Competences in Health Network Management

Intellectual Output 4:

Data Management in Health Networks

Erasmus+ Strategic Partnership

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Leading Organisation:

Technical University Sofia

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FOM University of Applied Sciences
Medical University of Silesia
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Preface

The objective of Intellectual Output 4 is to determine the requirements towards a Data System called "Health Network Management Data System"(HNMDS), which includes:

- determining the sources of information that the Regional Health Network Manager needs to perform his duties; analyzing the structure of the information in these sources, in order to evaluate existing indicators and to screen redundant ones;

- developing the architecture of the Health Network Management Data System;

- defining the digital competences and skills the Regional Health Network Manager needs to possess to work with the Health Network Management Data System, according to "Digital Competence Framework for Citizens DigComp 2.1", level 7/8;

- developing of software applications to support the teaching process under IO3, which will give the Regional Health Network Manager the necessary digital competences and skills;

I. Determining the sources of information for the Regional Health Network Manager

In order to perform his duties in today's digital world, the *regional health network manager* needs an *up-to-date* information about what is happening in his region. The problem is, that this information comes from different institutions (public and private) and that each of these institutions has its own computer system for collecting and storing the information it needs. Moreover the information in these systems is structured differently, even if these systems store the same type of information. Healthcare facilities can be given as the best example, because they use software from different developers, and although the type of information is the same, each developer has structured it differently. Thus arises the problem of communication between these systems.

Therefore, a study of the institutions that could be sources of information for the regional health network manager's activities was made. First it was fulfilled for Bulgaria by FDIBA. Then, the results were presented to the partners as a basis for study in their own countries.

As a result of this study, 7 main sources of information were identified, namely:

- Health care facilities

- Regional Environmental Inspectorate

- Regional Health Inspectorate

- Territorial Expert Medical Commission

- National Insurance Institute

- National Health Insurance Fund
- National Statistical Institute (Territorial Statistical Office)

It was found, that the information in these sources contains over 900 indicators, most of which were unnecessary for the work of the regional health network manager. Therefore, the idea was reached that the regional health network manager should possess his own database.

These more than 900 indicators were carefully analyzed and only the following were selected to participate in the database structure:

1. Information from the *health care facilities*:
    A. Establishments for primary outpatient care
        - Number of visits (outpatient, home)
        - Number of visits to dental care facilities
        - Number of immunizations performed by species
        - Number of clinical trials performed
        - Number of performed imaging examinations
        - Staff structure and workload
    B. Hospitals for active treatment
        - Hospitalizations by types of diseases
        - Structure of the beds by type
        - Usability of the bed stock
        - Duration of hospital stay
        - Staff structure and workload
    C. Post-treatment and long-term treatment hospitals
        - Patients served
        - Number of available beds
        - Usability of beds
        - Duration of hospital stay
        - Staff structure and workload
    D. Medical and social care homes, hospices, dialysis centers
        - Number of available beds
        - Usability of beds
        - Staff structure and workload
2. Information from the *Regional Environment Inspectorate*:

- Air quality information
- Information on noise and vibration in residential, public buildings and urban areas
- Information on ionizing and non-ionizing radiation in residential, industrial, public buildings and urban areas
- Information on chemical factors and biological agents in public facilities

3. Information from the *Regional Health Inspectorate*:
- Information on the morbidity with an emphasis on the socially significant ones (malignant neoplasms, tuberculosis, mental illnesses, infectious diseases, venereal diseases, etc.)
- Information on morbidity with temporary disability
- Structure of the medical staff by specialties
- Distribution of health care institutions by property and territory
- Financial indicators of the health establishments in the region

4. Information from the *Territorial Expert Medical Commission*:
- Number of disability decisions issued
- Structure of the issued decisions for disability by: age, group, illness, percentage of disability

5. Information from the *National Insurance Institute*:
- Recompenses paid for temporary incapacity for work by type
- Pensions paid by type
- Disbursements related to short-term measures

6. Information from the *National Health Insurance Fund*:
- Funds paid for primary pre-hospital care
- Paid funds of the primary pre-hospital dental care
- Paid funds for medical-diagnostic activities
- Paid funds for hospital care
- Payments for home remedies and medical devices

7. Information from the *National Statistical Institute (Regional Statistical Office)*:
- Main trends in the number and structure of the population
- Structure of the population by age and sex
- Birth rate, total and infant mortality and natural increase
- Mortality
- Mental and physical development
- Main macroeconomic indicators for development of the country
- Social environment - social factors (smoking, alcohol dependence, overweight, drugs, etc.)

Note: The architecture of the Health Network Management Data System, proposed below, is *open and flexible*, which means that in the future new sources of information may be added to it or existing ones may be removed. The structure of the information received from these sources can also be changed. This may happen when the legislation changes or by taking into account specific features of a country.

The whole list indicators, analyzed during the study, can be found on the project page:
`https://www.ComHeNet.eu/IO4/opensource/Indicators.docx`

II. Architecture of the Health Network Management Data System

As mentioned above, the most important thing for the effective work of the *regional health network manager* is the access to *up-to-date* information about what is happening in the region. The main sources of this up-to-date information are the *Primary Health Care* and the *Regional Environmental Inspectorate*. Therefore, the idea was reached to use *microservices* to supply the information from these institutions and to keep this information up-to-date, as shown on *Figure 1*, where the microservices are depicted with small red rectangles.

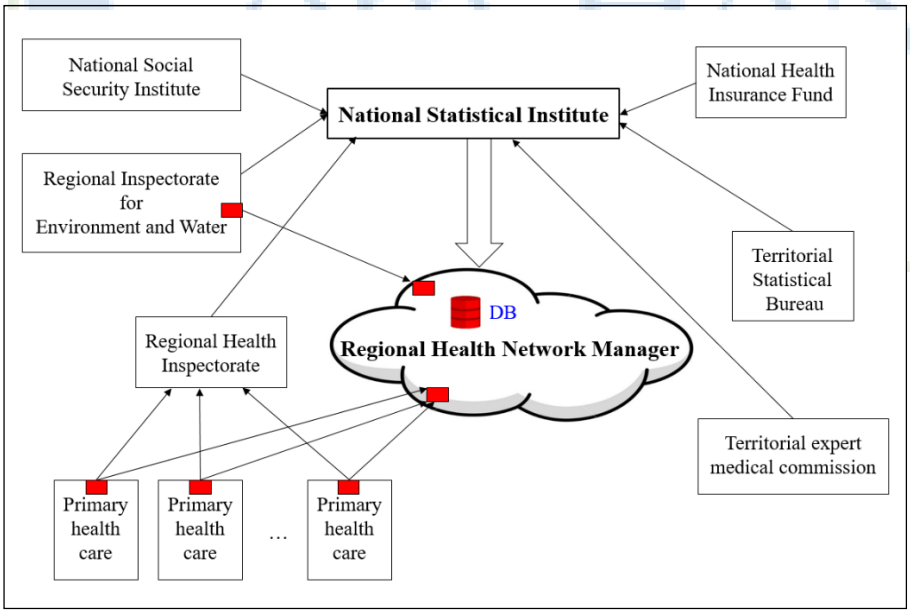

Figure 1: Service oriented architecture of the Health Network Management Data System. (own presentation & source)

A microservice is small piece of program code that transforms the data from the internal database of an institution into a uniform data transfer format or vice versa. Usually, microservices use SQL-queries to extract the required information from the database. On the side of the *regional health network manager*, there is also such a microservice, which transforms the data, received in the uniform data transfer format, into the internal structure of the database of the *regional health network manager* (which structure, is different from that of the other institutions).

Microservices also play a crucial role in protecting internal data from hacker attacks. They stand as a shield between the hacker and the system's internal data, because no one can get more data than the microservice is programmed to give him.

Languages such as XML, JSON etc. are typically used to depict the transferred data. The data itself are in plain text and are not as well structured as the data in a relational database, but are stored in their natural form, which allows repeatability of information, thus making this presentation format significantly more voluminous and more difficult to manage and process. This is the reason why this format should only be used for data transfer. Although such data are poorly structured, they still have some structure. That is why they are called *semi-structured data*. Their structure can be described in two alternative ways: using a DTD or an XSD.

III. Defining the digital competences and skills of the Regional Health Network Manager

The digital competences and skills the *regional health network manager* needs to possess, according to "Digital Competence Framework for Citizens DigComp 2.1", level 7/8 are:

- Skills for structuring the information so, that it can be stored and processed with the help of a computer
- Knowledge of how to describe the structure of a relational database
- Knowledge of how to retrieve data, already stored in a relational database
- Knowledge about the methods for gathering data from heterogeneous sources of information using microservices and semi-structured data

Therefore, during the course the students will gain knowledge about *Relational Databases*, as the most widespread and stable solution for storage and processing of data. Then they will learn the *Structured Query Language (SQL)* and use it to create the database structure and to retrieve data, already stored in the database. After that they will be introduced to methods for gathering data from heterogeneous sources of information using *microservices* and *semi-structured* data.

Additional the *regional health network manager* must posses knowledge about data protection and security, which includes:

- Knowledge about the EU Data Protection Regulation and especially in the part of protecting personal data
- Knowledge about data protection methods including anonymization, encryption, etc.
- Knowledge about hacking techniques and measures to block them

Therefore, during the course the students will gain knowledge about the EU Data Protection Regulation and especially in the part of protecting personal data. This is very important for the work of the *regional health network manager*, because he will have access to information about the health status of large groups of people. Therefore, the students will learn data protection methods including anonymization, encryption, etc. And at last but not least they will be introduced to the hacking techniques and the measures to block them.

During the lectures on EU Data Protection Regulation, students will learn about the rights and duties of the positions: data protection officer, administrator and processor. Thereafter they will be introduced in the procedures for storing and "forgetting" data.

Students will then be introduced to data anonymization methods as a means of protecting personal data. The following are basics of cryptographic methods for protecting information, such as: public key cryptographic algorithms, electronic digital signature, etc.

And last but not least, students get to know the types of hacker attacks specific to the area of public health, such as: cookie theft, sniffing, keylogging, malware/watering hole, phishing, "Man in the Middle" etc. They are also trained to recognize and block such types of attacks.

IV. Software applications, developed to support the teaching process

IV.1. Sample database and application to train information retrieval, using SQL

This feature was not included in the project proposal, but during the project development it was found that the students must have a tool with which they can practice the material they receive during the lectures. Therefore a sample database and an application were developed. With the help of this application, the students can formulate *SQL*-queries to the sample database, thereby adding and retrieving the information they need from it. The students will learn how to write such queries in the textbook issued under the project, as for example:

Get a list of all male patients over 60, with diagnosis Covid-19.

```
select P.SSN, P.Name, P.Family
from Patients P, MedicalExamintaions ME, Diagnoses D
where D.Name = 'Covid-19' and P.Gender = 'M' and
    (year(Today()) - year(BirthDate)) > 60 and
    P.SSN = ME.SSN and ME.DiagnosisID = D.ID
```

Get a statistik, separately for men and women, about the number of patients over 60 with a diagnosis of 'heart attack'.

```
select P.Gender, count()
from Patients P, MedicalExamintaions ME, Diagnoses D
where D.Name = 'heart attack' and
    (year(Today()) - year(BirthDate)) > 60 and
    P.SSN = ME.SSN and ME.DiagnosisID = D.ID
group by P.Gender
```

The structure of this sample database is given in *Figure 2*.

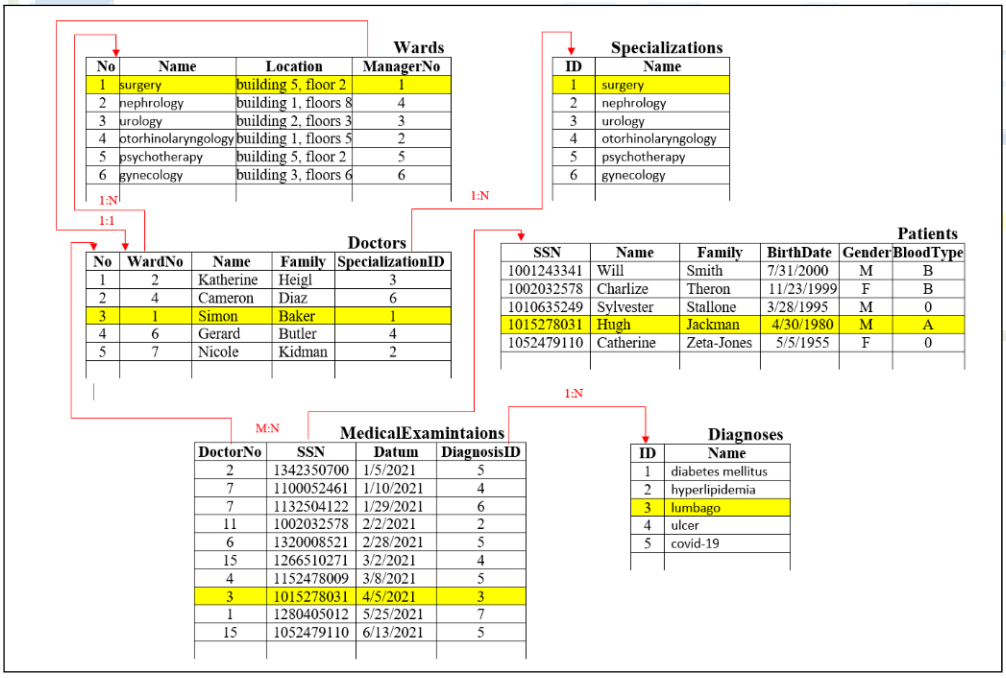

Figure 2: Structure of the sample database. (own presentation & source)

A description of the particular tables, which build the sample database, follows.

Field name	Field type	Size	Description
No	integer		An autoincrement field, which represents the number of the ward, and which will be used as *primary key.*
Name	varchar	20	Name of the ward.
Location	varchar	20	Ward location.
ManagerNo	integer		A *foreigh key*, which references to the table Doctors. It represents the doctor, who is manager of this ward.

Table 1: Table Wards. (own presentation & source)

Field name	Field type	Size	Description
No	integer		An autoincrement field, which represents the number of the doctor, and which will be used as *primary key.*
WardNo	integer		A *foreigh key*, which references to the table Wards. It represents the ward, to which the doctor belongs.
Name	varchar	12	First name of the doctor.
Family	varchar	15	Family name of the doctor.
SpecializationID	integer		A *foreigh key*, which references to the table Specialization. It represents the specialization the doctor has.

Table 2: Table Doctors. (own presentation & source)

Field name	Field type	Size	Description
SSN	integer		The Social Security Number of the patient, which will be used as *primary key.*
Name	varchar	12	First name of the patient.
Family	varchar	15	Family name of the patient.
Address	varchar	33	Patien's address.

Table 3: Table Patients. (own presentation & source)

Field name	Field type	Size	Description
ID	integer		An autoincrement field, which will be used as *primary key.*
Name	varchar	50	Name of the diagnose.

Table 4: Table Diagnoses. (own presentation & source)

Field name	Field type	Size	Description
ID	integer		An autoincrement field, which will be used as *primary key.*
Name	varchar	20	Name of the specialization the doctor has.

Table 5: Table Specializations. (own presentation & source)

Field name	Field type	Size	Description
DoctorNo	integer		A *foreigh key*, which references to the table Doctors. It represents the doctor, who made the examination. Together with the SSN of the patient it builds the *primary key.*
SSN	integer		A *foreigh key*, which references to the table Patients. It represents the examined patient, who made the examination. Together with the DoctorNo it builds the *primary key.*
Datum	date		Examination date.
DiagnosisID	integer		A *foreigh key*, which references to the table Diagnoses. It shows the diagnosis given to the patient.

Table 6: Table Medical Examinations. (own presentation & source)

The whole structure of the database, described in SQL-DDL, can be downloaded for free from the project page:

`https://www.ComHeNet.eu/IO3/opensource/DBStructure.sql`

The database file and the application can be downloaded for free from the project page:

`https://www.ComHeNet.eu/IO3/opensource/dbapplication/`

IV.2. Demonstration software for gathering data from heterogeneous sources of information

In addition to the knowledge about relational databases, the *regional health network manager* must have also knowledge of how to get data from heterogeneous sources of information, because in today's world of global digitization, almost every institution (whether public or private) has its own computer system for collecting and storing the information it needs for its activities.

For the purpose, a demonstration software was developed to assist the teaching process. This software should show students parts of a real system for exchanging semi-structured data

using microservices. During the exercises, the students can modify/redefine the structure of the data exchange protocol.

The schema of this software is shown on *Figure 3*. It represents only this part of the whole *Health Network Management Data System* (shown on Figure 1 and described in point II) where the communication between the *regional health network manager* and a *hospital* happens.

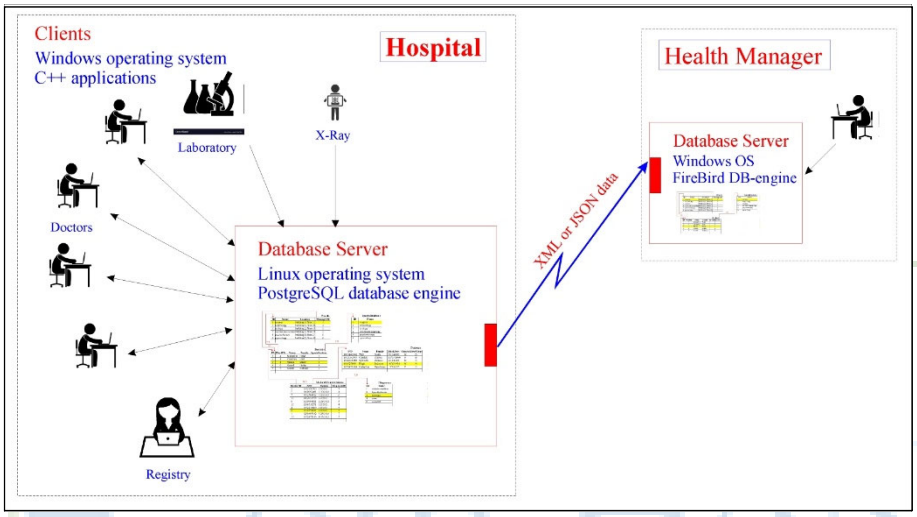

Figure 3: Gathering data from heterogeneous sources of information.(own presentation & source)

On the hospital side, a commercial software product developed by the company "Medical Information Systems Ltd." is running. This software is installed in many hospitals in Bulgaria, but software from any of the competing companies can work instead, as the principle of operation is the same.

The clients of this software, which runs on *Windows* operating system, are: doctors, laboratory, x-ray, registry, etc. They all use a common database, which is running on *Linux*. The database engine is *PostgreSQL*. Thus, the patient receives only one *bar code* at the *registry* of the hospital, and with this bar code, whichever office he goes to, the system knows what examinations and tests have been performed on him, and what their results are.

As part of the demonstration software, a microservice was developed for this system, indicated by the small red rectangle in *Database server*. It was written in the *C++ language* and compiled using the *GNU C++* compiler. This microservice runs on Linux. The source code of this service can be downloaded for free from the project page:

`https://www.ComHeNet.eu/IO4/opensource/primary_care/`

On the side of the *regional health network manager*, a microservice was developed that receives the data from the hospital, parses them, and saves them to the *regional health*

network manager's internal database. This database uses *Firebird* as database engine, which runs on Windows operating system. The microservice on the *regional health network manager* side was written in the *C++ language* and compiled using the *Borland C++* compiler. The source code of this service can be downloaded for free from the project page:

`https://www.ComHeNet.eu/IO4/opensource/health_manager/`

The full description of the data transfer protocol can be downloaded for free from the project page:

`https://www.ComHeNet.eu/IO4/opensource/TransferProtocol.xsd`

This demonstration software proves the applicability of the proposed approach for building the Health Network Management Data System.