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DATABASE FOR THE INFORMATION SYSTEM FOR MONITORING THE EPIDEMIOLOGICAL SITUATION

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Abstract: *The scientific paper proposes the projects of the conceptual and logical schemes of the relational database for the IT system for monitoring the epidemiological situation in the Republic of Moldova. The informational objects of the field of study are identified. The information base of the designed system is developed. The basic relationships between informational objects are highlighted. The integrity and referential constraints are proposed. Database's relationships are normalized up to NF3. The main idea is emphasized that the practical implementation of the database will allow solving the problems of efficient analysis of primary medical data and generation of consolidated reports, which will allow operative and strategic decisions to be made by the central administration of the Republic of Moldova*

Keywords: database, information system, design

JEL Classification: L86, I13

1 Introduction

The beginning of the SARS-Cov-2 virus pandemic in the Republic of Moldova in March 2020 found the information systems of medical institutions totally unprepared for prompt analysis and effective informational management of cases of infection with COVID-19. As it was demonstrated before (Oprea, 2020), the information systems of state organizations in the field of public health protection did not have reliable mechanisms for collecting and storing primary medical data in real time, for operative analysis of these data and for generating summary reports according to the criteria requested by the Government of the Republic of Moldova.

In order to obtain centralizing medical data at country level and to regulate the process of reporting cases of illness with COVID-19 by medical units in the territory, the Ministry of Health, Labor and Social Protection of the Republic of Moldova issued orders no. 294 of 20.03.2020 (MHLSP, 2020, 20 March) and no. 389 of 10.04.2020 (MHLSP, 2020, 10 April), in which the respective methodologies are described. In these orders, 5 forms of reports are specified, which were to be developed within the territorial medical units manually and transmitted in the form of Excel files to the higher hierarchical bodies. Due to the lack of specialized medical information systems, the entire process of collecting, organizing, processing and analyzing data regarding the epidemiological situation in the Republic of Moldova was carried out manually, by creating Excel files and sending them by e-mail to the hierarchically superior medical authorities. Obviously, this has generated a series of serious problems and made the work of the medical staff considerably more difficult, forced to

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spend unnecessary hours of work perfecting some documents with daily operative data.

The analysis of the summary reports, developed within the National Agency for Public Health, highlighted serious errors in the organization and processing of statistical data (Oprea, 2021a). The main sources of errors were: lack of data validation mechanisms; logical data redundancy; lack of necessary information for the generation of summary reports; data isolation (using calendar and text formats for time periods). To eliminate these shortcomings, the concept of a database was proposed (Figure 1), which would allow the operative management of medical data within the information system of the National Public Health Agency of the Republic of Moldova.

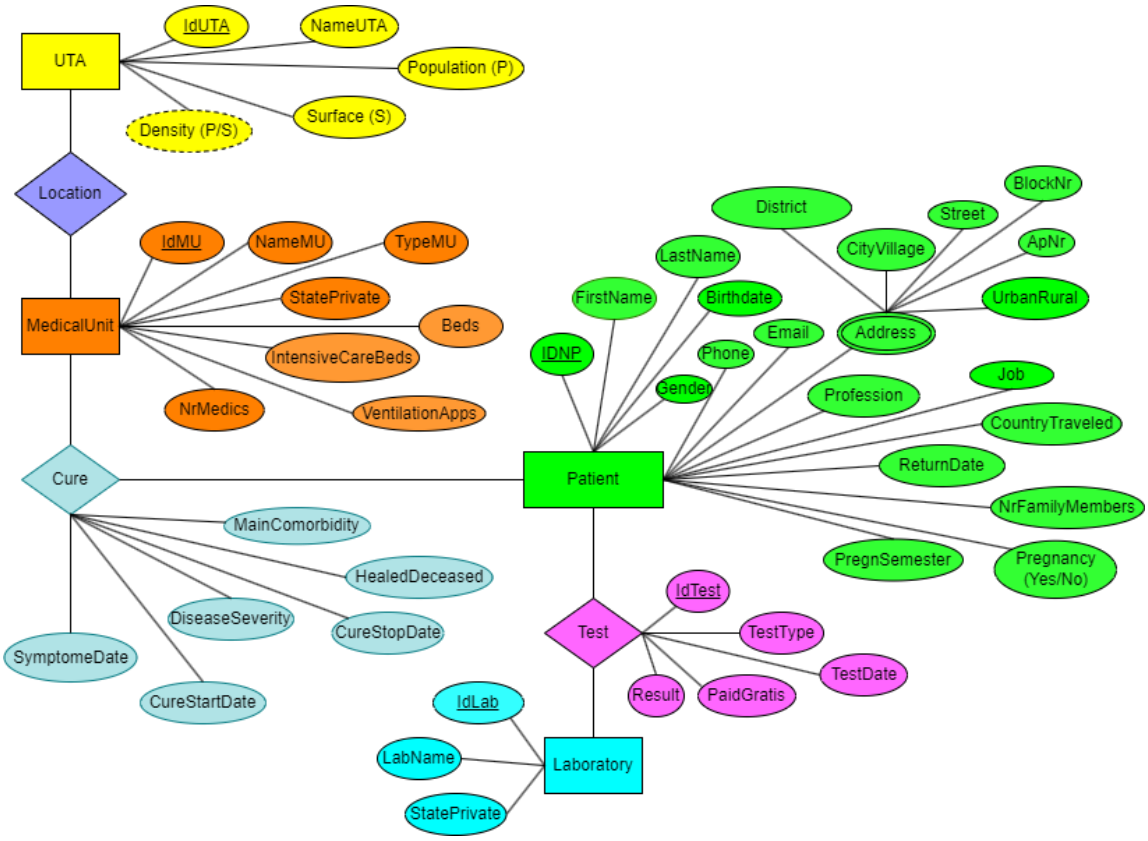

Figure 1. Conceptual schema of the database for monitoring COVID-19 cases

Source: author own study (Oprea, 2021a)

In order to use the database efficiently, it was proposed to create an information system for the management of the epidemiological situation (SIMSE) within the National Agency for Public Health (Oprea, 2021b). It is proposed that this computer system be set up on the basis of client-server technology (Figure 2), which would ensure real-time operation of the system and operational access of various categories of users to certain categories of data stored in a relational database. By applying mathematical calculation algorithms to the data in the database, all the synthesis data necessary for SIMSE operation can be obtained within the system (e.g., daily number of new cases of infection, total number of cases registered in territory, number of new import cases, total number of repeated positive tests, etc.). The implementation of the proposed database will allow the National Agency for Public Health to carry out operational monitoring of the epidemiological situation and to obtain the necessary

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information for decision-making at the state level.

The functional logic of the processing of personal data in the information system for monitoring the epidemiological situation (ISMES) is presented in Figure 2. Testing and identification of cases of COVD-19 will be performed in authorized medical units (licensed laboratories), which will take the biological samples from the citizens and will generate based on them the primary input data of the computer system in the form of test results. These data will also include the personal data of the tested citizens (state identification number of citizen (IDNP), name, surname, date of birth, sex, address, telephone, email, number of family members, profession, place of work, date of first symptom of the disease, country visited last 14 days, date of return to the country).

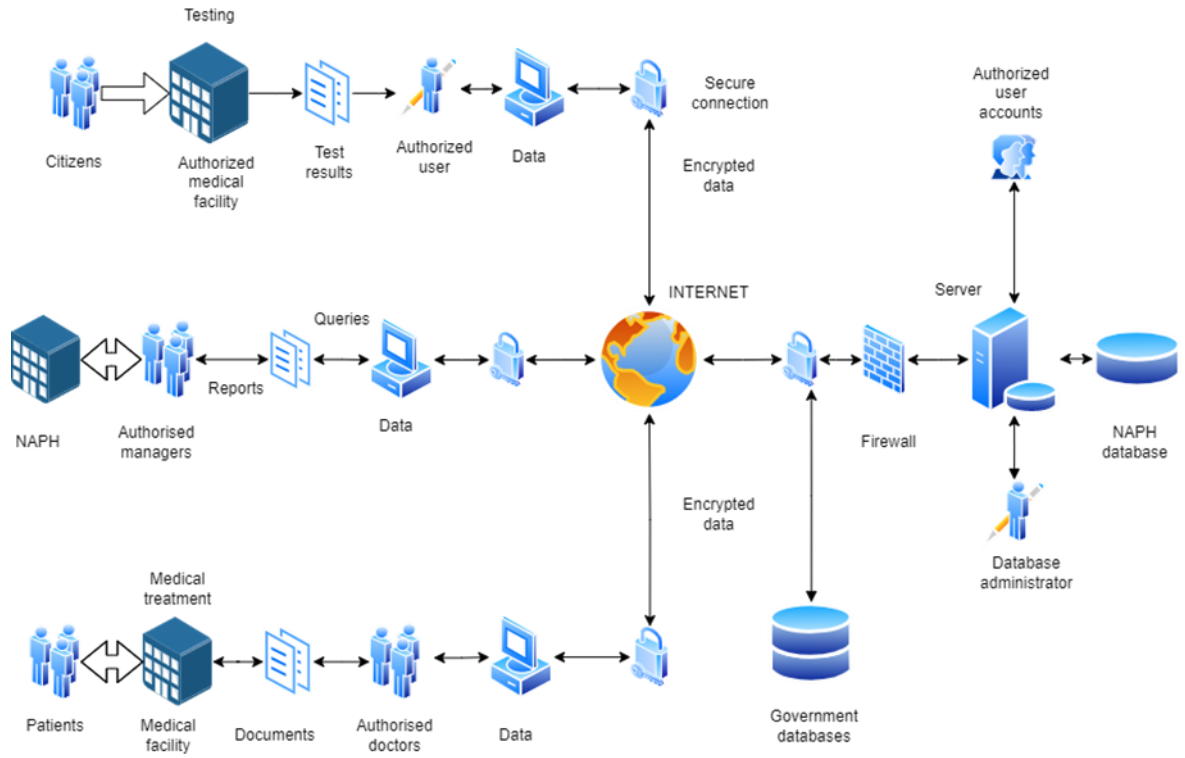

Figure 2. Functional logic of data processing based on client-server technologies

Source: author own study (Oprea, 2021b)

The information system for monitoring the epidemiological situation (ISMES) must be interconnected with other medical and governmental information systems, primarily with the automated information system "Primary Health Care" (AISPHC) (https://sia.amp.md/), but also with the information systems of the Public Service Agency, the Ministry of Internal Affairs and the Border Police (Figure 3), based on the principles of data exchange and interoperability.

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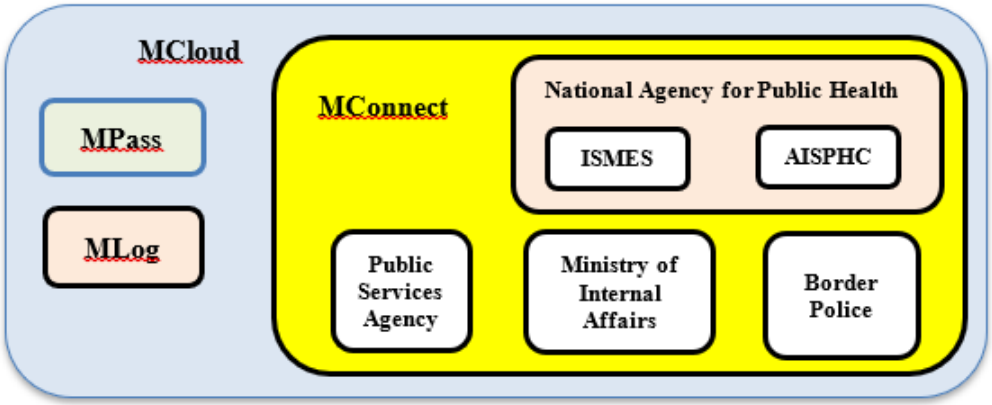

Figure 3. Interoperability of government information systems

Source: author own study (Oprea, 2021b)

2 Database logical design

The conceptual schema of the database (Figure 1) allowed the following entities to be identified in the analyzed field: **Patient** (Table 1), **Laboratory** (Table 2), **Medical Unit** (Table 3), **UTA** (Territorial-administrative unit) (Table 4), each having a set of mandatory or optional attributes.

Table 1 Entity Patient

Attribute	**Description of attribute meaning** (# - primary attribute, * - attribute with mandatory value, o – attribute with optional value)
# IDNP	Personal numerical code of the citizen
* FirstName	First name of the citizen
* LastName	Last name of the citizen
* Birthdate	Birthdate of the citizen
* Gender	Gender of the citizen
o Phone	Citizen's phone number
o Email	Citizen's email address
* Address	Address of the citizen. Compound attribute consisting of columns *NameUTA, *CityVillage, o Street, o BlockNr, o ApNr, *UrbanRural.
o Profession	Profession of the citizen (subsequently the field of professional activity can be added)
o Job	The citizen's workplace.
o CountryTraveled	The country where the citizen has traveled in the last 14 days
o ReturnDate	Date of return to the country from the trip
* NrFamilyMembers	The number of family members with whom the citizen lives together
o Pregnancy	In the case of women, it identifies the state of pregnancy
o PregnTrimester	In the case of pregnant women, it identifies the trimester of the pregnancy period

Source: own work

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Table 2 Entity Laboratory

Attribute	**Description of attribute meaning** (# - primary attribute, * - attribute with mandatory value, o – attribute with optional value)
# IdLab	The identifier of the authorized medical laboratory
* LabName	Name of the authorized medical laboratory
* StatePrivate	Form of ownership (state laboratory, private laboratory)

Source: own work

Table 3 Entity MedicalUnit

Attribute	**Description of attribute meaning** (# - primary attribute, * - attribute with mandatory value, o – attribute with optional value)
# IdMU	Identifier of the curative medical facility
* NameMU	Name of the medical facility
* TypeMU	Category of medical facility (hospital, AMT, AMU, etc.)
* StatePrivate	Form of ownership (state institution, private institution)
o NrBeds	The number of beds for patients in the medical institution
o NrIntensiveCareBeds	The number of beds in the resuscitation department of the medical institution
o NrArtifVentDevices	The number of machines for artificial ventilation of the lungs
* NrMedics	The institution's medical staff number. Optionally, it can be divided by categories of medical personnel (doctors, nurses, etc.)

Source: own work

Table 4 Entity Territorial-Administrative Unit (UTA)

Attribute	**Description of attribute meaning** (# - primary attribute, * - attribute with mandatory value, o – attribute with optional value)
# IdUTA	Identifier of the territorial-administrative unit
* NameUTA	Name of the territorial-administrative unit
* Population	The number of the population with a stable domicile in the territorial-administrative unit
* Surface	The total area of the territory of the territorial-administrative unit

Source: own work

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The relationships **Test** (Table 5), **Cure** (Table 6), **Location** with their specific attributes were identified between the database entities, with the possibility of expanding them if necessary.

Table 5 Relation Test

Attribute	**Description of attribute meaning** (# - primary attribute, * - attribute with mandatory value, o – attribute with optional value)
# IdTest	Test identifier
* TestType	Type of test performed
* TestDate	The date of the test
* PaidGratis	Free or paid test
* Result	Test result (positive / negative)

Source: own work

Table 6 Relation Cure

Attribute	**Description of attribute meaning** (# - primary attribute, * - attribute with mandatory value, o – attribute with optional value)
# IdCure	Medical treatment identifier
* SymptomeDate	The date of the first symptoms (for asymptomatic cases, the date of the first positive test is indicated)
* CureStartDate	Date of starting the application of the medical treatment protocol
* DiseaseSeverity	Disease severity (asymptomatic, mild form, severe form, intubation)
* CureStopDate	Date of termination of application of the medical treatment protocol
* HealedDeceased	Status of the patient (sick, cured, deceased)
o MainComorbidity	The main comorbidity of the deceased patient

Source: own work

3 Database normalization

Based on the requirements for summary reports, established in the orders of the Ministry of Health, Labor and Social Protection of the Republic of Moldova no. 294 of 20.03.2020 (MHLSP, 2020, 20 March) and no. 389 of 10.04.2020 (MHLSP, 2020, 10 April) the universal set of attributes of the relational database **CovidMonitoringDB** was developed:

CovidMinitoringDB*{#IDNP, FirstName, LastName, Birthdate, Gender, Phone, Email, Address, Profession, Job, CountryTraveled, ReturnDate, NrFamilyMembers, Pregnancy, PregnTrimester, #IdLab, LabName, StatePrivate, #IdMU, NameMU, TypeMU, NrBeds, NrIntensiveCareBeds, NrArtifVentDevices, NrMedics, #IdUTA, NameUTA Population, Surface, #IdTest, TestType, TestDate, PaidGratis, Result, #IdCure, SymptomeDate, CureStartDate, DiseaseSeverity, CureStopDate, HealedDeceased, MainComorbidity}*

On universal sets of attributes, the procedure of normalizing the relations up to the normal form 3 (NF3) was applied, obtaining the normalized relations:

Patient*(#IDNP, FirstName, LastName, Birthdate, Gender, Phone, Email, Profession, NrFamilyMembers, Pregnancy, PregnTrimester)*

PatientAddress*(#IDNP, #IdAddress)*

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***Address** (#IdAddress, Street, BlockNr, ApNr)*
***AddressCityVillage**(#IdAddress, #IdCityVillage)*
***CityVillage**(#IdCityVillage, NameCityVillage, UrbanRural)*
***CityVillageUTA**(#IdUTA, #IdCityVillage)*
***UTA**(#IdUTA, NameUTA, Population, Surface)*
***PatientJob**(#IDNP, #IdInstitution)*
***Institution**(# IdInstitution, InstitutionName)*
***LastPatientTravel**(#IDNP, #IdCountry, ReturnDate)*
***Country**(#IdCountry, CountryName)*
***PatientTest**(#IdTest, #IDNP)*
***Test**(#IdTest, TestType, TestDate, PaidGratis, Result)*
***TestLaboratory**(#IdTest, #IdLab)*
***Laboratory**(#IdLab, LabName, StatePrivate)*
***Cure**(#IdCure, SymptomeDate, CureStartDate, DiseaseSeverity, CureStopDate, HealedDeceased, MainComorbidity)*
***CurePatient**(#IdCure, #IDNP)*
***CureMU**(#IdCure, #IdMU)*
***MedicalUnit**(#IdMU, NameMU, TypeMU, NrMedics, NrBeds, NrIntensiveCareBeds, NrArtifVentDevices)*
***Location**(#IdUTA, #IdMU)*

4 Conclusion

As a result of carrying out the normalization process by decomposing the universal relation of attributes ***CovidMinitoringDB***, the relational schemas of the database in normal form 3 (NF3) were obtained. These relational schemas can serve as a starting point for the physical design of database relations. Based on the relational schemas, the data dictionary can be developed and integrity and referential constraints can be defined for the database objects. In the same way, it will be possible to develop the operating rules on the data from the database based on the business rules, identified in the analyzed field. The relational schemas, operation rules and data dictionary will enable the physical database design process to be carried out efficiently, as well as the development and testing of the database prototype.

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