The PNRR DARE project, territorial and urban planning, and the role of INFN: An interdisciplinary integration for health and sustainability

Mauro Patano*

Abstract

The Digital Lifelong Prevention (DARE) project is an innovative initiative aimed at improving health prevention and promotion across the lifespan. The project leverages digital technologies and big data to optimize healthcare, focusing on the One Health approach, which integrates human, animal, and environmental health. A central feature of DARE is its interdisciplinary approach, with key contributions from the National Institute for Nuclear Physics (INFN), which provides advanced computing infrastructure for big data management. The project's hub-spoke model promotes collaboration between universities, hospitals, and private companies to create a national digital healthcare ecosystem. By integrating health monitoring, artificial intelligence, and continuous data collection, DARE aims to improve public health policies, environmental sustainability, and indirectly urban planning. The project's success hinges on its ability to foster innovation and support preventative healthcare.

* National Institute for Nuclear Physics (INFN) Italy
Bari Division - Via E. Orabona 4 - 70125 – Bari, Italy

Keywords

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Introduction

The Digital lifelong prevention (DARE) project (Fondazione DARE, 2024) , funded by the Ministry of University and Research (MUR) (Ministero dell'Università e della Ricerca, 2024) under the National Plan for Complementary Investments (PNC) (Piamo Complementare, 2024) to the National Recovery and Resilience Plan (PNRR) (Piano Nazionale di Ripresa e Resilienza, 2024), is an ambitious initiative aimed at leveraging the immense potential of health data to improve prevention and health promotion across the lifespan.

A fundamental aspect of the project is its interdisciplinary approach, which combines expertise from various sectors – from healthcare to technology, from scientific research to industry – to address the integrated challenges of public health, sustainability, and territorial planning.

In this context, the INFN (National Institute for Nuclear Physics) (Istituto Nazionale di Fisica Nucleare (INFN), 2024) plays a crucial role by providing its expertise in advanced computing infrastructures and the management of big data, essential for the analysis and processing of sensitive information in the DARE project. The project, with its hub-spoke model, is designed to take advantage of interdisciplinarity and collaboration among multiple actors, creating an extended partnership involving universities, hospitals, research centers, private companies, and public institutions.

Objectives of the DARE project

The primary goal of the DARE project is to optimize the use of data for health and prevention, utilizing digital technologies to monitor, predict, and manage health across the lifespan. The specific objectives include:

- Developing a data-based healthcare ecosystem, through enhancing digital technologies for data collection and analysis;
- Promoting digital prevention at the national level, involving healthcare, industry, universities, and decision-makers;
- Encouraging interdisciplinary collaboration among different skills to create innovative healthcare solutions;
- Creating a cultural shift towards prevention, fostering trust and adoption of new technologies among the population.
- Supporting the One Health approach (World Health Organization (WHO)) (Food and Agriculture Organization (FAO), 2024) (European Commission (EU)) (Istituto Superiore di Sanità (ISS)), which integrates human, animal, and environmental health to address the interdependencies between these domains.

The One Health approach aims to improve public health, prevent diseases, and promote well-being by understanding the complex interactions between humans, animals, and the environment. First theorized in 1978, One Health is now recognized by the World Health Organization (WHO), the European Commission, and Italy's Ministry of Health as a critical strategy for enhancing collaboration across various disciplines, including medicine, veterinary science, environmental science, economics, and sociology. The Istituto Superiore di Sanità (ISS) has long been involved in

multidisciplinary collaborations to promote the One Health approach, addressing both current and future health challenges. The PNRR supports the One Health approach as a key element for tackling inequalities and promoting global health.
The DARE project is structured in a hub-spoke model, with:

- Spoke 1: Enabling factors and technologies for digital prevention;
- Spoke 2: Primary prevention based on community surveillance and digital preventive measures;
- Spoke 3: Secondary and tertiary prevention, supported by artificial intelligence, digital biomarkers, and continuous health monitoring.

Link to territorial and urban planning

Territorial and urban planning play a central role in the DARE project, as urban health and environmental sustainability are closely linked to the design and management of territories. The integration of digital technologies in the healthcare and prevention sectors offers an innovative approach to tackling challenges related to public health and environmental sustainability, contributing to the creation of healthier, more resilient, and sustainable cities. Key aspects of this integration include:
Territorial Health Monitoring and Prevention: The use of digital technologies and big data enables health monitoring at the territorial level, collecting data on diseases, environmental pollution, lifestyle factors, and risks. The surveillance systems developed in Spoke 2 can be applied to urban planning to identify at-risk areas and target preventive interventions, improving the distribution of healthcare services and optimizing public health policies.

Sustainable and Resilient Urbanization: Environmental health is a fundamental aspect of territorial planning. The digital solutions developed by DARE can help monitor urban environmental quality and design cities that promote citizens' health. Data on air pollution, noise pollution, access to healthcare, and living conditions can be used to plan public green spaces, reduce environmental risks, and improve urban infrastructure efficiency.
Sustainability and Integrated Health in Cities: The DARE project has a direct impact on urban sustainability. The ability to monitor population health in real-time, integrating healthcare data with environmental and social data, provides the opportunity to design healthier, more sustainable cities, where the use of digital technologies becomes an integral part of urban planning. Sustainable mobility policies, energy management, and the design of green spaces can be directed based on the data collected by surveillance systems, improving the quality of life.

The role of INFN in the DARE project

The INFN plays a key role in the DARE project, leveraging its expertise in advanced computing infrastructures and big data management. INFN provides crucial technical support for the management, processing, and analysis of sensitive health data, using cloud computing platforms and high-performance computing (HPC) infrastructures. Its role mainly focuses on the following areas:
Big Data Management and Analysis: INFN manages Italy's largest computing infrastructure, enabling the analysis and processing of large volumes of health data from wearable sensors, mobile applications, IoT devices, and other sources. The use of cutting-edge technologies ensures data security and compliance with privacy regulations.

Cloud Infrastructure and Support for Spoke 1: INFN supports Spoke 1, which develops enabling technologies for digital prevention, by providing the necessary computing infrastructure to implement and scale solutions on a large scale. Additionally, INFN contributes to the development and evaluation of technological solutions.
Support for Research and Innovation: Thanks to its experience in scientific research and the use of advanced technologies, INFN significantly contributes to the development of new healthcare prevention models based on artificial intelligence, machine learning, and digital biomarkers.

An extended partnership: interdisciplinarity and collaboration

The success of the DARE project largely depends on its interdisciplinary approach and the extended partnership involving numerous public and private stakeholders, including universities, hospitals, research institutions, and technology companies. They are Azienda Ospedale Università Padova (AOUP, 2024), Azienda Ospedaliero Universitaria di Catania (AOUPCT, 2024), Agenzia Regionale per la Protezione dell'Ambiente Sicilia (ARPA, 2024), Azienda sanitaria locale della provincia di Bari (ASL BARI, 2024), Azienda Unità Sanitaria Locale della Romagna (AUSL ROMAGNA, 2024), BI-REX Competence Center - Big Data Innovation & Research Excellence (BI-REX, 2024), Engineering S.P.A. ENG), 2024), Exprivia S.P.A. (Exprivia, 2024), Fondazione Policlinico Universitario Agostino Gemelli IRCCS (FPG, 2024), Fondazione Gimbe (GIMBE, 2024), Istituto Nazionale di Fisica Nucleare (INFN, 2024), Istituto Ortopedico Rizzoli (IOR, 2024), AOSP IRCCS S.Orsola

Bologna (IRCCS AOU BO, 2024), Istituto Tumori Bari Giovanni Paolo II IRCCS (IRCCS BARI, 2024), AUSL BO - IRCCS Istituto delle Science Neurologiche di Bologna (IRCCS ISNB, 2024), Istituto Superiore di Sanità (ISS, 2024), Leithà S.r.l (LEI, 2024), Maria Cecilia Hospital - Gruppo Villa Maria S.P.A. (MCH GVM, 2024), Fondazione Policlinico Tor Vergata (PTV, 2024), Azienda sanitaria locale Roma1 (ROMA1, 2024), Università degli Studi di Enna "Kore" (UKE, 2024), Università di Bari Aldo Moro (UNIBA, 2024), Alma Mater Studiorum - Università di Bologna (UNIBO, 2024), Università Cattolica del Sacro Cuore (UNICATT, 2024), Università degli Studi di Palermo (UNIPA, 2024), Università degli Studi di Padova (UNIPD, 2024), Università degli Studi di Parma (UNIPR, 2024), Università degli Studi di Roma Tor Vergata (UNIROMA2, 2024), University of Pittsburgh Medical Center Italy SRL (UPMCI, 2024). This partnership ensures an integrated vision of healthcare prevention, technology, and territorial planning, which leads to tangible benefits:

Collaboration between Healthcare, Research, and Industry: Cooperation between research centers (such as INFN and BI-REX), universities, and technology companies fosters the development of innovative healthcare solutions. The involved universities (e.g., University of Bologna, University of Padua, and University of Rome Tor Vergata) provide scientific and academic expertise, while companies (such as Engineering S.p.A. and Exprivia S.p.A.) offer advanced technological solutions.

Impact on Public Policy and Planning: The involvement of public decision-makers, such as regional health agencies (such as Azienda Sanitaria Locale della Provincia di Bari and Azienda Unità Sanitaria Locale della Romagna) and ministries, ensures that the project's results directly influence health policies and territorial planning at both national and local levels.

The PNRR DARE project represents an example of how interdisciplinarity and collaboration between different sectors can create innovative solutions to tackle global challenges in health and urban sustainability. The integration of digital technologies in healthcare and territorial planning offers new opportunities to build healthier, more resilient, and more sustainable cities. INFN, with its expertise in big data and advanced computing infrastructures, plays a central role in providing the technological support necessary for the realization of these innovative solutions, promoting the adoption of advanced technologies in public health and territorial management. The strength of DARE lies precisely in the synergy between public and private actors and in the interdisciplinary approach that makes the project a fundamental pillar for the health of the future.

Conclusions

In recent decades, technological advancements have catalyzed a profound change in the way scientific research and planning practices evolve. The emergence of advanced technologies such as cloud computing, HPC (High Performance Computing), and HTC (High Throughput Computing), along with the rise of multidisciplinary approaches, is transforming the epistemological paradigm that underpins these fields. Epistemology, understood as the study of the nature and limits of knowledge, is profoundly influenced by the introduction of new computational resources and the growing integration between diverse disciplines.

Traditional epistemology in planning

Traditionally, planning has been dominated by theoretical models and methodological approaches that relied primarily on relatively simple data and algorithms, often supported by limited computational tools. Decisions were made based on analysis, but models were often simplified relative to the complexity of real-world phenomena. In this context, the traditional epistemological paradigm was based on linear logic and a deterministic causal view, where forecasting and planning were based on historical data and predefined scenarios.

The shift: Cloud, HPC, and HTC

With the advent of cloud computing , HPC , and HTC , a radical transformation has begun. These technologies provide extraordinary computational capabilities, allowing the processing of vast amounts of data and the simulation of complex phenomena with unprecedented accuracy and speed.

Cloud computing

Thanks to cloud technologies, research and planning can access scalable, distributed computational resources, overcoming the limitations of traditional infrastructures. The on-demand availability of computing power enables the processing of large datasets in real-time, facilitating the adoption of more sophisticated models that integrate variables and dynamics that were previously unimaginable.

HPC (High Performance Computing)

HPC has revolutionized how complex problems are addressed, such as simulating dynamic systems (e.g., climate models, urban simulations, or transportation studies). These models, which were previously unfeasible due to their computational intensity, can now be run in shorter times, enabling more agile and accurate planning.

HTC (High Throughput Computing)

HTC allows for the simultaneous execution of a large number of computational experiments, each of which may be relatively light on resources. This is particularly useful in contexts like urban or territorial planning simulations, where it is crucial to explore different options quickly and with high granularity.
These technologies allow a shift from a deterministic approach to a probabilistic and stochastic one, where simulations no longer provide a single, deterministic outcome, but a distribution of possible results. The use of models that incorporate uncertainty and variability reflects a fundamental epistemological change: planning is no longer seen as a practice aimed at determining a single optimal solution but as a dynamic process that explores a broad spectrum of future possibilities.

Multidisciplinarity as a new paradigm

Another significant change concerns the growing multidisciplinarity characterizing research and planning. Modern technologies have broken down the barriers between disciplines, allowing for the integration of

knowledge from diverse fields such as engineering, data science, social sciences, economics, and urban studies. This multidisciplinary approach is essential for tackling the complex and interconnected challenges of our time, such as climate change, rapid urbanization, and sustainable resource management.
For example, a contemporary urban development plan must consider not only the physical design of spaces but also economic, social, environmental, and technological factors. The use of modern technologies enables the integration of these various areas of knowledge into models and simulations, with the goal of achieving solutions that are sustainable and adaptive over time. In this context, multidisciplinarity is not just an added value, but a necessity for addressing the growing complexity of problems.

The future: Distributed and interconnected knowledge

The epistemological shift we are experiencing paves the way for distributed and interconnected knowledge, where rigid boundaries between different fields of study no longer exist. Advanced technologies not only enhance computational capacity but also promote new forms of global collaboration and data sharing. Data lakes, for instance, enable the collection and analysis of data from disparate sources, making it possible to form a holistic view of phenomena and improving the quality of decision-making.
The ability to aggregate and analyze data across multiple scientific and practical domains implies that knowledge itself becomes more dynamic and contextualized, responding in real-time to changes in the environment. This leads to a conception of planning that is more flexible, evolving continuously through the integration of new

information and technologies.
The epistemological paradigm shift in research and planning, driven by new technologies such as cloud, HPC, and HTC, as well as by increasing multidisciplinarity, represents a fundamental change in our approach to knowledge and the resolution of complex problems. It is no longer just about gathering data and applying predefined models, but about facing the complexity of the world with more adaptive, integrated, and dynamic approaches. In this new paradigm, planning is not just a process of forecasting, but an exploration of alternative scenarios, decisions, and solutions, accounting for the uncertainties and variability inherent in complex systems.

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