

# Contribution to national security system, by creating an integrated open source portal with access to geo-information and telemedicine technologies for public health management (COVID 19 pandemic)

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**Abstract:** Despite repeated attempts to reform the Romanian health system, as an important part of the national security system, after 30 years of reforms, except for large university centers, the Romanian health system does not have enough family doctors or specialists, not enough local medical services and units, no available information, early warning and prevention programs at the level of the authorities in the field. As a reliable solution to the real situation of the health system in Romania, this paper comes up with a technical and medical solution in the event of a pandemics, case study for COVID 19 pandemic, which can substantially contribute to *national security system*. Building an integrated open source portal with access to geoinformation and telemedicine technologies for public health management is intended to act as an early warning system by communicating and exchanging data accurately, efficiently, securely and consistently with various computer systems, software applications and networks, ensuring the operational work processes of the institutions involved (Ministry of Health, Ministry of Internal Affairs, Ministry of National Defense, Public Health Directorates, Hospitals, Epidemiologists, family physicians, specialists physicians, pharmacies and last but not least patients), while maintaining data confidentiality.

**Keywords:** security, open source, early warning, public health, telemedicine.

## Contribuție la sistemul de securitate națională, prin crearea unui portal open source integrat cu acces la tehnologii de geo-informare și telemedicină pentru managementul sănătății publice (pandemia COVID 19)

**Rezumat:** În pofida încercărilor repetate de reformare a sistemului de sănătate din România, ca parte importantă a sistemului de securitate națională, după 30 de ani de reforme, cu excepția marilor centre universitare, sistemul de sănătate din România nu are suficienți medici de familie sau specialiști, nu are servicii și unități medicale de proximitate, nu are programe de informare, avertizare timpurie și prevenire la nivelul de autorităților din domeniu. Ca soluție fiabilă la situația reală a sistemului de sănătate din România, această lucrare vine cu o soluție tehnică și medicală în caz de pandemie, studiu de caz pentru pandemia COVID 19, care poate contribui substanțial la sistemul de securitate națională. Construirea unui portal open source integrat cu acces la tehnologii de geospațiale și telemedicină pentru managementul sănătății publice este menit să acționeze ca un sistem de avertizare timpurie prin comunicarea și schimbul de date cu precizie, eficiență, securitate și consecvență cu diferite sisteme de calculatoare, aplicații software și rețele, asigurând procesele operaționale de lucru ale instituțiilor implicate (Ministerul Sănătății, Ministerul Afacerilor Interne, Ministerul Apărării Naționale, Direcțiile de Sănătate Publică, Spitale, Epidemiologi, medici de familie, medici specialiști, farmacii și nu în ultimul rând pacienți), păstrând în același timp confidențialitatea datelor.

**Cuvinte cheie:** securitate, open source, avertizare timpurie, sănătate publică, telemedicină.

### 1. Introduction

Even if not all threats to life are threats to national security, we must admit that epidemic diseases or pandemics can become relevant elements of national security. The reality in which we live shows us that there have been few attempts to analyze these diseases in terms of security, even if human and economic losses are key elements of the national security equation.

In the conditions of the Covid-19 pandemic and its multiple consequences, ensuring the health of the population has led to the need to design and implement an “Integrated open source portal for public health management in the case of the pandemics, with access to geoformation technologies and telemedicine” which represents a national security priority for the healthcare system and ordinary people. At the international level (Reeves, J. et al., 2020) there is a large effort to optimize the flow of data and information for the management of health systems, as studies (Wang, J. et al, 2020) show that medical and economic efficiency is strongly influenced by the level of development and complexity of implementing an integrated epidemiological monitoring and modeling system. The analysis of the recent literature reveals various approaches and solutions, adopted by public and private institutions in Europe, the United States, China, Russia and Japan, etc., but characterized by heterogeneous approaches: deep-learning (Gozes, O. et al., 2020), virtualization and 3D (Stuerzlinder, W. et al., 2006), AI techniques and the use of smart phones (Maghdid, H. et al, 2020), which do not fully appeal to standards and methodologies recognized in the field and involve the use of various systems, inhomogeneous, at various times of life cycles. This leads to data redundancy and reduced possibilities for functional extensibility and integrality. The proposed solution is addressed to all public and private institutions involved in combating the pandemics (Ministry of Health, Public Ministry, Ministry of National Defense, Public Health Directorates, hospitals, pharmacies, etc.), using methods and standards recognized in the field (SOA architecture, 2020, compliance with the GDPR standard).

The general objective of this paper is to contribute to the increase of the security environment in Romania by creating an early warning mechanism among the authorities (Ministry of Health, Ministry of Internal Affairs, Ministry of National Defense, Public Health Directorates), hospitals, doctors and ordinary patients who do not have access to health care services in areas poorly represented by the medical system.

The present paper had as primary research method, the study of international literature in pandemics and national security, in conjunction with simulations, testing and validation of various modules and software in the laboratory. The theoretical research, simulation, testing and validation activities were performed multidisciplinary among the authors of this study, engineer, computer scientist and epidemiologist.

The present paper is structured on the following sections:

- section 2 defines and establishes R&D methodology and the objectives of the integrated open source portal with access to geoformation and telemedicine technologies for public health management system;
- section 3 establishes the scientific and technical presentation of the pilot project. Also, presented here are the technical architecture, the software instruments, the functionalities of the component blocks of the internal and external portal;
- section 4 presents discussions and results;
- section 5 ends up the paper with conclusion, limitations and future work.

## 2. R & D methodology

The integrated open source portal with access to geoformation and telemedicine technologies for public health management system will use the following generic categories of data:

- *Patient data*: defines all the data associated with a patient, already existing in computer systems as a result of previous medical consultations and episodes, stored in the systems of the Ministry of Health. This includes demographic data, medical data of any kind, as well as associated metadata whose processing allows the unique identification of the patient. These data are available to physicians who are associated with a medical episode, based on the patient's implicit or explicit consent.
- *Statistical data*: defines the group of data derived from anonymized patient data, so that by processing it cannot make the unique identification of the patient. These data

are fully available to the health authorities for the evaluation of the parameters and indicators of the system and partially (those corresponding to the medical episodes with which they were associated) to the specialists.

In this respect, the role of the portal component is to generate a web interface for users, in which the result of the analytical processing of input data can be queried and displayed in a GIS manner. The web interface should be standardized, simple and intuitive according to the recommendations of the World Wide Web Consortium (hereinafter W3C) for HTML5.

The portal is entirely of web type which allows the integration with characteristic GIS and Telemedicine web functionalities, fulfilling the following requirements:

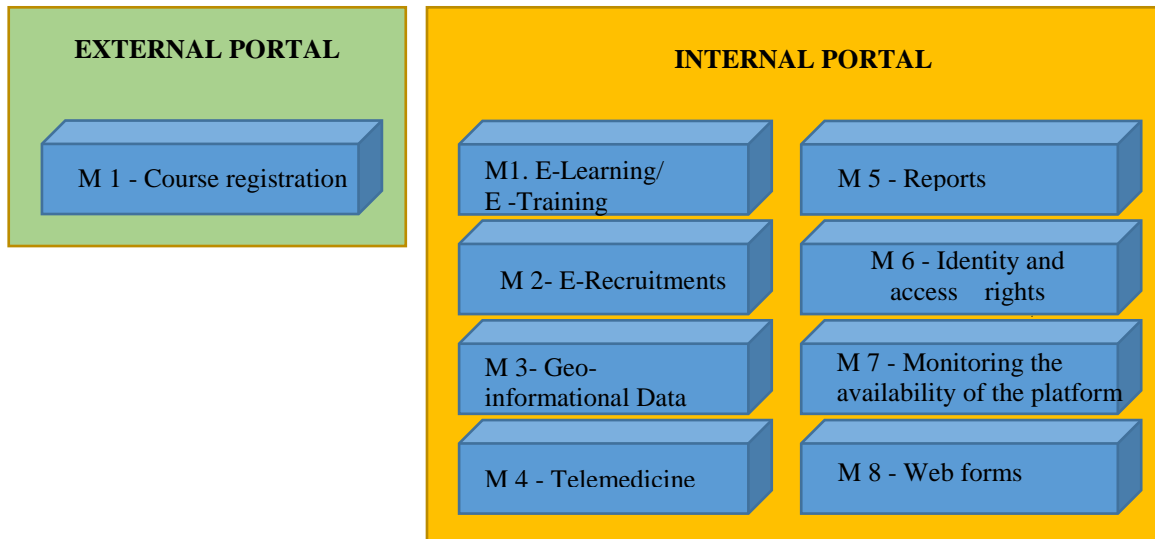
- high degree of system security, which guarantees the confidentiality and security of data user for unauthorized access, both outside and inside the system;
- modular services, which allow the further development of new functionalities;
- provides access to all resources present in the portal through a single authentication, at the opening of the session;
- includes user management functionalities and tools specific to the administrator role.

The specific stages of the portal design and implementation are:

- O1 - Development of an open source portal for public health management in case of the pandemics
  - Open source information technologies and their efficient use improve the quality of services and are an important source of financial savings. The main functions performed by the integrated portal are: Automation of reporting - the use of standardized forms for reporting that automatically extract and synthesize data, while ensuring the electronic communication of reports to central bodies,
  - Harmonization and efficiency of the activity of local authorities by ensuring authorized access to stored data and information.
- O2 - Development of training and recruitment modules for doctors for the telemedicine platform
  - The integrated portal will present a dynamic training and recruitment platform, which will be multi-modularly developed under an object-oriented environment. In other words, it will contain a course / recruitment management system created to help platform users conduct quality courses / recruitment sessions online. Users only need a browser (e.g. Chrome) to attend a recruitment course / session.

### **3. Scientific and technical presentation of the pilot project**

The design of the platform aims to: standardize the interaction between components, standardize modeling principles, create a layer of reusable infrastructure services at the organizational level, create a unique centralized identity service and generate the premises for compliance with GDPR requirements on the processing of personal data, the extensibility of the platform by creating connectors, securing the system at all its levels. In order to achieve the objectives, ensure the results, versatility and capability of further development, the functional blocks of the platform are structured as follows:



**Figure 1.** Software architecture

- Functional Block Management of identity and access rights:
  - Ensures the unitary administration of user accounts (creating user accounts, defining users, user groups and defining access rights to various functionalities and information), authorization rules and provides secure authentication mechanisms. The way of configuring the roles is unitary, unlimited in number and will take into account: mode, operation, type of information, organizational level, etc. Thus, the portal will ensure access to information according to the defined role.

#### EXTERNAL PORTAL FUNCTIONAL BLOCK:

- The module ensures enrollment in courses. It will allow you to complete the course registration form online.

#### INTERNAL PORTAL FUNCTIONAL BLOCK:

- E-Learning / E-Training Functional Block:
  - The module displays sections for users, activities, search, administration, courses, news, future events, recent activities, etc. Within this module, the portal will also provide a mechanism dedicated to teleconferencing.
- Functional Block E-Recruitments:
  - Allows the enrollment of doctors. The enrollment of doctors will be done by filling in an online form, provided by the portal.
- Geoformation Data Functional Block:
  - Allows the visualization of geospatial data at map level, with the possibility of selecting thematic layers. It can be integrated into any module that requires the geospatial representation of modeled resources.
- Telemedicine Functional Block:
  - The module allows remote consultations (via a video call) with a specialist;
  - The specialist doctor can monitor the patients.
- Functional Block Reports:
  - Template-based reports will be generated; custom reports will be defined. This module can be described by its two areas, one related to the description of the parameters that the report will take into account, and the other to the display of the report. The user

can choose to select one or more metadata that will be displayed in the reports. Reports can be exported to PDF, CSV, HTML, EXCEL but be graphical, for charts, in PNG, JPEG, SVG, PDF formats.

- Functional Block Monitoring platform availability:
  - Provides functions for assessing the technical condition and availability of the platform through a graphical interface, which allows individual tracking of each component of the platform or at the group level of components.
- Web Forms Functional Block:
  - The IT solution will offer the possibility to adapt / customize web forms.

*All system modules can run on Linux operating systems. All libraries used to build the platform are available with "open source" licensing.*

The integrated portal has the ability to communicate and exchange data accurately, efficiently, securely and constantly with various computer systems, software applications and networks in various settings, ensuring the operational work processes of the institutions involved (Ministry of Health, Public Ministry, Ministry of National Defense, Public Health Directorates, hospitals, pharmacies, etc.), ensuring the preservation of data consistency. The integrated portal will allow the data to be organized in a standardized way in order to ensure their interoperability. In the conditions of globalization and transmission of information in electronic format, the integrated portal validates its compliance by using high-level technologies that provide integration tools with external solutions.

The use of SOA technology will make it possible to provide specific standardized formats for structuring the information in the Integrated Portal and the messages through which this information is communicated between computer systems, as well as defining how these messages work with protocols used in computer -systems. In order to ensure interoperability with other systems, the integrated portal will allow the configuration of any type of API interface.

The technical architecture of the platform is structured on three levels:

The DMZ level ensures the direct user interface and is represented by the load balancers for the balanced distribution of user requests to viable application servers, respectively to infrastructure services, as well as moving traffic on the viable node in emergency situations.

There are two loading swings, of software type, configuration in IP Failover mode to which the traffic will be redirected from the firewall, one swing being used as the main one, the other representing the backup.

The software instruments which are used to create the platform are:

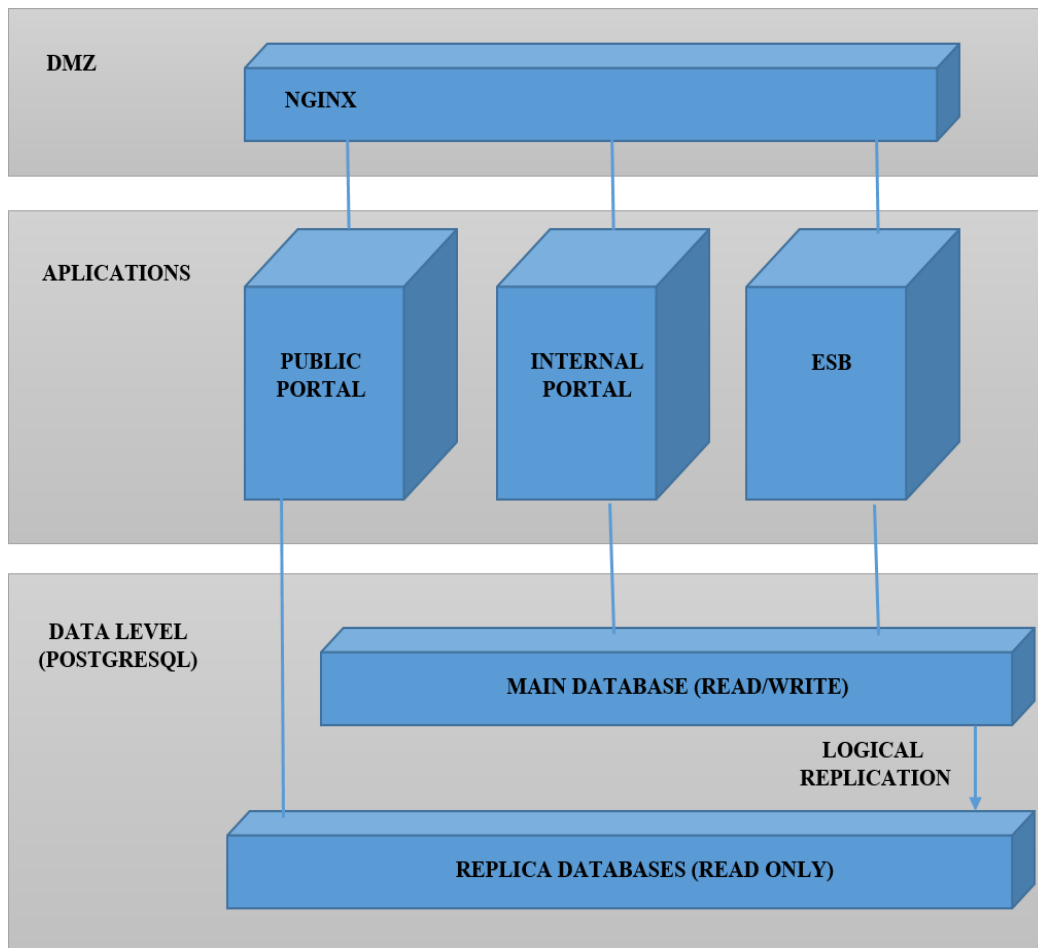
- **Apache Tomcat** - <https://tomcat.apache.org/download-80.cgi>;
- **WSO2 Identity Server** - <https://wso2.com/identity-and-access-management>, role: identity management and unit authorization at platform level;
- **OPEN LDAP** - <https://www.openldap.org/> role: storage credentials platform users;
- **WSO2 Enterprise Integrator** - <https://docs.wso2.com/display/EI611>;
- **NGINX** - <https://www.nginx.com/resources/wiki/> role: load balancer for application servers and infrastructure services;
- **Postgres** - <https://www.postgresql.org/docs/10/static/release-9-6.html>, role: relational database;
- **HAProxy** - <http://www.haproxy.org/>, role: database cluster connection manager;
- **Patroni** - <https://github.com/zalando/patroni>, role: database configuration management for promoting a slave node of the cluster in the master node in case of master failure;

- **ZABBIX** - <https://www.zabbix.com>, role: technical monitoring and availability of the platform. All system modules can run on Linux operating systems. All libraries used to build the platform are available with "open source" licensing.

The degree of complexity of the platform is high, due to the diversity of types of functional blocks offered as well as the multitude of technological components of the platform, as shown by the technical architecture, which makes it particularly necessary to group and specialize replicable functionalities in the form of infrastructure centralized services. The monitoring component, ZABBIX, plays an important role through the notification capacity but also through the possibility to execute some preventive actions, in relation to some found technical situations.

After creating/developing the functional prototype of the platform, the modules from the technical scheme are tested and validated. Thus, the arrangement of the software components on the TEST environment is schematically presented in Figure 2., structured on 3 distinct levels:

- DM;
- Applications;
- Data level (POSTGRESQL).



**Figure 2.** Arranging the software components on the TEST environment

The arrangement of virtual machines on the TEST environment is presented in the diagram in Figure 3, in which the following can be distinguished: NGINX, public portal, internal portal, ESB, main data bases, replica data bases. The arrangement of virtual machines on the production environment is shown in Figure 4.

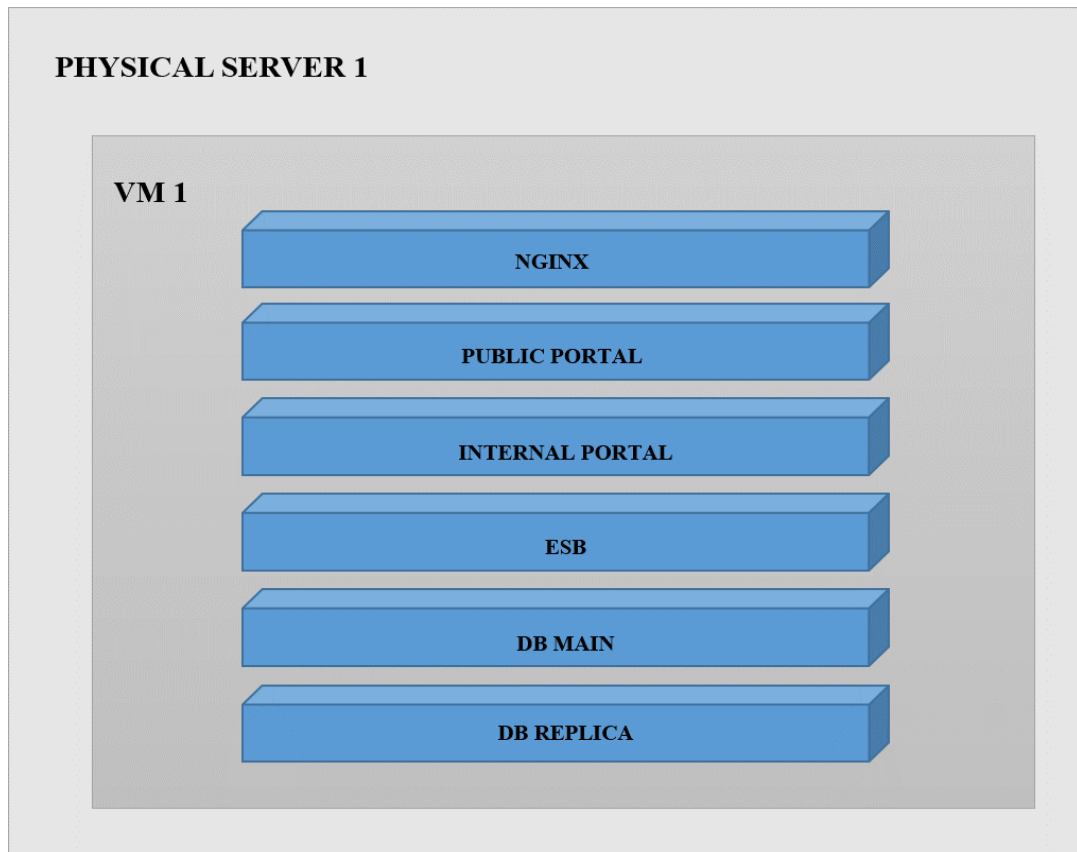


Figure 3. Diagram of the arrangement of virtual machines on the test environment

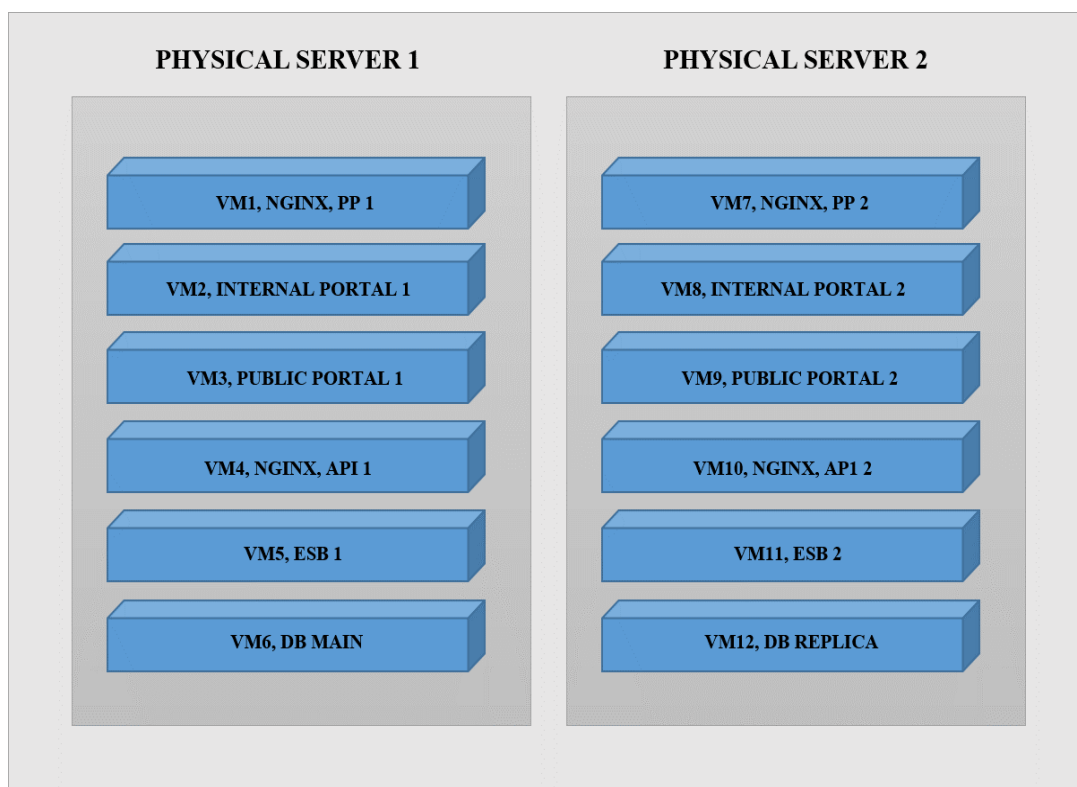


Figure 4. Diagram of the arrangement of virtual machines on the production environment

Elements of innovation at the platform level:

- flexibility of the proposed platform (possibility to create document type structures based on existing metadata);
- allows the configuration of any type of API interface;
- search and identify documents based on syntax using NLP algorithms;
- development of connectors for GDPR platforms;
- development and integration of MS Office connectors (Word, Excel), MS Outlook;
- implementation of the “data diode” concept of software type that allows communication in one direction (by blocking HTTP Response related to an HTTP Request).

Platform level security features:

- through integrated identity management and security policies (e.g. password validity), authorization rules and multifactor authentication;
- through tools from the WSO2 range that offer features such as password encryption in configuration files;
- mechanisms for encrypting data in the database at the column level and secure connections to it, encrypting backup files;
- isolation at network level of the accessibility of the platform components according to the strict need.

The development of information systems and databases will take into account Commission Recommendation (EU) 2020/518, April 8, 2020 on a common set of Union-wide tools for the use of technology and data in order to combat the crisis caused by the COVID-19 pandemic and get out of this crisis, especially with regard to mobile applications and the use of anonymized mobility data. (<https://www.ilegis.ro/eurolegis/ro/index/act/71387>)

## 4. Discussions

Managing the Covid 19 pandemic, mitigating its effects and returning to normality has become a top national security issue for governments, under severe social contract pressure through which citizens expect the state to protect them in times of crisis, in the early moments when people had imagined a disease out of control and in which governments seemed incapable of ensuring the safety of their citizens. Non-medical responses to the pandemic, such as forced quarantine, border screening, restricting freedom of movement, have led to a sense of insecurity at the individual and group level. The fear and panic that arose during the Covid 19 pandemic generated a level of disruption in society, probably disproportionate to the burden of health that the disease itself has. At first sight, international cooperation could be the solution to diminish the vulnerability of individual states and their purely domestic actions taken in response to the pandemic, given that its size is transnational and imposes the growing interdependence of states.

The solution proposed in this paper to resist such challenges / threats would be based on the collective and institutional interest in the exchange of health information through an integrated open source portal with access to geoformation and telemedicine technologies for public health management. In this sense, among the results intended to be obtained by implementing the portal as an early warning system by accurately, efficiently, securely and consistently communicating and exchanging data with various computer systems, software applications and networks, ensuring the operational work processes of the institutions involved, are those both at the level of patients:

- Better communication between the involved institutions and between doctors helps in training and professional education in health care;
- Carrying out, at the level of the family doctor, the management of chronic diseases



with major impact in the population, with the support of specialist doctors;

- Medical expertise equally available, regardless of where the patient lives, urban or rural area;
- Improving the quality of medical decisions by ensuring greater availability of existing information to patients;
- Improving the efficiency and productivity of health services by reducing routine administrative work, due to existing information in electronic format;
- Ensuring a continuous training of the medical staff;
- Ensuring the adequate use of local and regional resources.

## 5. Conclusion, limitations and future work

Concluding, the national security and social impact of this research is due to the planned applications of managing the flow of information which is a first step in considerably improving the response time and efficiency of human response services. Moreover, the holistic approach to institutional interoperability influences strategic level factors at the societal level.

The impact of the efficiency of the healthcare system consists in:

- public health care, by reducing the time between data collection and processing and medical decision making;
- better communication between the involved institutions, between doctors helps in training and professional education in healthcare.

The impact on reducing the pandemics in the community consists in:

- disease prevention - the analysis of collected patient/person at medical risk data decisively contributes to the decrease of the incidence of diseases;
- the possibility of monitoring isolated patients at home.

*Limitations of the study:* The main limitation of the proposed solution in this work is that it does not take into account the degree of digital training of family doctors / specialists, nor the level of the level of equipment of hospitals with IT&C to be integrated in the pilot project.

*Future research:* A specialized training program for medical staff and national security institutions participating in this integrated portal is being considered in order to have an integrated understanding.

## Highlights

This paper brings important elements of innovation at the platform level, such as: possibility to create document type structures based on existing metadata, allowing the configuration of any type of API interface, search and identify documents based on syntax using NLP algorithms, development of connectors for GDPR platforms, development and integration of MS Office connectors (Word, Excel), MS Outlook, implementation of the concept of “data diode” of software type that allows communication in one direction (by blocking HTTP Response related to an HTTP Request).

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