efficiency, innovation, and overall societal advancement.

2 EU and Data space

2.1 The European data strategy

The concept of DSs is continuously evolving, driven by technological advancements, policy changes, and data commercialization. In the early stages (the early 2000s), when the DS concept was not yet defined, the internet and digital technologies rose. This rise highlighted the potential of data as a valuable resource. In this period, the European Union (EU) started recognizing the need for a coordinated approach to data governance as big data initiatives emerged in the public and private sectors. With the Digital Single Market strategy, the EU aimed to create a coherent online environment. In this period, the concept of DSs was not yet entirely defined (Otto, 2022). The critical evolution towards the concept of DS was in 2020 when the European Commission provided a European data strategy. This strategy aims to make the EU a leader in a data-driven society and define the DS concept that enables the free flow of data within the EU. A particular emphasis is on using data between sectors to benefit entrepreneurship, researchers, public administrations, and ordinary residents. The strategy is implemented through legislative and technical measures. The key legislative measures in the DS area are (Commission, 2022):

- the European Data Governance Act,
- the Data act, and
- the AI Act.

This legislative framework specifies explicit rules for data management and sharing and regulates artificial intelligence use. The initial focus was health, agriculture, manufacturing, energy, mobility, finance, public administration, skills, and research. Additional DSs emerged through the years in media and cultural heritage areas. The current goal is to gradually interconnect these DSs, forming a unified market for data across Europe. Common data infrastructures and governance frameworks are being developed to ensure secure, fair, and green data sharing. In Addition, implementing and integrating existing DSs are underway, encouraging fully operational and interconnected DSs. The continuous evolution of technology, such as artificial intelligence and the Internet of Things, pushes additional improvements and innovations in DS. At the same time, the EU continues to refine its policies to adapt to new challenges and opportunities in the data economy (Commission, 2022; Otto, 2022).

2.2 Common European Data Spaces

Clear rules support trust in data and consequently grow the data economy. Supporting the data economy is one of the critical objectives of the European Data Strategy, which can also be seen from the funds allocated for this purpose in the 2021-2027 financial perspective. Common European Data Spaces is an EU initiative for data sharing and exchanging. To maximize data's value for Europe's economy and society, the European Commission defined fourteen data areas that are key to the development of the society and the economy (Scerri et al., 2022): agriculture, cultural heritage, energy, finance, green deal, health, language, manufacturing, media, mobility, public administration, research and innovation, skills, and tourism.

These DSs will eventually interconnect, forming a unified market for data. The key features of a common European DS can be summarized as follows (Commission, 2022):

- clear and structured rules for access and use of data,
- secure and privacy-preserved data pooling, accessing, using, and sharing,
- fairness and transparency in non-discriminatory usage and access of data to all,
- reliable data governance mechanisms, and
- promotion of EU values and freedoms with an emphasis on data and consumer protection.

3 The data space concept

In continuation, our understanding of generalised DS concept is presented with its components. Fig. 1 provides a design of a DS that identifies the essential component necessary for building and managing it. It serves as a guideline to ensure interoperability, scalability, and efficiency in data integration and utilization. In continuation roles of main components are presented.

Data provider transfers the owner's data to the DS. The transfer is done by data connector that provides a gateway for data or services. DS connectors are usually configured using the Vocabulary services. They provide definition of data used in ds in the form of ontologies and specifications for semantic interoperability. Similarly, Broker provides information in form of metadata about content, structure and other features of the data to the data connector. Data connector has implemented capabilities which ensure trusted and secured environment for participates in DS communication. These capabilities are provided by identity provider. It is in charge for trusted and secured environment for participates by enabling services for providing and managing credentials for trust among the participants of the system. Data consumer process data
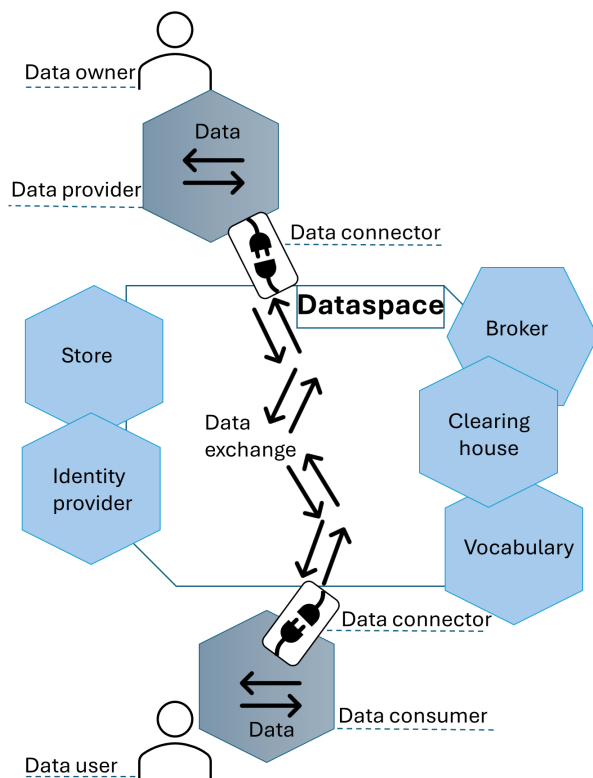
Figure 1: Components of a DS

omy, science and public services. The emphasis for each stakeholder regarding the adoption of the EU data strategy that defines the sharing and use of data brings certain opportunities or added value.

On the other hand, according to the National Development Strategy of the Republic of Croatia, until 2030, digital transformation has been identified as a key element for developing the economy and public administration. Within the strategy, one of the development directions is 'Green and digital transition' which includes the strategic goal 'Digital transition of society and economy'. This strategy emphasizes the importance of digitization as a means of achieving efficiency, innovation, and competitiveness in the economy, as well as improving the quality of public services. In particular, the need to develop infrastructure and capacity for data management is highlighted, which includes the establishment of a system for transparent and efficient data management at the national level.

4.1 Opportunities for public services

Besides the corruption and nepotism, the main problem of Croatian public administration is it's inefficiency and lack of transparency (Kopric, 2019). Establishing a single, public DS where citizens can access to the government data could enhance transparency and boost confidence in public institutions. Furthermore, using sophisticated data analysis for public financial data and transaction could help identify and prevent corrupt practices. DS can also assist in improving coordination and information sharing between different government departments and agencies, as well as integrating data from various governmental agencies, enabling Croatia to provide more state-of-the-art services to its citizens and business.

For instance, developing a health DS for patient records integration can enhance healthcare delivery and patient outcomes. This system could integrate health records from hospitals, clinics, and pharmacies. Analyzing health trends and outcomes could improve public health interventions' effectiveness and resource allocation. Likewise, a cohesive DS for government services could significantly enhance operational efficiencies concerning licensing and permits, particularly within the construction industry. This optimization can lead to more strategic infrastructure investments, while DS for citizen services can considerably reduce bureaucratic procedures across a multitude of services (e.g., the process of business registration or the application for social benefits). Adopting smart city technologies, such as Internet of Things (IoT) sensors coupled with DS, can revolutionize urban infrastructure management, ranging from traffic coordination and waste management to optimizing energy consumption. This integration of technology into city planning and operations aims not only to boost the quality of life for its inhabitants by making cities more efficient and sustain-

that data user requests. Requested data is offered by data provider in term of they policies and with ensuring that data is quality and reliable. Services that handle the transaction between provider and consumer, including contracting, logging, and data transfer are provided by the Data exchange, while Clearing house services provide clearing and settlement service for all data exchange and financial transactions if data provider's policy request. App provider provides applications that can be deployed at the connector end to execute tasks like data transformation and aggregation, data analytics, machine learning or federated learning (Farahani and Monsefi, 2023).

4 Data space opportunities for Croatia

While EU data strategy, legal framework and financial instruments are set, Croatia is standing at a historic crossroads to adopt these directions for digital transformation and data economy. The adoption the EU data strategy by the economy, research organizations, and public service are path to the establishment of data economy, economic growth and progress of civil society. For this reason, it is necessary to identify opportunities for key stakeholders in this process: econ-

able but also to reduce operational costs significantly. Furthermore, by enhancing the overall livability and efficiency of urban areas, these innovative solutions have the potential to attract increased investment into cities. Such advancements promise to pave the way for more resilient, eco-friendly, and smarter urban environments in the future. Policy-makers have the opportunity to harness the power of aggregated and anonymous data for guiding decisions in various vital sectors such as public health, education, and urban planning. By leveraging this data, they can not only gain insights into current conditions but also anticipate future challenges. These challenges could range from demographic shifts and economic fluctuations to environmental concerns. Utilizing this data-driven approach enables policy-makers to effectively prepare and strategize for these upcoming changes, ensuring more resilient and responsive governance.

4.2 Opportunities for the economy

DSs have the potential to revolutionize industries by fostering a more level playing field for businesses and streamlining the exchange of data securely through well-established set of rules. In the context of Croatia, which profoundly values conventional wisdom, deploying DS in the tourism sector could be particularly transformative. Such systems can facilitate highly targeted marketing strategies by collating data on tourists' preferences, travel habits, hotel occupancy figures, and local attractions. Furthermore, they can significantly enhance the tourist experience and allow for a more effective allocation of resources within the tourism industry. Conversely, Croatia's agricultural sector has witnessed a decline in production despite receiving substantial subsidies (Banski and Kaminska, 2022). Here, a DS that assembles critical data on weather trends, soil quality, crop health, and prevailing market rates could be a game-changer for farmers. This information hub can drive agricultural productivity and sustainable practices forward by enabling precision agriculture and improving market access.

Croatia boasts significant potential for green energy development (Schneider et al., 2007; Smajla et al., 2020), while DS platforms can play a pivotal role in disseminating information regarding energy consumption, the efficiency of energy use, and opportunities within renewable energy sources. This dissemination is essential for encouraging the growth of businesses and stimulating investments in the green energy sector. In addition, Croatia has a strategic location in the corridors of Europe's transportation, including its well-developed Adriatic seaports and excellent connections to major European cities. There is an enormous opportunity for DS logistics companies to offer access to real-time information concerning shipping routes, current traffic conditions, and the availability of warehousing. This would play a significant role in enhancing the efficiency of logistics operations, reducing transportation-related expenses, and ultimately strengthening the resilience of supply chains.

4.3 Opportunities for science and research

A centralized data repository in form of DS can serve as a collaborative hub, enabling researchers from different institutions in Croatia to share, access, and leverage an extensive range of datasets, academic publications, and various research outputs. This innovative platform is instrumental in stimulating interdisciplinary research partnerships. Such collaborations pave the way for accelerated scientific advancements by removing barriers to data access and reuse. By facilitating this level of openness, the platform promotes the principles of data sharing and reuse, acknowledging these practices as pivotal drivers for enhancing the overall impact and efficiency of research endeavours. A DS can promote data sharing among Croatian researchers and their international colleagues throughout the EU and beyond. This can bolster global research partnerships while ensuring adherence to international standards and practices. Overall quality of Croatian research and sciencs, leveraging cross-border knowledge and international evaluation. This approach not only aligns with global research trends but also significantly contributes to the advancement of scientific and academic pursuits across various fields.

Furthermore, DS can rid the gap between academia and the commercial sector by offering an expansive repository of information, including patents, cutting-edge technologies, and detailed insights into current market demands. This can optimize the technology transfer process, promoting a synergistic environment that supports innovation by connecting academic research with practical industrial needs. Moreover, researchers can convert scientific findings into viable commercial solutions, accelerating technological advancement and economic growth.

5 Conclusion

Croatia's integration of the EU data strategy presents numerous opportunities for catalyzing digital transformation across public services, the economy, and broader civil society. For public services, implementing data spaces can enhance transparency, efficiency, and collaboration between government entities. This approach not only aims to restrain corruption and improve service delivery but also sets the foundation for the economy of data. Economically, DS can level the playing field for businesses, particularly in tourism, agriculture, and green energy, by enabling data-driven decision-making, optimizing resource allocation, and opening new avenues for sustainable practices. By embracing these opportunities, Croatia stands on the brink of a transformative shift, poised to establish a

robust data economy that promotes economic growth, enhances public services, and secures a resilient, prosperous future for its citizens.

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