Guidelines

For the course project

For the course «Practical seminar of database design»

For students of specialty 121 «Software engineering»

Створено на основі

Методичних вказівок для виконання курсової роботи з дисципліни «Проектування та експлуатація баз даних» для студентів, що навчаються за спеціальністю «Комп'ютерні науки і інформаційні технології» / Уклад. Орловський Д.Л., Чередниченко О.Ю., Вовк М.А., Копп А.М. – Харків: НТУ «ХПІ», 2017. – 44 с.

INTRODUCTION

Modern information systems are based on databases that store different information. Therefore, methods and tool used to work with databases in order to improve efficiency of human activities in any domain are developing and widely spreading these days. These tools and methods are related to generalization and various additional approaches to data processing. Basic ideas of modern information technology are based on a concept according to which data should be organized in databases in order to adequately reflect the real world that changes and to satisfy informational needs of customers as well. These databases are created and functioned under the control of specialized software that is called database management systems (DBMS).

Guidelines for the course project in discipline “Practical seminar on database design” are for students of specialty 121 “Software engineering”.

By working on the course projects, students will elaborate theoretical knowledge and practical skills obtained during lectures and practice classes.

Guidelines cover main questions related to course project implementation, report paper preparation, and defense of the course project.

1 GOAL OF THE COURSE PROJECT

The goal of the course project is to develop an application used for automation of data storing and processing tasks for a chosen domain. Such application should contain a database and an application used to solve practical tasks and oriented to an end used with no specific skills.

During the course project student should obtain skills used to solve the following problems:

- research a given domain;
- develop business rules system for a given domain;
- develop a data model intended to be implemented using a relational DBMS;
- use modern CASE tool to solve data modeling tasks;
- document designed data model;
- make motivated choice of DBMS and application development tools;
- develop a database based on the data model using the chosen DBMS;
- develop the application using modern development tools;
- debug and test the application;
- document the developed database and application;
- present results of his/her work.

2 MAIN STAGES OF THE COURSE PROJECT

2.1 Domain analysis

It is required to collect and analyze information about a certain part of enterprise which operations would be supported by a database application. Such information might be collected in the following ways:

– interviewing of employees and mostly specialists in the most important parts of an enterprise;

– monitoring enterprise activities;

– studying documents used to collect and represent information;

– using questionnaires in order to cover the wide range of users;

– using the experience in design of similar systems etc.

The core user requirements are defined using the collected information. This information is the basis for a system of business rules, a data model, and database design in general.

Information collection and analysis is the first stage of the conceptual database design which includes analysis of user requirements in order to define all required details. Amount of the collected information depends on the problem that requires automation and the current business rules of an enterprise.

2.2 Data model design

It is required to implement basic phases of the database design: conceptual, logical, and physical design.

The conceptual modeling phase includes development of the conceptual data model of the considered domain. This model should be fully independent from any implementation details, including:

– chose type or a concrete DBMS;

– structure and components of a software;

– used programming language;

– specific software or hardware platform or any other implementation details.

Therefore, the conceptual modeling phase produces a conceptual view of a database which includes definition of the most important entities and existing relationships. There should be also defined the common structure of each entity, including its attributes with domains, key attributes etc. In order to implement the conceptual data model, you can use ER/EER, IDEF1X and other modeling notations.

It is also important to analyze business processes of a considered domain, including the structure of each business process, and used information. The data flow diagrams or any other methodologies of conceptual modeling might be used to solve this problem. It is also required to start design the business rules system at the conceptual modeling stage.

The next, logical design, stage includes transformation of the conceptual data model into logical data model including the chosen type of DBMS (e.g., a relational database). This task includes solution of the basic issues related to business rules creation. The logical data model is the source for the physical design stage. It provides designer with the tools of the wide analysis of various aspects of data operations. It is urgent for an effective design solution. It is recommended to use the IDEF1X models in order to implement logical data models in this course project. There is also required to check conformance of the logical model to normalization requirements.

The physical design phase includes the final decision on the way used to implement a database. Thus, this stage is important to be done by considering all the features of a used DBMS. There is a certain feedback between physical and logical design phases. Therefore, the decisions on the physical data model might also require additional consideration on the logical data model. It is recommended to use the IDEF1X data models in order to implement the physical data model. However, other notations are also allowed.

2.3 Database implementation using a chosen DBMS

The database implementation using a chosen DBMS is a final step in the physical design phase. The database should be created using the automatically generation based on the data model (e.g., using the AllFusion Process Modeler (ERWin) or similar CASE tool) or manually. The structure of the created database should fully correspond to the designed data models. Also, there should be considered requirements and business rules, as well as the requirements based on business-logic features of a considered domain. These restrictions should be implemented using views, stored procedures, and triggers.

2.4 Application development

The application should be designed for non-technical end-users with no skills in databases. Therefore, it is required to use all the interface design tools (forms, menus etc.) and follow the user interface requirements. User interface should provide the whole set of activities of data manipulation (e.g., adding new data into a database, updating and removing existing data, and data processing) in the most comfortable way for end-users.

2.5 Experimental application usage and analysis of obtained results

Experimental application usage should confirm its correctness. There should be found and eliminated errors and functional issues that were not found during the development and testing phase. The results of experimental usage are used to define functionality of the software and, therefore, to conclude about its readiness for deployment.

It is required to pay attention to networking features of the software and analyze its behavior in concurrent environment during the experimental usage stage.

3 COURSE PROJECT STRUCTURE AND CONTENTS

This section considers the recommended structure of the course project report. The paper includes introduction, three parts, conclusion and appendices. The approximate structure of the paper is shown in appendix A.

Warning! The (…) should be replaced with the domain according to the course project task!

Let's review the short description of parts and section of the course project report.

INTRODUCTION

It includes goals and tasks that should be completed as the result of this course project, outlined relevance of a considered problem.

Approximate size – 1-1,5 pages.

Part 1 MODERN DBMS AND THEIR USAGE FOR AUTOMATION OF INFORMATION STORING AND PROCESSING IN THE FIELD OF …

The main goal of this part is to show that student have done the preliminary analysis of a domain considered in the course project, studied main trends in database design and development, existing software used to solve such problems. The part should be finished with the research problem statement, which should include goals of the course project and tasks that should be solved during the work on the course project.

Section **1.1 Database design and development trends**

This section should include a short description of the basic modern approaches to database design and development. There should be analyzed advantages and drawbacks of various data models and the conclusion about the usage of a certain data model (e.g., relational data model) should be made. Trends in the field of software design and development tools should be

analyzed, as well as the conclusion about the usage of certain CASE tools to design database should be made. There should be analyzed features of the modern DBMS considering the support of a certain architecture type (file-server, client-server) and the conclusion about the usage of a certain DBMS that support a specific architectural approach should be made.

Approximate size – 3-5 pages.

Section **1.2 Features of data storing in the field of ...**

This section provides a brief description of a domain. The main tasks related to data storing and processing, main features of information storing and processing automation tasks in a considered domain should be outlined. The main goal of the section is to outline the relevance of information storing and processing automation problem within a considered domain.

Approximate size – 3-5 pages.

Section **1.3 Review of software used for automation of information storing and processing in the field of …**

This section includes review and analysis of the software used to support automation of storing and processing data in a certain domain. The main goal of this review is to show which software exists on market, its functionality, features and shortcomings. For example, if the course project considers human resources management, it is required to outline the software used to solve the whole set of tasks or certain tasks (e.g., staff accounting) in this field. It is required to analyze outlined software examples, including functionality, domain, features and shortcomings. It is also required to denote references (e.g., Internet resources, books, articles etc.). Links to references should be used in the text. The reference should be shown in the references part and they should be prepared according to the requirements of NTU “KhPI”.

This section should contain analysis of at least 3-4 software solutions. The list of reviewed software is formed by a student and confirmed by a supervisor of the course project.

A supervisor should provide a student with the input data for search, control and analyze collected information.

A student should collect information that shows the state of art about the automation of storing and processing information in a research area, collect and arrange data about software used to solve such problems. Information should be found in printed sources (specialized literature, periodicals etc.), as well as in Internet resources.

The software review should contain the following topics.

1 Common description of a software.

2 Information about a vendor.

3 Functionality of a software – which tasks should be solved by using it.

4 Networking features of a software, work in concurrent environment.

5 Programming and customization tools (reports, forms etc.).

6 Configuration, tuning, and administration features.

Approximate size – 10-12 pages.

Warning! The review section should contain only applications used for automation of information storing and processing in a considered domain.

Hence, the review should not include the software tools such as:

– CASE tools used to analyze and model a domain, support the software development (e.g., ERWin, Visio, Visual Paradigm etc.);

– DBMS (e.g., Microsoft Access, Microsoft SQL Server, MySQL etc.);

– spreadsheets (e.g., Microsoft Excel, Open Office Calc etc.);

– text editors (e.g., Microsoft Word, Open Office Writer etc.);

– integrated development environments (Microsoft Visual Studio, Eclipse etc.).

Internet resources (web-sites, portals, forums etc.) that show information about a domain (a list of products or services etc.) should not be considered as the examples of software and, therefore, in the review. These sources might be considered as the references related to a domain. Such information might be placed in the previous section (where a domain is described).

Existing works (diploma thesis, projects etc.) found and downloaded from any Internet resources should not be used as the examples of software and should not be included in this review. Such works might be considered as the source of information about a domain.

Section **1.4 Research problem statement**

This section should demonstrate the relevance of a problem solved in the course project. It should contain the list of basic tasks of automation of storing and processing information required to be solved.

It is required to outline and describe the main goals that should be reached as the result of the course project:

1) research and description of a domain;
2) data model design;
3) selection of the DBMS and software development tools;
4) implementation of a database using the chosen DBMS;
5) application development;
6) experimental application usage and analysis of obtained results.

Approximate size – 1-1,5 pages.

Part 2 DEVELOPMENT OF INFORAMATIONAL AND SOWTWARE SOLUTION FOR AUTOMATION OF INFORMATION STORING AND PROCESSING IN THE FIELD OF …

The main goal of this part is to describe results obtained during the process of informational and software solution development. This part should contain documented results obtained during the data modeling, database development, and software development stages.

Section **2.1 Argumentation of chosen DBMS and application development tools**

This section should describe features of at least 2-3 software tools used to solve problems of data storing and processing automation – DBMS and

application development tools. In case if application development tools are integrated into a DBMS, the software development features of a DBMS should be analyzed separately. Here should be outlined the main advantages and drawbacks of considered software tools.

The section should be finished with the argumentation of the chosen DBMS and application development tools. E.g., according to the considered materials it is required to implement a database using the MySQL DBMS and integrated development environment Eclipse in order to develop an application.

Approximate size – 5-10 pages.

Section **2.2 Database development**

This sections should describe the main results of the domain analysis, database design and development stages.

Subsection **2.2.1 Domain analysis**

This subsection should describe results of the domain analysis stage. It means that main business processes should be outlined and described, main activities of each business process should be defined. The example of the possible description of business process structure is shown in appendix B.

Approximate size – 2-3 pages.

Subsection **2.2.2 Business rules system development**

This subsection should describe formalized results of the domain analysis stage shown as the business rules system. The business rules system should define the structure of informational objects of a database, as well as relations between these objects. It is recommended to keep the classification of business rules, e.g., business rules related to facts, restrictions, operation triggers, and calculations should be separated. The example of business rules system is shown in appendix C.

Approximate size – 2-4 pages.

Subsection **2.2.3 Data models development**

The conceptual data model might be shown using the ER/ERR model. The ER/ERR model should be placed as the figure in a text of the course project

report (the example is shown in appendix D). It is not necessary to include the ER/ERR model into the report.

The conceptual (logical in terms of the ERWin CASE tool) data model should be described using the IDEF1X notation. The IDEF1X model also should be placed as the figure. The example of a data model is shown in appendix E.

The logical (physical in terms of the ERWin CASE tool) data model should be described using the IDEF1X notation. The logical (physical) IDEF1X data model should be placed as the figure. It is required to consider features of a chosen DBMS while implementing this model. It is necessary to provide this model in the work. The example of a data model is shown in appendix F.

Approximate size – 2-3 pages.

Subsection **2.2.4 Database implementation**

A database should be created using the chosen DBMS and based on the data model. It is required to provide the detailed description of each relational table structure. It is recommended to describe a database structure using the tabular format. The example is shown in appendix G. It is required to describe also the purpose and structure of database views.

Besides the tables description it is recommended to provide the database scheme according the concrete implementation in a chosen DBMS. The example of a database scheme is shown in figure H.

Approximate size – 2-3 pages.

Section **2.3 Application development**

This section should describe the main results of the application development stage – purpose and functionality of the software, its basic components and relations between them. The detailed description of the software is shown in part 4.

Subsection **2.3.1 Purpose and functionality of an application**

The software should provide end users with the ability to work with a database, e.g., the users that do not have special skills in DBMS maintenance.

It is required to use the use case diagram in order to outline purpose and functionality of an application. This diagram should demonstrate basic user roles (e.g., database administrator, manager, supervisor etc.), their activities and functions. The use case diagram should be placed as the figure. The examples of use case diagrams are shown in appendix K.

Approximate size – 3-5 pages.

Subsection **2.3.2 Application structure**

This subsection should describe the main components of an application, as well as the relations between these components. The application structure might be presented using the class diagram, components diagram, deployment diagram, etc. The figure should be annotated with the description of each component.

Approximate size – 3-5 pages.

Section **2.4 Software installation**

This section should describe the procedure of software installation on the end-user's computer. This procedure should be described as the sequence of steps. It is required to describe the sequence of actions when the application is started first time (e.g., how to run program and how to shut it down).

It is recommended to outline the basic requirements to the hardware and the software: operating system (e.g., Windows 7/8/10), specialized software (e.g., MySQL 5.7 or later), processor type, minimal RAM size, free storage space etc.

Approximate size – 1-2 pages.

Part 3 USING DEVELOPED SOFTWARE FOR AUTOMATION OF INFORMATION STORING AND PROCESSING IN THE FIELD OF …

The main goal of this part is to describe obtained results of using the developed informational and software solution to solve problems in a considered domain. It should describe the sequence of actions that users could perform with

an application. Results obtained by solving practical tasks (data processing using queries, reports generation etc.) should be outlined and analyzed.

Section **3.1 User's work with the software**

This section describes user's work with the developed application. It should be considered as a part of the user's manual. This description should be detailed in order to allow user without special skills to work with the software. It should contain screenshots of application forms placed in the text as figures. The example of the application form is shown in appendix L.

Approximate size – 8-10 pages.

Section **3.2 Results obtained by using the application**

This section outlines the results obtained by using the software, including stored procedures, queries, reports. It is recommended to provide the description with the screenshots of queries results, forms and reports etc. The full list of queries and reports implemented in the software is recommended to be shown in appendix B of the course project report paper.

Approximate size – 8-10 pages.

CONCLUSIONS

Conclusions should briefly discuss the results of the course project; contain conclusions about correctness of the developed application and its applicability to solve practical problems.

Approximate size – 1-1,5 pages.

REFERENCES

References should list the sources used to complete the course project and prepare the report paper. All references should be provided with the corresponding links in the text of work. There might be printed or electronic books, scientific articles, Internet resources etc. The references should be prepared and formatted according to the requirements of NTU "KhPI".

APPENDIX A Information stored in database tables

This part should describe information entered into all database tables. The example of data entered into the database table is shown in appendix M.

APPENDIX B Information processing tools stored in the database and the results obtained while using these tools

This part should describe all information processing tools stored in the database, as well as the results obtained when they are used. This tools include queries, stored procedures, reports and other tools implemented in the database or in the software. For each tool should be outlined its purpose, source code (e.g., for queries or stored procedures), and the execution results. Tables, figures, and graphs might be used to demonstrate these results.

This structure of the report paper is recommended. It shows the necessary information that should be outlined in the report. The content and structure of the report parts should be modified in case such change is approved by the course project supervisor.

Warning! The report should be provided with information about materials developed for the course project (an archive named after the student's lastname and group number):

- **data model;**
- **database;**
- **source code of the software (according to the development tools used to implement the project);**
- **executable files of the software;**
- **full report text;**
- **presentation materials.**

4 SOFTWARE REQUIREMENTS FOR THE COURSE PROJECT

4.1 Selection of data model design tools

Data models design is the one of main stages of application development. Occurred errors may negatively affect the further phases. Therefore, it is recommended to use modern tools that allow to develop data model (conceptual, logical, and physical) rapidly, as well as to find design errors. CASE tools might be used for this purpose. The following CASE tools might be used for this purpose: AllFusion Erwin Data Modeler (or just Erwin), Visual Paradigm, Rational Rose, Sybase Power Designer etc.

4.2 Selection of DBMS

A relational DBMS should be used in this course project. The chosen DBMS should satisfy all requirements to the modern DBMS (graphical user interface, SQL support, data integrity support, data access control, security mechanisms etc.). You should consider both hardware and software requirements when selecting DBMS. It is not recommended to use a DBMS that may cause installation or maintenance issues.

Selected DBMS must be compatible with the “client-server” architecture. There are Oracle, Microsoft SQL Server, PostgreSQL, MySQL, MariaDB etc.

4.3 Selection of application development tools

You should consider compatibility of the selected tools with the selected DBMS. These should be RAD (Rapid Application Development) tools, which have integrated development environment, visual design etc. These tools might be divided into the two categories:

1 RAD tools included into DBMS. There are Microsoft Access, Microsoft Visual FoxPro etc.

2 Independent RAD tools that communicate with DBMS through specific interfaces. There are Microsoft Visual Studio, Eclipse etc.

Application development tools should be selected with considering the following factors:

– experience in usage of a certain tool;

– accessibility of a tool including freeware versions, academic licenses etc.;

– efficiency of application development including the support of visual design and development tools, built-in debugging tools etc.;

– possible consulting, support, reference materials or guidelines on usage of a certain tool.

4.4 Basic functionalities of an application

The application should allow users without specific skills (end users) to work with a database. The main functions are data modification and processing.

Data modification (entering new data, deleting or updating existing data) should be performed using application forms. End users should access data only by using application forms. The application should provide view and update operations on data stored in one or several tables. It is recommended to group forms by their functions using a menu, main form etc. It is required to control user actions using triggers. There are recommended to be implemented at least 4 – 5 triggers. Data processing should be implemented using stored procedures that contain queries used to process data and generate reports. There are recommended to be implemented at least 9 – 10 queries including at least 3 queries with sub-queries. It is recommended to use stored procedures to generate reports. Reports might include graphical materials (graphs, diagrams etc.) if it is necessary.

Software installation and execution should be simple and should not require specific skills.

5 COURSE PROJECT PRESENTATION

5.1 Course project presentation process

The course project report should be signed by supervisor. That means that student have competed the course project and allowed to present it. The report should correspond to the requirements of NTU "KhPI". The feedback provided by supervisor should outline the correspondence of the work to the assignment, originality of the work etc.

Student should also prepare presentation materials and the application developed during the course project.

It is required to use computer in order to present the course project. The presentation materials, database, and the application should be installed on the computer before the presentation is stated.

At first student should present the work using the presentation materials. A speech should include the goal of work and main results. After the speech, student should demonstrate the developed application and answer the questions.

Course project defense is public which means besides the committee any interested persons might attend and ask questions on the subject of work.

5.2 Requirements to presentation materials

Presentation materials should be included into the report as figures, tables, schemes etc. Otherwise, the presentation materials should be included as the appendices for the report.

The approximate list of the presentation materials (posters, slides).

1 Title page with the information about the subject, student (academic group code, last name and initials), scientific supervisor (position, academic title and scientific degree, last name and initials).

2 Research problem statement.

3 Brief description of a domain.

4 Sample business rules.

5 Use-case diagram (one or several).

6 Data model (conceptual, logical, and physical).

7 Structure of an application (class diagram, components diagram, deployment diagram etc.).

8 Illustration of the developed software – user interfaces, forms, reports, graphs and diagrams etc.

Total amount of the presentation materials (posters, slides) – about 10-12.

The presentation materials should be provided as printed or electronic. Materials should be printed using A4 paper on a printer. All labels and figures should be clear and readable. Handwritten materials are not allowed. Electronic materials created using the specific software (Microsoft Power Point etc.) are demonstrated using a computer.

The presentation materials should be comfortable for perception as much as possible. Therefore, the amount of text information should be minimal.

5.3 Requirements to the speech

The speech is intended to outline the goals of the course project, show and describe the main stages and obtained results. It should take about 5 minutes. In case if the time limit is exceeded, the speech can be interrupted by the committee regardless of its completeness.

Student should use the presentation materials during the speech only for the illustration purposes.

Warning! It is not allowed to read text information shown in the presentation materials. This might be considered as the inappropriate preparation and might cause decrease of the final score.

After the speech student demonstrates a developed software.

5.4 Requirements to demonstration of the application

It is required to demonstrate correctness of the developed application, its functionalities, convenience etc.

Student should demonstrate the use cases related to data modification and processing. Student should be able to modify the software if it is necessary.

6 COURSE PROJECT EVALUATION CRITERIONS

The feedback from scientific supervisor is one of the most important criterions for the course project evaluation. There should be outlined:

- relevance of the work;
- completeness of the work;
- originality of the work;
- obtained results;
- evaluation of the work.

The following factors might also affect the final score.

1 Errors in data models and database structure including:

– a data model and/or database structure does not correspond to a domain;

– a data model does not describe features of a domain completely, therefore, the data models is not adequate to a problem solved in the course project;

– a data model does not correspond to a database structure;

– the normalization rules are violated – all database tables should correspond to the requirements of at least third normal form. In case if normalization rules are violated (e.g., atomicity requirement is ignored), this should be described and explained, as well as the way to fix such issues should be demonstrated.

2 Poor presentation materials that do not describe features of a domain, obtained results, have a lot of text information etc.

3 Errors, defects, issues in a software found during the demonstration. There might be the following drawbacks:

– end user actions are not controlled enough, so it is possible to intentionally insert incorrect date or delete important data etc.;

– incorrect exceptions processing, error messages that are not understandable for the end user;

– concurrent access issues etc.

Poor quality of the user interface, e.g.:

– intuitively incomprehensible elements of the user interface including labels that do not correspond to a domain etc.;

– violations of ergonomic requirements to the user interface – the inconvenient placement of control elements (e.g. forms, buttons, menus, lists, checkboxes) decreases efficiency of the end user work with the software etc.;

– requirements for the end user to remember codes and commands instead of using the elements of graphical user interface.

4 Poor presentation of the course project.

5 Student's answers are not provided or inadequate to the questions of the committee members.

6 Poor quality of the report including violations of the preparation rules, corrections, grammar and other mistakes etc.

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APPENDICES

APPENDIX A

Approximate structure of the course project report

APPENDIX B

Example of the business process structure description

This example shows the fragment of business process related to product supply.

1 Create order for product supply
   1.1 Define products to be ordered
   1.2 Define list of suppliers
   1.3 Analyze prices proposed by suppliers
   1.4 Analyze possible terms of supply
   1.5 Select a supplier
   1.6 Send order to the supplier
   1.7 Receive confirmation from the supplier
2 Agree terms and payment options with the supplier
   2.1 Agree supply terms
   2.2 Agree payment options
   2.3 Agree payment terms
   2.4 Conclude a contract
   2.5 Pay or produce the invoice
3 Product delivery
   3.1 Find transportation provider
   3.2 Conclude a contract for transportation
   3.3 Pay for transportation services
4 Receive supplied products
   4.1 Check order fulfillment and product quality
   4.2 Prepare documents
   4.3 Receive supplied products to the warehouse

APPENDIX C

Example of business rules system

This example demonstrates the fragment of business rules system defined for the domain of product supply.

The following business rules system is defined as the result of domain research and analysis.

There are following facts.

1 Each supplier is described using the name and address. Unique code is used to identify each supplier.

2 Supplied products belong to various product groups. Each product group is described using the code and name. Unique code is used to identify each product group.

3 Each product is described using the code and the name. Unique code is used to identify each product. Each product is assigned to the particular product group.

4 Each product supply is based on the contract concluded with the specific supplier. The number of each contract is unique. The date is specified for each contract.

5 Each contract defines supplied products and corresponding amounts. The same product cannot be supplied twice within a single contract.

There are following restrictions.

6 As the business entity supplier can be either legal entity or individual entrepreneur.

7 The tax payer number is unique for legal entities.

8 Each contract is assigned to the particular supplier. It is not allowed to skip the data about supplier.

9 The date of contract is required. If the date is not specified, the current date should be used.

10 The amount of supplier product is always specified. It cannot be zero or negative.

11 The price of the supplied product is always specified. It cannot be zero or negative.

There are following operation triggers.

12 When adding data about the supplier as the legal entity, it is required to check is if the data about this supplier as the individual entrepreneur has already been entered. If so, the operation is prohibited.

13 When adding data about the supplier as the individual entrepreneur, it is required to check is if the data about this supplier as the legal entity has already been entered. If so, the operation is prohibited.

There are following conclusions.

14 The account is considered as expired if the payment has not been completed within 30 calendar days from the moment of sending the order.

15 The order is considered as unfulfilled if supplier has not sent an order within 5 calendar days from the moment of receiving the order.

APPENDIX D

Example of an ER model

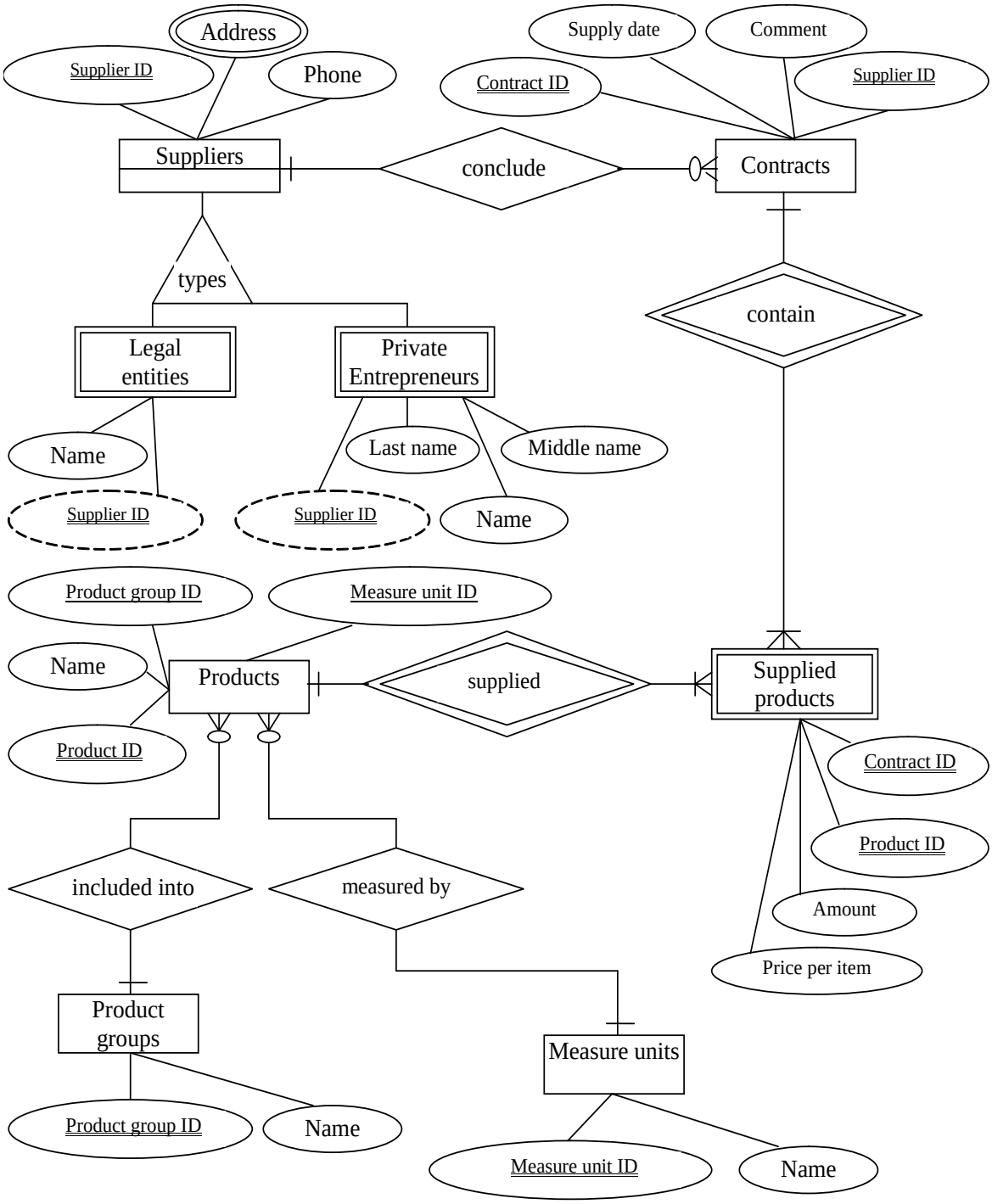

Figure D.1 – ER data model

APPENDIX E

Examples of a data model (using the IDEF1X notation)

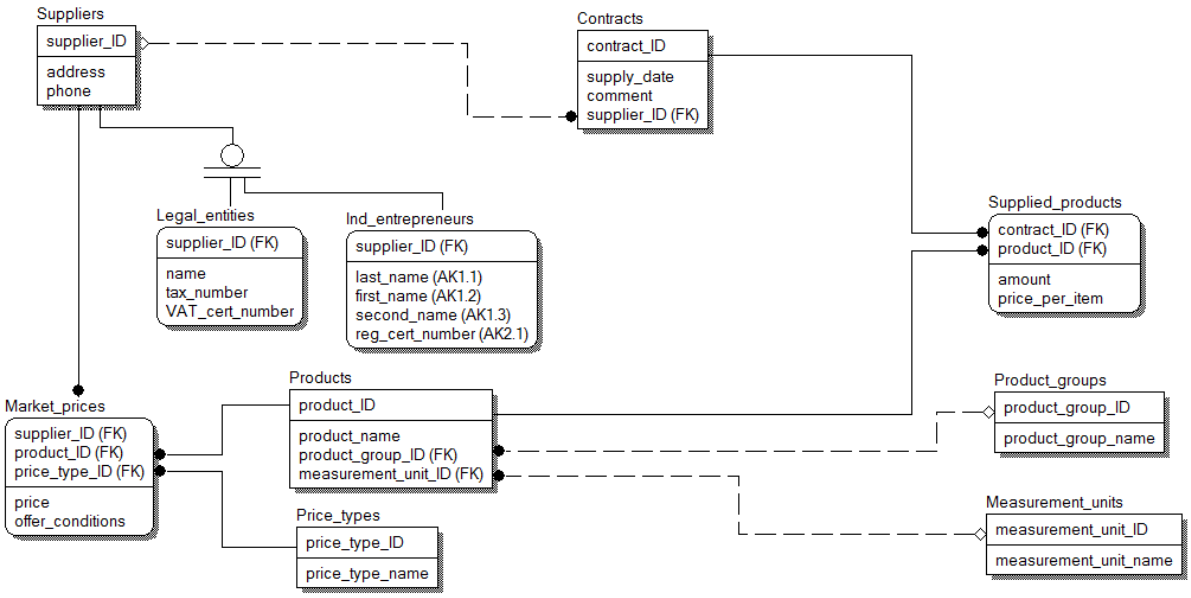

Figure E.1 – Conceptual (logical) data model

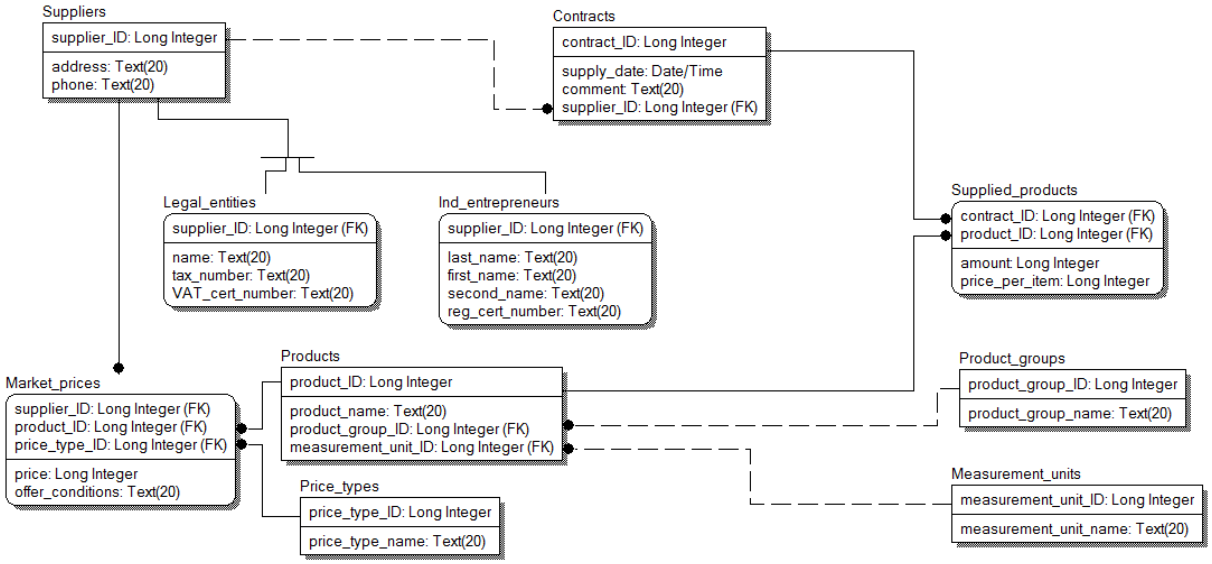

Figure E.2 – Logical (physical) data model

APPENDIX F

Example of description of a database table structure

The table “Contracts” is required to store information about contracts. Each record in this table contains the following fields shown in table F.1.

Table F.1 – Description of the database table “Contracts” structure

Key	Field name	Data type	Field size	Description
PK	ContractNumber	Number	Integer	contract number
	ContractDate	Date/time	Short date	contract date
FK	SupplierID	Number	Integer	supplier unique identifier
	ContractName	Text	50	contract name
	Comment	Text		note

The table “Supplied” is required to store information about products supplied according to the contracts. Each record of this table contains the following fields shown in table F.2.

Table F.2 – Description of the database table “Supplied” structure

Key		Field name	Data type	Field size	Description
PK	FK	ContractNumber	Number	Integer	contract number
	FK	ProductID	Number	Integer	product unique identifier
		Amount	Number	Integer	product amount
		PricePerItem	Number	Single double	price per item of product

APPENDIG G

Example of a database scheme
(using the MySQL DBMS)

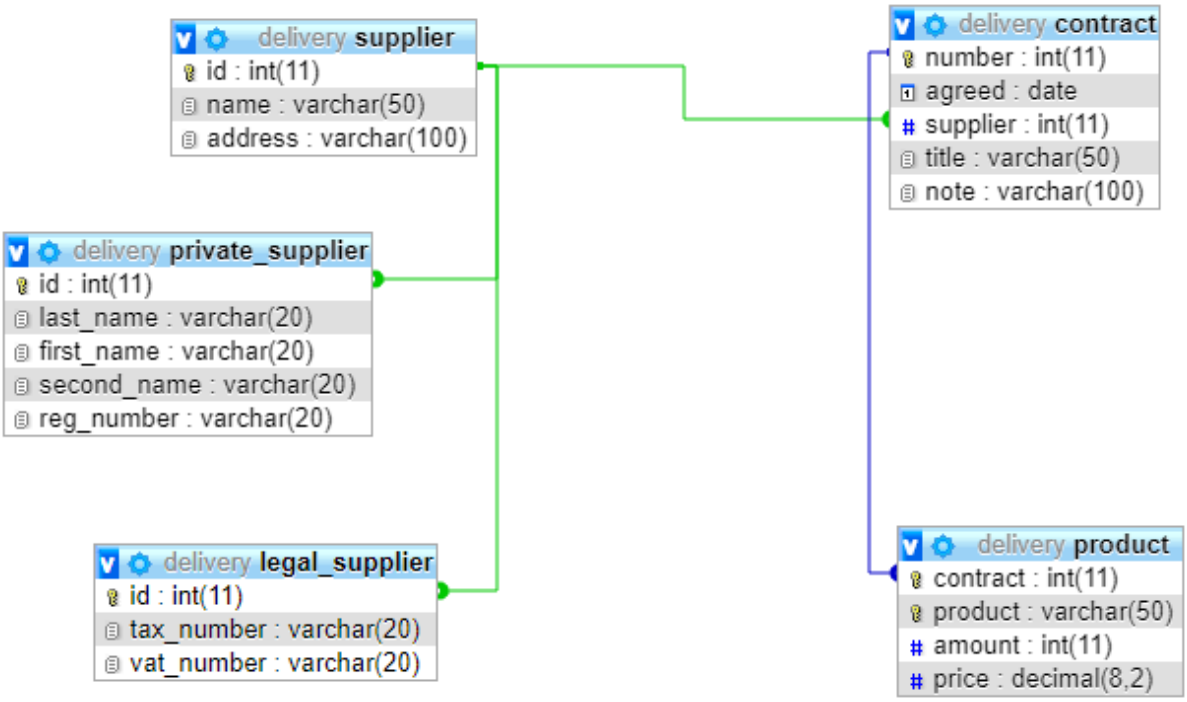

Figure G.1 – Database scheme implemented using the MySQL DBMS

APPENDIX H

Example of a use-case diagram

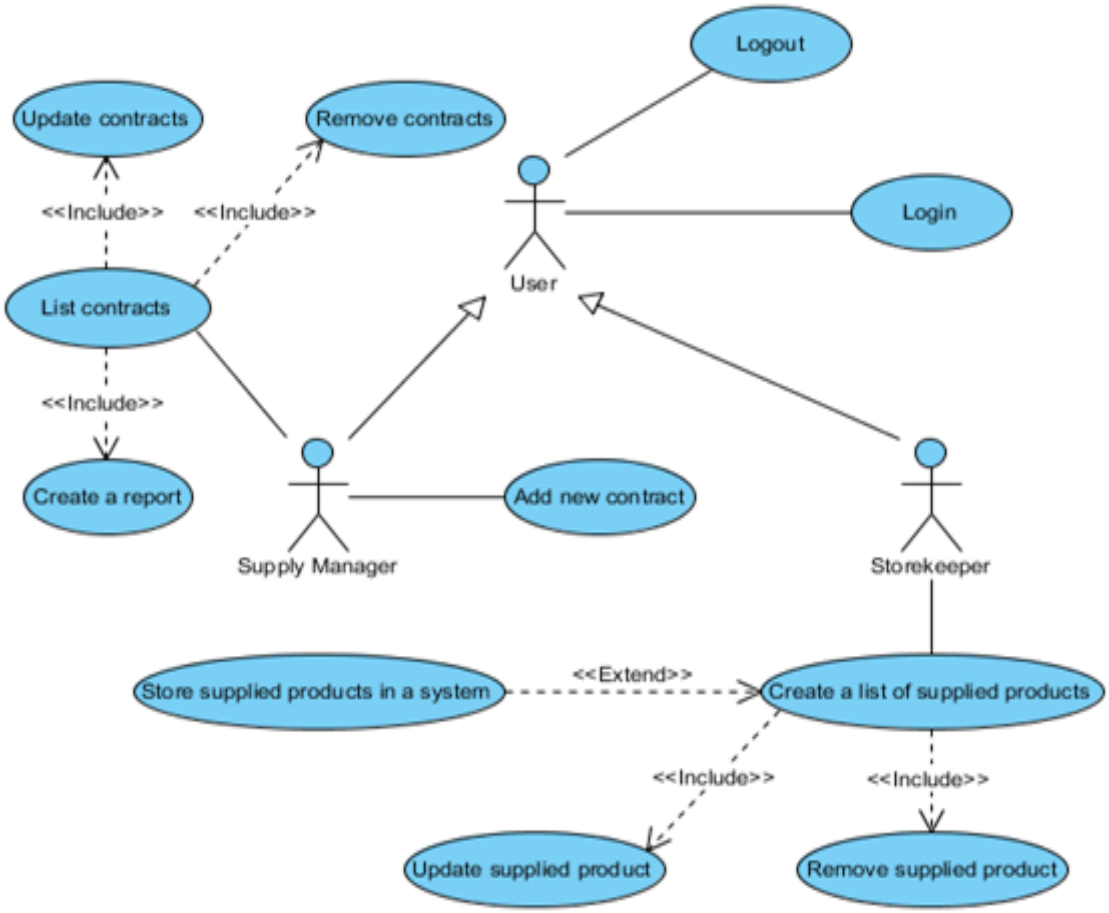

Figure H.1 – Use-case diagram for user functionalities

APPENDIX K

Example of an application form

User: *manager* | Logout

Contracts

New contract Export data

Contract number	Contract date	Supplier	Note	Action
1	2018-09-01 00:00:00	Petrov Pavlo Petrovych	Order 34 on 30.08.2018	Update Delete
2	2018-09-10 00:00:00	Petrov Pavlo Petrovych	Invoice 08-78 on 28.08.2018	Update Delete
3	2018-09-23 00:00:00	Ivanov Illia Illych	Order 56 on 28.08.2018	Update Delete
4	2018-09-24 00:00:00	Interfruit Ltd.	Order 74 on 11.09.2018	Update Delete
5	2018-10-02 00:00:00	Interfruit Ltd.	Invoice 09-12 on 21.09.2018	Update Delete
7	2018-12-27 13:30:04	Petrov Pavlo Petrovych		Update Delete
13	2019-01-10 13:20:48	Transservice LLC	Order #9876	Update Delete

Figure K.1 – Application form “Orders”

User: *storekeeper* | Logout

Supplied products

by contract 13 - Transservice LLC (2019-01-10 13:20:48) ▾

Product	Amount	Cost	Action
TV Set	10	19799	Remove
Audio Player	23	1499	Remove
Printer	15	5899	Remove

Store products

New product

Product	Amount	Cost
Monitor	18	3999

Add product

Figure K.2 – Application form “Product supplies”

APPENDIX L

Example of data stored in a database

Table L.1 – Data stored in the table “Contract”

Contract number	Contract date	Supplier ID	Contract name	Comment
1	01.09.1999	1	Reason – invoice № 34 on 30/08/99	Contract № 1
2	10.09.1999	1	Reason – invoice № 08-78 on 28/08/99	Contract № 2
3	10.09.1999	3	Reason – invoice № 08-78 on 28/08/99	Contract № 3
4	23.09.1999	3	Reason – order № 56 on 28/08/99	Contract № 4
5	24.09.1999	2	Reason – invoice № 74 on 11/09/99	Contract № 5
6	01.10.1999	1	Reason – invoice № 09-12 on 28/09/99	Contract № 6

contract_number	supplied_product	supplied_amount	supplied_cost
1	Audio Player	25	700.00
1	New Product	15	100.00
1	TV	10	1,300.00
1	Video Player	12	750.00
2	Audio Player	5	450.00
2	Stereo System	11	500.00
2	Video Player	8	450.00
3	Audio Player	11	550.00
3	Monitor	85	550.00
3	TV	52	900.00
4	Audio Player	22	320.00
4	Printer	41	332.50
4	TV	56	990.00
5	Audio Player	33	580.00
5	TV	14	860.00
5	Video Player	17	850.00
7	Phone	5	5,999.00
7	TV	10	2,999.00

Figure L.1 – Data stored in the table “Supplied”