Joint EU-MNE Programme for
Employment, Education and Social Welfare

WP 2.1 -Development of Data Warehouse model for prescription of medicines in PHC IS

DEV 2.1 - Report

"Data warehouse model for prescribing medicine in PHC"

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Monitoring the prescription of diclofenac with the aim of optimization of its safe use

The project is implemented by

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1. Introduction

Data warehouse (DW or DWH) is a system used for reporting and data analysis, and is considered a core component of business intelligence. DWs are central repositories of integrated data from one or more diferent sources. They store current and historical data in one single place that are used for creating analytical reports for anlisys.

The data stored in the warehouse is uploaded from the operational systems (in our case Primary Healthcare IS). The data may pass through an operational data store and may require data cleansing for additional operations to ensure data quality before it is used in the DW for reporting.

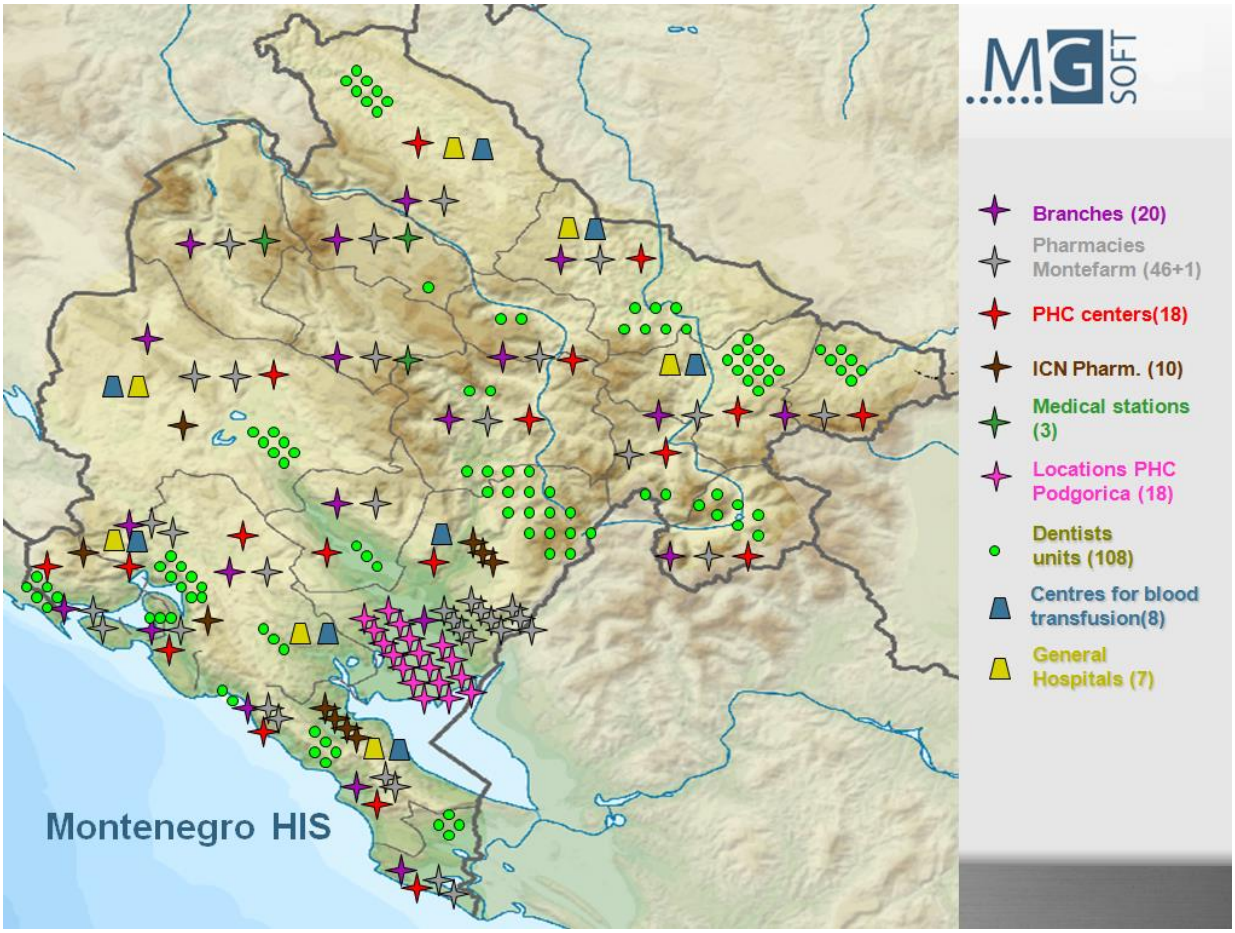
Extract, transform, load (ETL) and extract, load, transform (E-LT) are the two main approaches used to build a data warehouse system.

The main source of the data is cleansed, transformed, catalogued, and made available for use by CALIMS professionals for online analytical processing and decision support. Additionally, BI (Business Intelligence) tool on a data warehouse database will be established, which will initially be filled with prescription information from 2016 from PHC information system and will then be updated on a daily basis to monitor the effects of the project in the next stages. Users from CALIMS will be trained in usage of delivered BI tools in order to deliver needed analysis intended by the project and to successfully monitor effects of the project on daily bases.

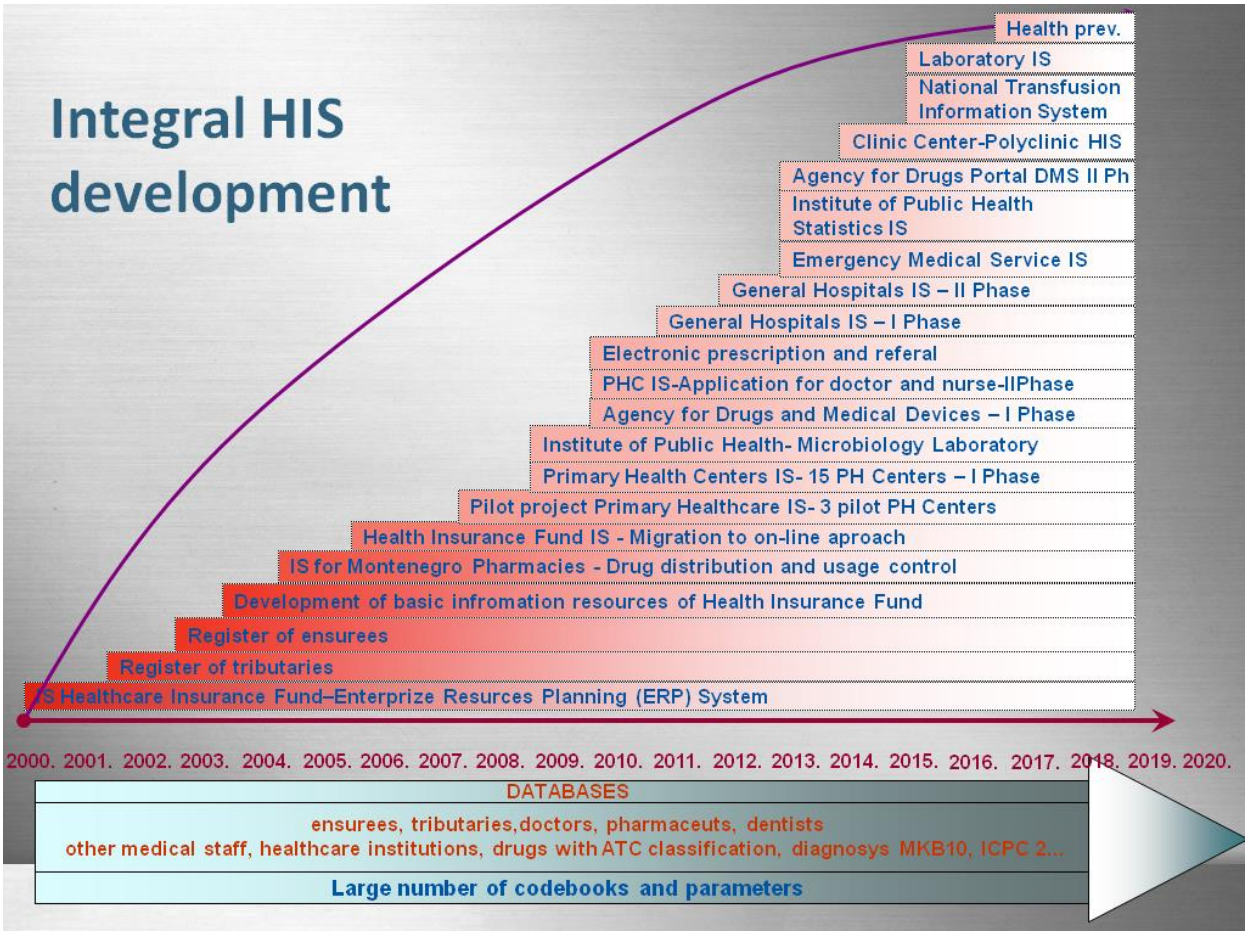
2. Data source (PHC Information System)

Data source for development of Data Warehouse for prescribing of medicines in PHC, is Information System of PHC, which is part of Integral Healthcare Information System of Montenegro.

The Integral Information System for primary healthcare is implemented at a very high technological level. It is integrated with the Health Insurance Fund, the pharmaceutical sector, with all providers of health services at primary level and completely open for connection with higher levels of healthcare and other participants of the system. The entire population of the state is included.



The patient is placed at the center of the system with evidence considering all the treatments, services and drugs that were provided by the system. This implies standardization and support of the processes "end-to-end" from the registration in Health Insurance Fund through the choice of a physician and getting all needed services and medicines from health care providers and pharmacies.



Encryption methodology for drugs is introduced by ATC, for services ICPC2 for ICD10 diagnosis.

Information system	No of Locations	No of computers	No of Application users
Health Insurance Fund	21	212	204
Montefarm Montenegro Pharmacies	45	125	314
Public Healthcare Centers (PHC) and EMSI	60	1092	2612
General Hospitals	7	572	1424
Dentist units	178	178	337
Institute for Public Health of Montenegro	1	25	51
Klinic Center of Montenegro- Polyclinic ambulants	1	45	290
Total	**313**	**2249**	**5232**

The essence of „integrity“ of the system lies in fact that it is deployed in whole country and in the fact that once data is entered into the system, it becomes available in a proper way to all segments of the system with respect to the rules of access and authority. For example, general registration data of the any insured person generated in the Health Insurance Fund database becomes available to all other subjects in the system without need for rewriting it. This approach reduces possibility for mistakes and makes easy collection of information in the system.

3. Data Warehouse model for prescribing medicines in PHC

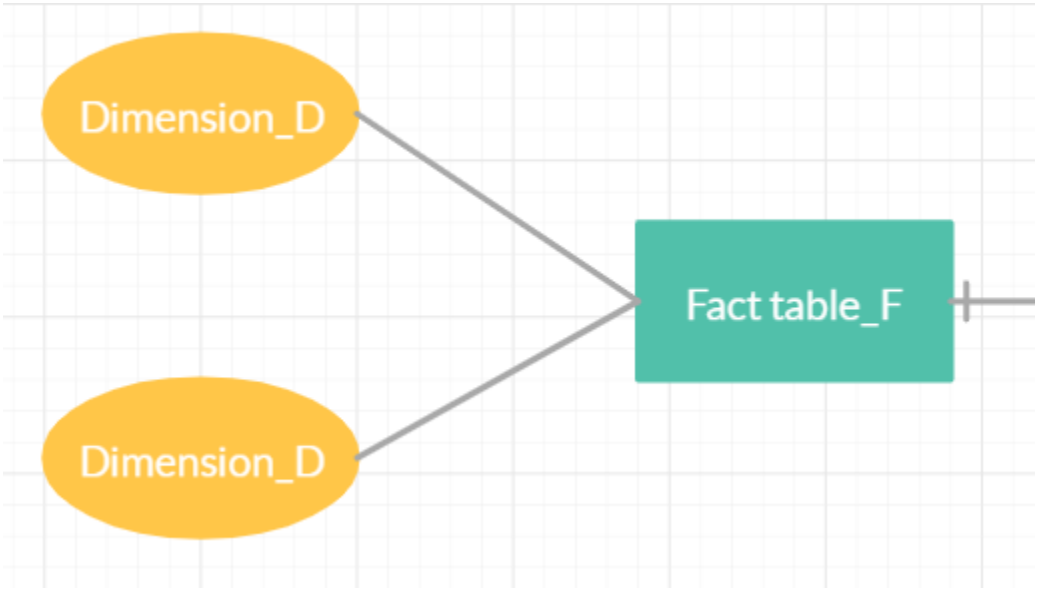
Having in mind, large data sets generated by large number of users in all segments of IHIS of Montenegro, in operational databases configured for fast insert and update of data, significant transformations of data are needed for efficient data reporting using BI tools based on Data Warehouses.

The main PHC source of the data is cleansed, transformed, catalogued, and made available for use by professionals for data mining, online analytical processing and decision support. However, the means to retrieve and analyze data, to extract, transform, and load data, and to manage the data dictionary are also considered essential components of a data warehousing system. An expanded definition for data warehousing includes business intelligence tools, tools to extract, transform, and load data into the repository, and tools to manage and retrieve metadata.

The typical extract, transform, load (ETL)-based data warehouse uses staging, data integration, and access layers to house its key functions. The staging layer or staging database stores raw data extracted from data source systems. The integration layer integrates the different data sets by transforming the data from the staging layer often storing this transformed data in an operational data store (ODS) database. The integrated data are then moved to yet another database, called the data warehouse database, where the data is arranged into hierarchical groups, called **dimensions**, and into **facts** and **aggregate facts**. The combination of facts and dimensions is called a star schema. The access layer helps users retrieve data.

Fact table consists of the measurements, metrics or facts of a target processes. It is located at the center of a star schema or a snowflake schema surrounded by dimension tables. Where multiple fact tables are used, these are arranged as a fact constellation schema. A fact table has two types of columns: those that contain facts and those that are a foreign key to dimension tables. The primary key of a fact table is usually a composite key that is made up of all of its foreign keys. Fact tables contain the content of the data warehouse and store different types of measures like additive, non additive, and semi additive measures.

Fact tables provide the additive values that act as independent variables by which dimensional attributes are analyzed. Fact tables are often defined by their grain. The grain of a fact table represents the most atomic level by which the facts may be defined. Other dimensions might be members of this fact table but these add nothing to the uniqueness of the fact records. These "affiliate dimensions" allow for additional slices of the independent facts but generally provide insights at a higher level of aggregation.



DW model for prescribing medicines in PHC, identifies following fact tables:

- **W_RECEPT_F**
- **W_EPIZODE_F**
- **W_LIJEK_F**

W_RECEPT_F contains data about medicine prescriptions by Chosen Doctors in PHC IS. Data scoupe had to be expanded to include orders to issue medicine in PHC institution (not trough prescriptions), which doctors issue to nurses to adminiter medicines to patients. Appropriate indicatior provides information which medicine is provided by prescription or by order. All other available data about prescriptions and orders is included in this fact table.

W_EPIZODE_F contains data about desease treatments provided by Chosen Doctors in PHC, to patients. Medicine prescriptions and orders are provided for desease treatments, with all information about treatment entered by Chosen Doctor. Desease treatments also include information about ICD-10 desese classification of the treatments. The ICD-10 (International Classification of Diseases, Tenth Revision) is a system used by physicians and other healthcare providers to classify and code all diagnoses, symptoms and procedures recorded in conjunction with hospital care.

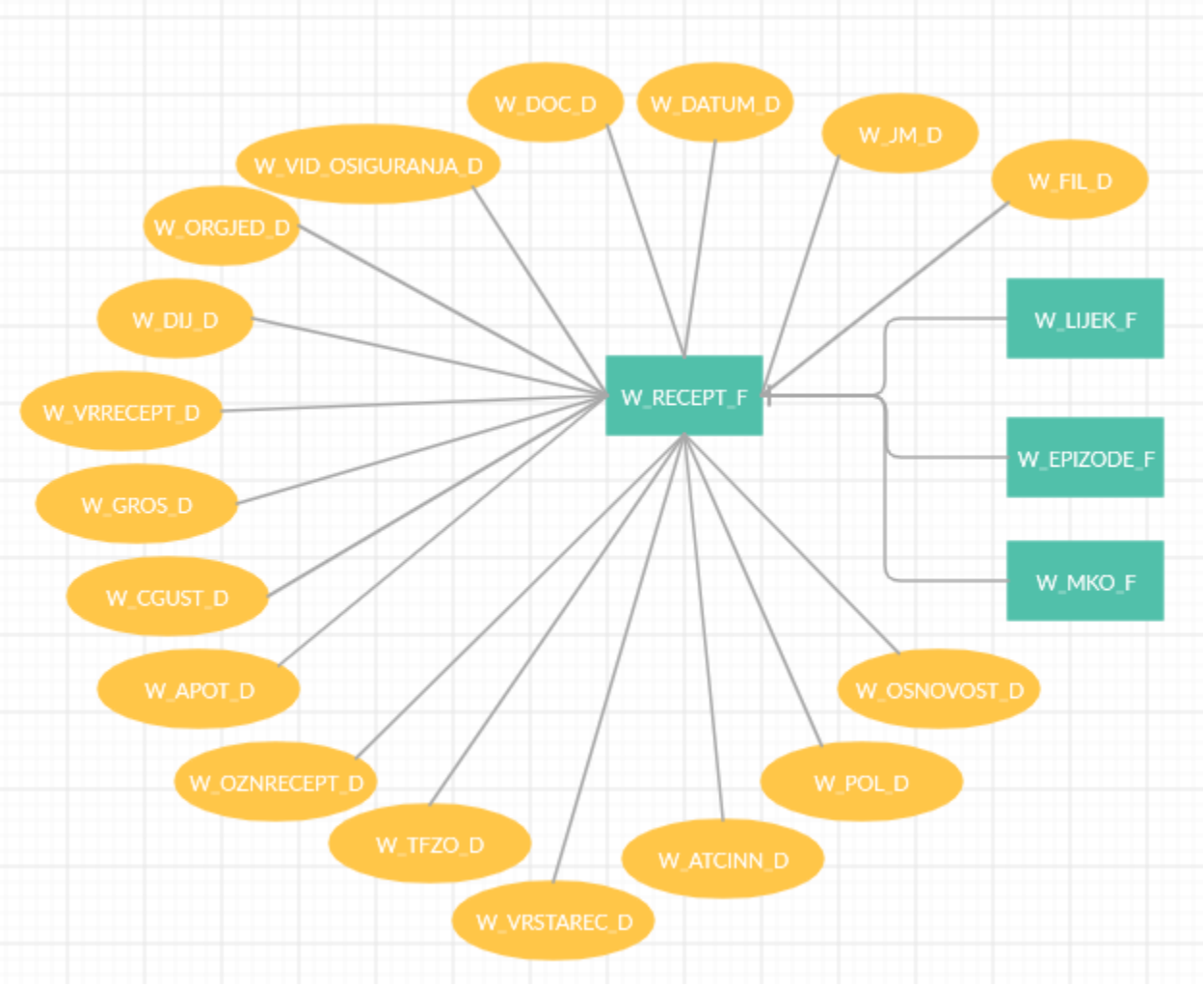
W_LIJEK_F contains all available data about medicine that is provided to the patients. Our data model include all medicines, not only diclofenac, in order to provide posibilities for analisys of medicine interactions. Also this data model is intended to be improved further for other medicine analisys not only for this project.

Eksternal fact tables iclude table with patients data (**W_MKO_F**). In this project patient data wont be shown during BI analisys and all patients will be treated as anonymus.

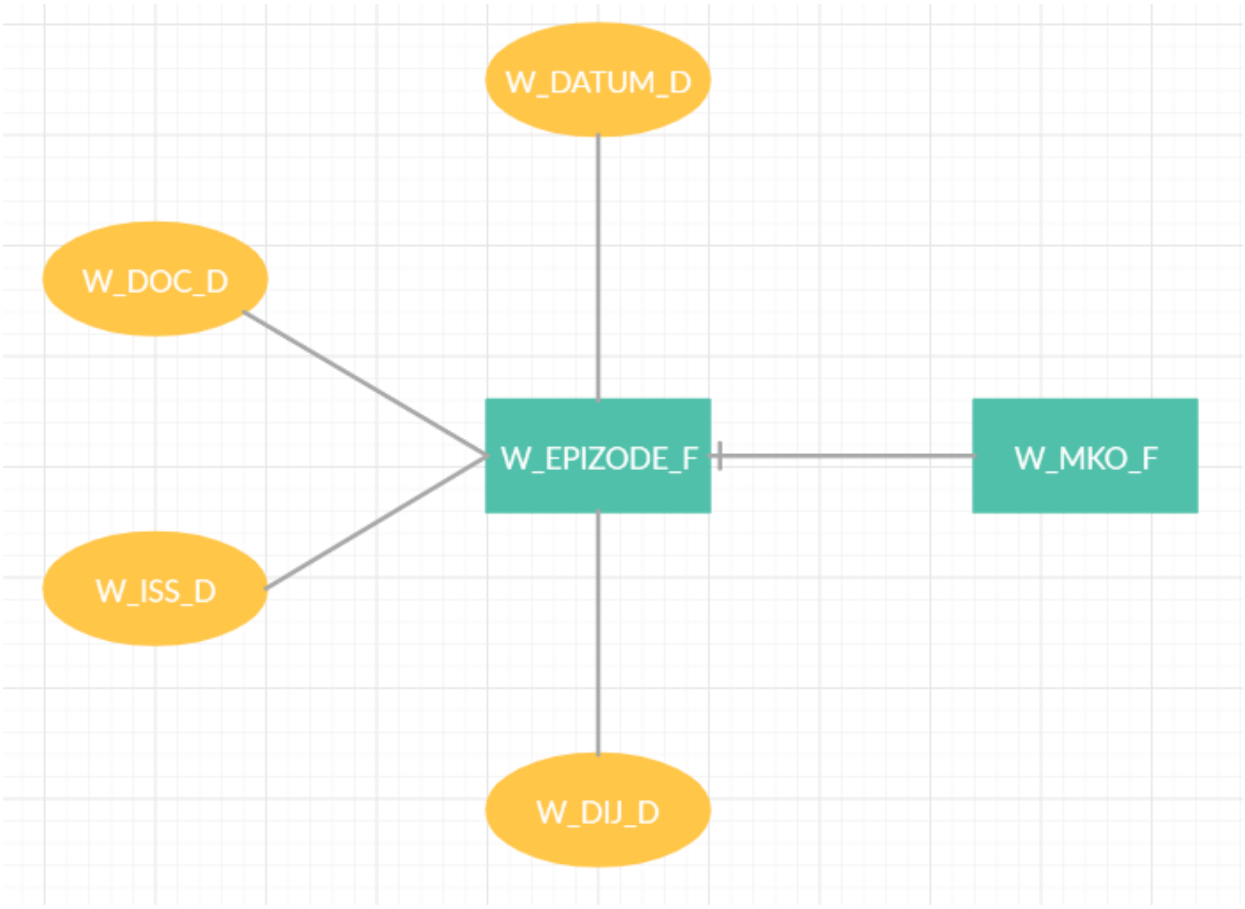
Fact tables are linked with dimensions. A dimension is a collection of reference information about a measurable event. In this context, events are known as "facts." Dimensions categorize and describe data warehouse facts and measures in ways that support meaningful answers to questions.

Dimensions that are included in DW for prescribing of medicines include all available reference information in PHC IS, that describe events during prescription of medicine process.

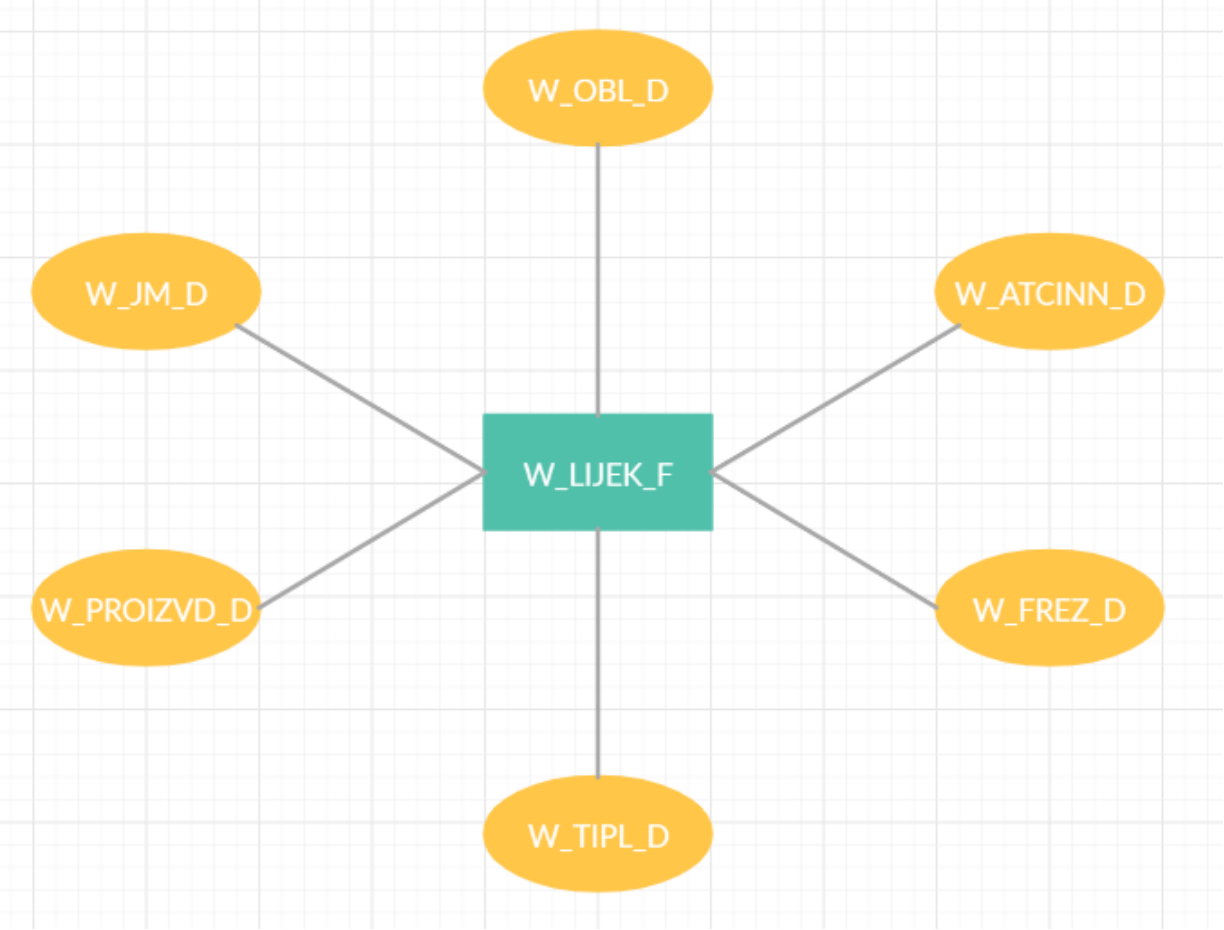
W_RECEPT_F fact table with dimensions:



W_EPIZODE_F fact table with dimensions:



W_LIJEK_F fact table with dimensions:



A dimension is a structure that categorizes facts and measures in order to enable users to answer questions.

Dimensions provide structured labeling information to otherwise unordered numeric measures. The dimension is a data set composed of individual, non-overlapping data elements. The primary functions of dimensions are threefold: to provide **filtering, grouping and labelling**.

A dimensional data element is similar to a categorical variable in statistics.

W_RECEPT_F is linked with dimensions:

- W_FIL_D
  Health Insurance Fund Branch ID,
- W_JM_D
  Measuring unit of issued medicine,
- W_DATUM_D
  Date of prescribing medicine,Date of issuing of medicine, Date of start of prescription vaildity, End date of prescription validity,
- W_DOC_D
  Chosen doctor prescribing medicine,
- W_VID_OSIGURANJA_D
  Type of medical insurance of patient,
- W_ORGJED_D
  Istitution of prescribing doctor, Organisational unit of prescribing doctor, Post of prescribing doctor,
- W_DIJ_D
  ICD-10 Diagnosys,
- W_VRRECEPT_D
  Type of prescription/order,
- W_GROS_D
  Group of Insurance of patient,
- W_CGUST_D
  Pharmacy institution,

- W_APOT_D
  Pharmacy organization unit,
- W_OZNRECEPT_D
  Prescription mark,
- W_OSNOVOS_D
  Bases of patient insurance,
- W_TFZO_D
  Is medicne payed by HIF,
- W_VRSTAREC_D
  Prescription type.

W_EPIZODE_F is linked with dimensions:

- W_DOC_D
  Chosen doctor of treatment episode,
- W_ORGJED_D
  Institution of Chosen doctor of treatment episode, Organisational unit of Chosen doctor of treatment episode,
- W_DIJ_D
  Working ICD-10 diagnosis, Final ICD-10 diagnosys,
- W_DATUM_D
  Start date of treatment episode, End date of treatment episode,
- W_ISS_D
  Treatment outcome.

W_LIJEK_F is linked with dimensions:

- W_OBL_D
  Form of packaging of medicine,
- W_JM_D
  Measuring unit of dose strength, Measuring unit of package volume,
- W_PROIZV_D
  Medicine producer,

- W_TIPL_D
  Type of medicine,
- W_FREZ_D
  HIF drug prescribing regimen,
- W_ATCINN_D
  ATC/INN code of medicine.

Fact tables also contain all available alpha-numeric data that is evidenced in PHC IS:

W_RECEPT_F	Data type	Description	Dimensions
RECEPT	VARCHAR2 (15 Byte)	Unique identifier of prescription or order ID	
LIJEKPR_ID	NUMBER(10)	Prescribed medicine	W_LIJEK_F
LIJEKIZD_ID	NUMBER(10)	Issued medicine	W_LIJEK_F
FIL_ID	NUMBER(10)	Health Insurance Fund Branch	W_FIL_D
JMI_ID	NUMBER(10)	Measuring unit of issued medicine	W_JM_D
DATIZDLIJ_ID	NUMBER (8)	Date of issuing of medicine	W_DATUM_D
SREDSTVO	VARCHAR2 (20 Byte)	Internal code for medical supplies	
MBGR	VARCHAR2 (13 Byte)	National ID of citizen (Citizen number)	
MKO_ID	NUMBER(20)	Patient ID	W_MKO_F
DATDOK_ID	NUMBER (8)	Date of report of doctor/commission which recommended issuing of medicine	
ST	NUMBER (1)	Status of prescription or order (Unprocessed , Prescribed, Issued, Canceled)	
UPOTREBA	VARCHAR2 (150 Byte)	Description of way of use	
JMLIJEKA_ID	NUMBER(10)	Measuring unit of prescribed medicine	W_JM_D
SPEC	VARCHAR2 (6 Byte)	Code of doctor/commission which recommended issuing of medicine	
KOL	NUMBER (12,4)	Prescribed quantity (number of packages)	
NAZIV_SREDSTVO	VARCHAR2 (80 Byte)	Internal name for medical supplies	
DATPRLIJ_ID	NUMBER (8)	Date of prescribing medicine	W_DATUM_D
KOLIZD	NUMBER (12,4)	Issued quantity (number of packages)	
LJEKAR_ID	NUMBER(10)	Chosen doctor prescribing medicine	W_DOC_D
VIDOS_ID	NUMBER (3)	Type of medical insurance of patient	W_VID_OSIGURANJA_D

ORG_ID	NUMBER(10)	Organizational unit of prescribing doctor	W_ORGJED_D
DIJ_ID	NUMBER(10)	ICD-10 Diagnosis	W_DIJ_D
FARM_ID	NUMBER(10)	Pharmacist issuing medicine	W_DOC_D
VRRECEPT_ID	NUMBER(10)	Type of prescription/order	W_VRRECEPT_D
UST_ID	NUMBER(10)	Institution of prescribing doctor	W_ORGJED_D
PUNKT_ID	NUMBER(10)	Post of prescribing doctor	W_ORGJED_D
GROS_ID	NUMBER(10)	Group of Insurance of patient	W_GROS_D
APOT_UST_ID	NUMBER(10)	Pharmacy institution	W_CGUST_D
APOT_ID	NUMBER(10)	Pharmacy organization unit	W_APOT_D
STAROST	NUMBER (3)	Patient age	
OZNRECEPT_ID	NUMBER(10)	Prescription mark	W_OZNRECEPT_D
OSNOVOS_ID	NUMBER(10)	Bases of patient insurance	W_OSNOVOS_D
TFZO_ID	NUMBER (1)	Is medicine payed by HIF	W_TFZO_D
AP	NUMBER (1)	Automatic cancelation (Yes, No)	
VRSTAREC_ID	NUMBER (3)	Prescription type	W_VRSTAREC_D
RECEPT_SIFRA	VARCHAR2 (15 Byte)	Prescription code	
BRPON	NUMBER (2)	Number of repetitions	
DATVAZ_ID	NUMBER (8)	Date of start of prescription validity	W_DATUM_D
ZAMJENA	NUMBER (1)	Can parallel medicine be issued (Yes, No)	
DODAT_ID	NUMBER (8)	End date of prescription validity	W_DATUM_D
DOPLATA	NUMBER (1)	Billing surcharge (Yes, No)	
CIJENAFZO	NUMBER (16,5)	Cost paid by HIF	
CIJENAOSIG	NUMBER (16,5)	Cost paid by patient	

CILJANI	NUMBER (1)	Targeted medicine (Yes, No)	
IND_DOPL	NUMBER (1)	Indicator of surcharge (Yes, No)	
IZNOS	NUMBER (16,2)	Total cost of medicine	
POL_ID	NUMBER(10)	Patient sex	W_POL_D
ATCINN_ID	NUMBER(10)	ATC/INN code of medicine	W_ATCINN_D
RAZMAK	VARCHAR2 (60 Byte)	Time interval of usage	
BRDANA	NUMBER (2)	Number of days	
DNPUTA	NUMBER (3)	Number of times per day	
DANI	NUMBER (3)	Interval in days	

W_EPIZODE_F	Data type	Description	Dimensions
EPIZODE_ID	NUMBER (18)	Unique identifier of treatment episode ID	
MKO_ID	NUMBER (20)	Unique identifier of patient ID	W_MKO_F
LJEKAR_ID	NUMBER (10)	Chosen doctor of treatment episode	W_DOC_D
UST_ID	NUMBER (10)	Institution of Chosen doctor of treatment episode	W_ORGJED_D
ORG_ID	NUMBER (10)	Organizational unit of Chosen doctor of treatment episode	W_ORGJED_D
PUNKT_ID	NUMBER (10)	Point of Chosen doctor of treatment episode	W_ORGJED_D
DIJ_ID	NUMBER (10)	Working ICD-10 diagnosis	W_DIJ_D
ODDAT_ID	NUMBER (8)	Start date of treatment episode	W_DATUM_D
DODAT_ID	NUMBER (8)	End date of treatment episode	W_DATUM_D
ST	NUMBER (1)	Status of treatment episode (Open, Closed, Canceled)	
DIJD_ID	NUMBER (10)	Final ICD-10 diagnosis	W_DIJ_D
ISS_ID	NUMBER (10)	Treatment outcome	W_ISS_D
ANAMNEZA	VARCHAR2 (4000 Byte)	Anamnesis	
MBGR	VARCHAR2 (13 Byte)	Citizen number of patient	

W_LIJEK_F	Data type	Description	Dimensions
SIFRA	VARCHAR2(15)	Medicine code	
RBR	NUMBER(5)	Medicine version	
NAZIV	VARCHAR2(70)	Protected name of medicine	
OBL_ID	NUMBER(10)	Form of packaging of medicine	W_OBL_D
BRDOZ_PAK	NUMBER (12,4)	Number of doses in the package	
DOZA	VARCHAR2 (1000)	Dose strength	
JMDOZ_ID	NUMBER (10)	Measuring unit of dose strength	W_JM_D
VOL_PAK	NUMBER (12,4)	Package volume	
JMVOL_PAK_ID	NUMBER (10)	Measuring unit of package volume	W_JM_D
PROIZV_ID	NUMBER (10)	Medicine producer	W_PROIZV_D
TIPL_ID	NUMBER (10)	Type of medicine	W_TIPL_D
PREZ_ID	NUMBER (10)	HIF drug prescribing regimen	W_FREZ_D
ATCINN_ID	NUMBER (10)	ATC/INN code of medicine	W_ATCINN_D
BRDDD_PAK	NUMBER (20,4)	Number of daily dosages of medicine in package	
CIJENA	NUMBER (16,5)	Medicine cost	
PNAZIV	VARCHAR2 (100)	Medicine full name	
DDD	NUMBER (12,4)	Daily defined dosage	

3. Conclusion

Described Data Warehouse model contains all data that are related to prescription and issuing of medicines to patients in PHC. All data that are generated in medicine prescription and issuing process in PHC, are cleansed, transformed, catalogued, and made available for use by professionals for analytical processing and decision support. However, the means to retrieve and analyze data, to extract, transform, and load data, and to manage the data dictionary are also considered essential components of a data warehousing system. Data warehousing includes business intelligence tools, tools to extract, transform, and load data into the repository, and tools to manage and retrieve metadata which will be the next step in the process of delivering appropriate Business Inteligence (BI) tools for data anlisys (DEV 2.2).

Delivered SW model will serve as a recommended model (pilot product) for monitoring of prescribing practice for other medicines of public health interest, especially when there is a reasonable suspicion that they are non-rationally prescribed and used.