TEACHING MATERIAL GUIDANCE

1) Title of the material

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https://www.mdpi.com/1424-8220/21/1/236

2) Which section of the SUMP it is relevant to?

This paper presents an efficient cyber-physical platform for the smart management of smart territories. The global intelligence of the platform could potentially coordinate its decision-making processes with intelligent nodes installed on the edge, which would use the most advanced data processing techniques. Therefore, the article can be linked to the third, fourth and fifth sections of the SUMP circle related, respectively, to the determination of planning framework, analysis of the mobility situation (in particular the analysis of problems and opportunities for all modes of transport - **Subsection 3.2.**), scenario building and joint evaluation (development of scenarios of possible futures - **Subsection 4.1**.) and vision and strategy development (arguments for stakeholders - **Subsection 5.1**).

3) Which Mobility Manager knowledge this material is the most relevant to?

It is related to Transport and mobility planning (section 1 of the Mobility Manager competencies) especially 1b (employment of ITS/ICT and smart measures) and Data analysis for mobility planning (section 5 of the Mobility Manager competencies) especially 5a (data collection and analysis) as well as Stakeholder involvement tools (section 7 of the Mobility Manager competencies).

4) Problem approached and content overview

Problem approach – general understanding of how to manage data in smart cities. This paper presents a cyber-physical platform for intelligent area management. The platform facilitates the implementation of data acquisition and management methods, as well as data representation and dashboard configuration. The platform allows the use of any type of data source, from IoT multifunctional sensor device measurements to relational and non-relational databases. It is also intelligent as it includes a complete set of artificial intelligence for data analysis; including techniques for data classification, clustering, prediction, optimisation, visualisation, etc. It is also compatible with the concept of edge computing, which allows distributed intelligence and the use of smart sensors. The

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concept of smart cities is evolving and adapting to new applications; the trend of creating smart neighbourhoods, settlements, or territories is becoming increasingly popular, as opposed to the previous approach of managing an entire megacity. The paper presents the platform and describes its architecture and functionalities. Furthermore, its performance is verified in a case study in which a bike rental service was managed in the Paris-Vélib metropolis. This platform can enable smart territories to develop adapted knowledge management systems, adapt them to new requirements, and exploit multiple types of data and perform efficient computational algorithms and artificial intelligence. The platform optimises decisions made by human experts using explainable artificial intelligence models that obtain data from IoT sensors, databases, the Internet, etc.

The platform has been used to develop several smart territory projects in the cities of Santa Marta and Carbajosa (Spain), in Caldas (Colombia), in Panama City, in Istanbul (Turkey), etc. The paper presents the state-of-the-art on this topic; furthermore, Deepint.net is presented as a platform for managing smart territory projects. Results obtained from the application of the platform in Paris (France) are also presented, as well as conclusions and future and future research directions.

5) Who could be interested in this material?

The article is aimed at students and those looking for inspiration in the implementations of intelligent solutions to manage data in transport systems when such measures are applied in SUMP.

6) What is worth mentioning as an innovative factor for the reader?

The research presented in this paper has developed a platform that can apply the most well-known techniques in the data analysis sector in a simple and user-friendly way. The design of the platform makes it fully prepared to manage smart cities and territories, regardless of their size and data origin (Fig. 1). Deepint.net not only processes data but also automates data ingestion, visualisation and integration with any other platforms and dashboards. The platform is easy to use and does not require specialists in artificial intelligence, edge computing or machine learning. Deepint.net is designed to provide managers with data analysis tools and help them generate models efficiently without the need for specialist data analysts or developers.

The platform supports the data analysis process at different levels:

- it gives IT support so that cities do not need to invest in infrastructure;
- it offers mechanisms for ingesting data from different sources (relational and non-relational databases, files, CKAN-based repositories, streaming data, multi-functional IoT sensors, social networks, etc.) and in different formats;
- it offers data processing mechanisms to all users who do not have programming knowledge (information fusion, data filtering, etc.
- it offers information representation techniques based on interactive graphics to facilitate the understanding of data, analysis results and quick decision-making;

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- it helps select methodologies that can be applied to user-supplied data and automatically finds the configuration that provides the best results (through cross-validation) so that the user does not need to configure anything at all.

The platform, therefore, includes signal processing methods capable of transforming and using data (even in real-time) from any source: IoT sensors, advanced multifunction sensors, intelligent edge nodes, next-generation networks, etc. or even data from relational and non-relational databases. The platform helps users to select and use the most appropriate combination of mathematical models; dynamic data assimilation and artificial intelligence systems are capable of working with knowledge and data; they adapt to new time constraints and can explain why a certain decision was made. Research into the creation of explainable adaptive mixtures of expert systems is a key innovation of this project along with its application in the field of intelligent logistics..

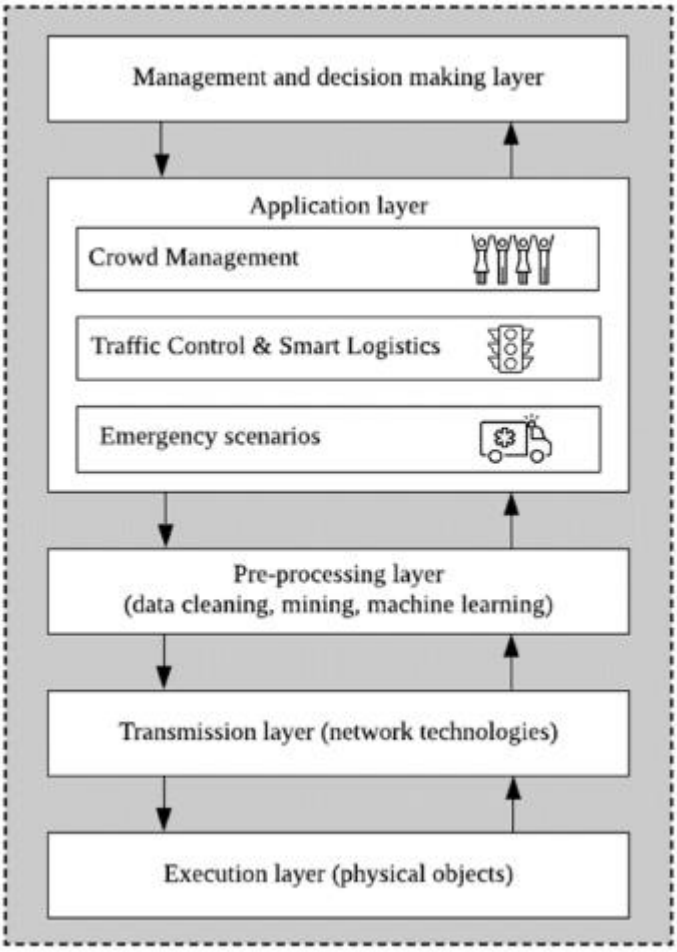

Figure 1. Smart city (SC) management architecture

Deepint.net is a platform that facilitates knowledge management and the creation of intelligent systems for effective territory management. The platform enables the use of centralised intelligence and edge architectures, with intelligent nodes allowing both decentralised and centralised analysis. The implementation of intelligent territory management systems is associated with a reduction in costs associated with maintenance

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and resource management. Depending on the application, the platform can facilitate traffic optimisation, create systems to analyse citizens' opinions in social networks, or help assess and prevent pollution, etc.

In general, the use of this type of platform, which allows the use of any cloud, reduces the initial investment needs. Typically, expensive infrastructure is required to analyse medium to large volumes, as the cost can be very high when 1 GB is exceeded. This cost would be significantly reduced by processing data in a remote cloud-based infrastructure, tailored to the needs of each territory. The use of commercial infrastructure also reduces risk and increases the security of data management. Moreover, it is possible to scale the infrastructure to the needs of each moment. The platform is adapted to download and manage any type of infrastructure, such as smart nodes, facilitating the decentralisation of intelligence and the creation of intelligent distributed models in edge computing mode. Similarly, the areas or cities where this platform would be used would not need to have staff with programming or data analysis expertise, only knowledge of the information held by their company. The user takes on the role of a data analysis expert; working with the data and understanding whether the results obtained are satisfactory or not. This allows the user to focus on the result and not on the development costs, which will be negligible thanks to the proposed system.

The system can be operated in real time by any user in the city. Users without IT knowledge could only display information on a dashboard in real time, while managers would be responsible for monitoring the overall performance of the company. All stakeholders in the city could benefit.

The wizards offered by Deepint.net for integrating data sources, creating visualisations, dashboards, and modelling cover the entire ecosystem within the data analytics lifecycle. This proposition has advantages over other commercial data analytics solutions that are much more limited in terms of functionality and usability.

The development process for this platform has been streamlined by using Deepint.net. This platform also facilitated the case study in the city of Paris. Furthermore, Deepint.net is very versatile and is currently undergoing further development to include new features that can be adapted to a wider range of smart territories, with the ultimate goal of becoming a comprehensive agent capable of accelerating the development of any smart city. In addition, an in-depth research is being conducted on the many technologies that make up deepint.net.

7) Limitations

The problem was analysed at a high level of generality, but the presented idea (introduced in the city of Paris) could support integration processes within new technologies and methods to support mobility management, especially in data management issues. The conclusions presented may serve as inspiration for Polish cities regarding the problems that may occur during the implementation of smart cities solutions.

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