MODEL-DRIVEN DEVELOPMENT OF ONLINE SYSTEM FOR E-COMMERCE

МОДЕЛНО-УПРАВЛЯВАНА РАЗРАБОТКА НА ОНЛАЙН СИСТЕМА ЗА ЕЛЕКТРОННА ТЪРГОВИЯ

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Abstract: *Nowadays E-commerce is gaining more and more popularity, it contains all possible financial and trade transactions which are made via computer networks. Model-driven software development (MDSD) is the key to create the exact and accurate software application. All the necessary information is taken from a database. The most widely used database management system is MySQL. The latter is an open-source relational database management system, which is written in C programming language. In order to clarify the working process of an organization, a UML class diagram is created. The UML (Unified Modeling Language) is used for making graphical visual models for all the business processes. The paper presents the main stages of e-commerce transaction, using E-shop as an example.*

Keywords: ELECTRONIC COMMERCE, MODEL-DRIVEN SOFTWARE DEVELOPMENT, DATABASE, MYSQL, UML.

1. Introduction

Internet becomes more attractive environment for business development. It offers attractive methods and tools for implementation of marketing, advertising and commerce. Business on the Internet is gradually becoming an integral part of economic life and becomes a daily routine for everyone. The reason for this is that networks have changed the way of communication for millions of users having access to the Internet and there are no limits caused by time and space. Online shopping has become an integral part of the economy of any country. Recent researches show that external trade has grown around 18,3 % in comparison to 2014, which means, that money turnover has measured up 1,35 trillion US dollar in 2015. [1]

Model-driven development (MDD) is a paradigm for writing and implementing computer programs quickly, effectively and at minimum cost. The methodology is also known as model-driven software development (MDSD) and model-driven architecture (MDA) [2]. Stages of creating model in MDD: defining boundaries, structuring solution, designing the domain model. MDD operates using UML (Unified Modeling Language). It is a standardized object-oriented language for graphical modeling of the architecture and functionality of software applications. It is a family of graphical notations, united by a common meta-model that support the description and design of Object Oriented software systems. Based on unified symbolic names and semantics, UML defines a set of diagrams and notations for modeling object-oriented systems [3, 4]. The unified language can be used for modeling of different in types, volume and destination systems, hardware and /or software, technical and /or public, real and /or virtual. Based on the development and use of different types of diagrams different viewpoints and aspects of states, functioning, relationships and interactions of these systems can be modeled.

The main aim of the paper is to apply an MDD approach for development of on-line system for e-commerce. The paper is structured in 5 parts. After the introduction, in part 2 a short analysis of E-commerce structure and business processes involved are proposed. Part 3 describes the main features of databases, MySQL, UML and class diagrams. In Part 4 the suggested approach is represented. At the end, some conclusions are made.

2. Short analysis of E-commerce structure and involved business processes

E-commerce is a continuous cycle of data processing and exchange, realizing a unified and integrated information support of all participants in the overall commercial transaction, whatever their field of activity, sector, country, and so on. More formally, it focuses on digitally enabled commercial transactions between and among organizations and individuals carried out in real time via telecommunications networks [5]. The term "e-commerce" is widely used, as it includes virtual examination of goods, selecting products to purchase and choice of payment methods. In e-commerce there is no prior agreement between the parties - client and vendor. It is performed over the Internet using a technology developed for sharing, access and data storage. E-commerce covers out open processes with customers, suppliers and external partners. These include: marketing, taking orders, shipping, customer service, purchasing of raw materials for the production and supply.

Applications for e-commerce from type "business-customer" are similar to business operations, supporting e-commerce from type "business-business", but are usually associated with retail trade, i.e. purchases by end users. As a type of economic activity, E-commerce consists of different business processes. A business process is a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers [6]. The basic processes related to electronic commerce are shown in Fig.1 and are the following:

Visiting the website: Main objective of this process is to attract potential customers to the site by using Internet. Banner ads sending targeted emails, giving away prizes and other activities have an important role in the trade cycle. A new trend is the creation of societies whose goal is the formation of environment for attracting visitors through discussion forums, surveys, chats and others. Customers in e-commerce are served by a website i.e. customer e-shop is a member of the global network. User is an individual whose goal is to pay by credit or debit card and receive the goods at home.

Review of electronic catalog: Unlike traditional trading after the initial visit, the client began building their profile, i.e. draw in opinion about goods interested at. The process then continues with the examination of electronic catalogs containing information on individual goods and services. What's important at this stage is the customer interest at the application or e-commerce site to offer sales, advertising campaigns, new or improved goods.

Selection of goods and services: This phase of e-commerce includes the selection of goods by the customer. The e-commerce must have a well developed management system that preserves the current status of the order (usually in the form of shopping cart), which contains information about the quantity and price of goods.

Placing an order. The next stage is the shaping of the order. In the model business-customer, purchaser enters address data for delivery and shapes the way of payment. It can introduce additional requirements of the customer in the form of a note (packing the purchase as a gift, time delivery and more. ancillary services).

Shaping of payment and delivery. After receiving the information about the place of delivery and payment, e-shop determines the value of goods and delivery costs. The program can be improved by developing opportunities for international contracts (regarding distance in determining the value of the supply).

Payment. After calculating the value of goods and delivery costs, presents bill payment from the buyer. Depending on the customer's wish credit, debit cards or cash can be used. There is a protection when transferring data over the network between the buyer and the online store in order to protect personal data and verify their authenticity.

The next steps are **order processing**, **order execution**, and its **delivery**, which is the final stage of e-commerce type of business.
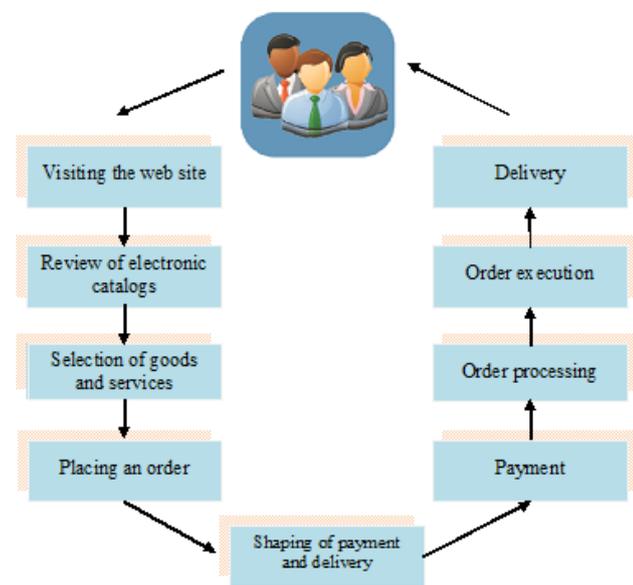

Fig.1: Main processes in an e-commerce application

3. Short review of the applied techniques

3.1. Unified Modeling Language (UML)

In order to apply MDD, the Unified Modeling language (UML) is used. It is a standardized modeling language enabling developers to specify, visualize, construct and document artifacts of a software system [3]. Thus, UML makes these artifacts scalable, secure and robust in execution. It uses graphic notations to create visual models of software systems. UML is designed to enable users to develop an expressive, ready to use visual modeling language. In addition, it supports high level development concepts such as frameworks, patterns and collaborations. UML presents different types of diagrams, used for different purposes. The variety of UML diagrams is shown on Fig.2 [8].

A class diagram is at the heart of UML. It represents the core purposes of UML because it separates the design elements from the coding of the system. UML was set up as a standardized model to describe an object-oriented programming approach. Since classes are the building blocks of objects, class diagrams are the building blocks of UML. The diagramming components in a class diagram can represent the classes that will actually be programmed, the main objects, or the interaction between classes

and objects. The class diagram is composed of three sections [9] (an example of a class "order" from an UML class diagram is presented on Fig.3):

- Upper section – includes the name of the class. This section is always required whether you are talking about classifier or an object.
- Middle Section – contains the attributes. They are variables which describe the qualities of the class. This is only required when describing a specific instance of a class.
- Bottom section – contains the operations (methods) which describe how a class can interact with data.
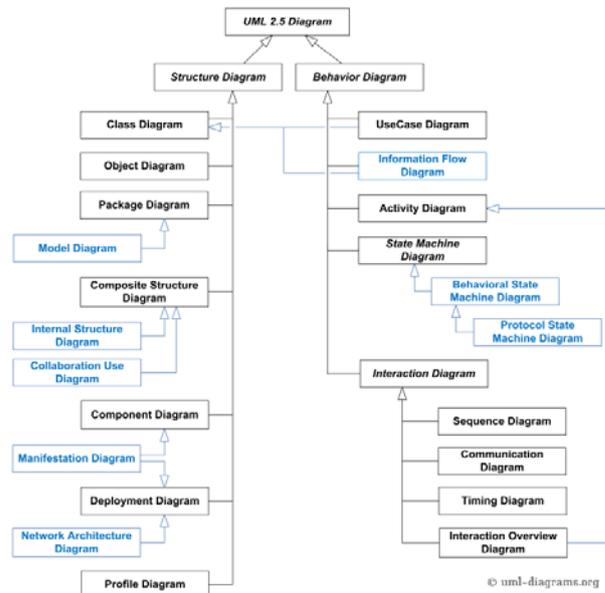

Fig.2: The structure of diagrams which could be made using UML [8]

All classes used in the diagram are connected between each other via relationship. In UML there are different types of relationships, the main types of them are as follows [9]:

- Dependency – the basic type among the objects;
- Association - represents a family of links;
- Aggregation - a variant of the "has a" association relationship;
- Composition - a stronger variant of the "has a" association relationship;
- Generalization - indicates that one of the two related classes is considered to be a specialized form of the other;
- Realization - is a relationship between two model elements, in which one model element (the client) realizes (implements or executes) the behavior that the other model element (the supplier) specifies.
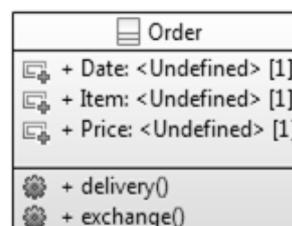

Fig.3: The example view of the Order class in the created class diagram

3.2. Database management system MySQL

An information system for e-commerce is a system that implements automated collection, processing and manipulation of data and includes technical resources, software and maintenance labor force [10]. It includes a computer system, one or more databases (DB), a database management system (DBMS) and a set of applications (software). The database provides information

storage and it is a renamed set of information sorted by certain rules, including the general principles of description, storage and manipulation of data. A database management system is a selection of software and a variety of language resources designed for creating, maintenance and using of database [10]. The main functions of DBMS are as follows [11]:

- Information storage and protection;
- Changes (updating, adding and deleting) of the stored data;
- Information search and selection according to users' requests;
- Processing the information and displaying the results.

The development of e-commerce applications is based on a variety of technologies, according to the specific characteristics and complexity of application. The combination of PHP programming language and database management system MySQL is widely used in the development of professional web applications, since both products are highly compatible.

PHP programming language is placed on a web server and can be installed in addition to the most widespread software packages to serve web applications (Apache, Internet Information Server, TomCat and others). One of the biggest advantages of this language is that it is platform independent - a program written in this language can be performed on almost all operating systems (Windows, Linux MacOS and others).

Since the application requires a database to store product information, photos of products, customer information, order information of customers and others the use of DBMS is needed. One of the most versatile DBMS is MySQL, which is a freeware DBMS. One of the main advantages of MySQL is that there is very good support. Furthermore, the use of this non-commercial database management system does not require a license. Another advantage is that it supports client-server mode and embedded into the database procedures and triggers (a procedure that is performed automatically in the case of data change). But the biggest advantage is that the system is open source, which allows bugs to be removed immediately. This leads to much greater stability of the software – i.e. this is due to the good reputation of this software.

4. Description of the suggested approach

Throughout the working process on the paper, on-line clothes renting system was chosen as an example of E-commerce.

In order to follow the MDD type of creating software application, the developer's focus was drawn to the model. In this case, the UML model was created in the Visual Paradigm tool. Class diagram was chosen from the variety of UML diagrams. Class diagram helps to make the visual implementation, shows the relations and operations between classes. It is commonly used for modeling of business processes. In this particular example, on Fig.4, the model of on-line clothes rent system is built. The main classes are: customer, clothes, and purchases. All other classes are secondary - they provide appropriate function of the whole system. Currency and currency rate make the purchases more individual for each customer. Class of sizes, and designers spread the variety of goods which are offered to users. Customer's login and purchases delivery help developer to monitor and control the working process of the system. All the components are connected and have their particular role.

To describe one of the business flows inside the system, activity diagram was created using the "Visual Paradigm" tool, and is shown on Fig.5. The process begins with the customer's request for purchase, in this case the order is made, after the system receives the order form, it sends a message about order processing. Next step is receiving payment from the customer

and closing the order process. Order process connects to delivery process which connects to the customer, and the cycle begins.

All the data which is used and will be used during the development of the exact working process is stored in the database. MySQL was chosen for this purpose as one of the most protected type of DBMS. Using extended entity–relationship model (EER-model) gives opportunity to show results of the work in more structured view than making list of tables. The EER model in computer science is a high-level or conceptual data model incorporating extensions to the original entity–relationship model, used in the design of databases.

The ER diagram is shown below on Fig.6. This diagram represents all the tables which are used in the database and shows all the relationships between them. The diagram shows the relationships between tables. Tables contain the main information about type of clothes, sizes, designers, prices, delivery and customers. It is quite important to have all of this data and to make the correct correlation between them. For instance, table "designer_clothes" has information about one specific type of clothes and designer who made the goods. Moreover, this data is used for table 'prices' and it is connected to purchases. Thus, it is clearly shown that all information is correlated. All connections have to be predicted and measured.

5. Conclusions

The main purpose of the work was to start developing of a software application using model-driven development approach. This means that the great attention was devoted to models. UML was used as the more common and automatized graphical implementation of models. Class diagram was chosen to represent classes and relations between them. Activity diagram was created to give an example of possible business process within the system. Also important stage of the development is creating database as storage for all useful information which is used and will be used in further expands of the system. For convenience, database is presented as ER-diagram, which shows all tables and correlations between them. E-commerce development is now becoming even more relevant and MDD is widely spread for developing different types of software. The paper is a base for further researches in the field of on-line commerce, such as amplification and making company's web-site.

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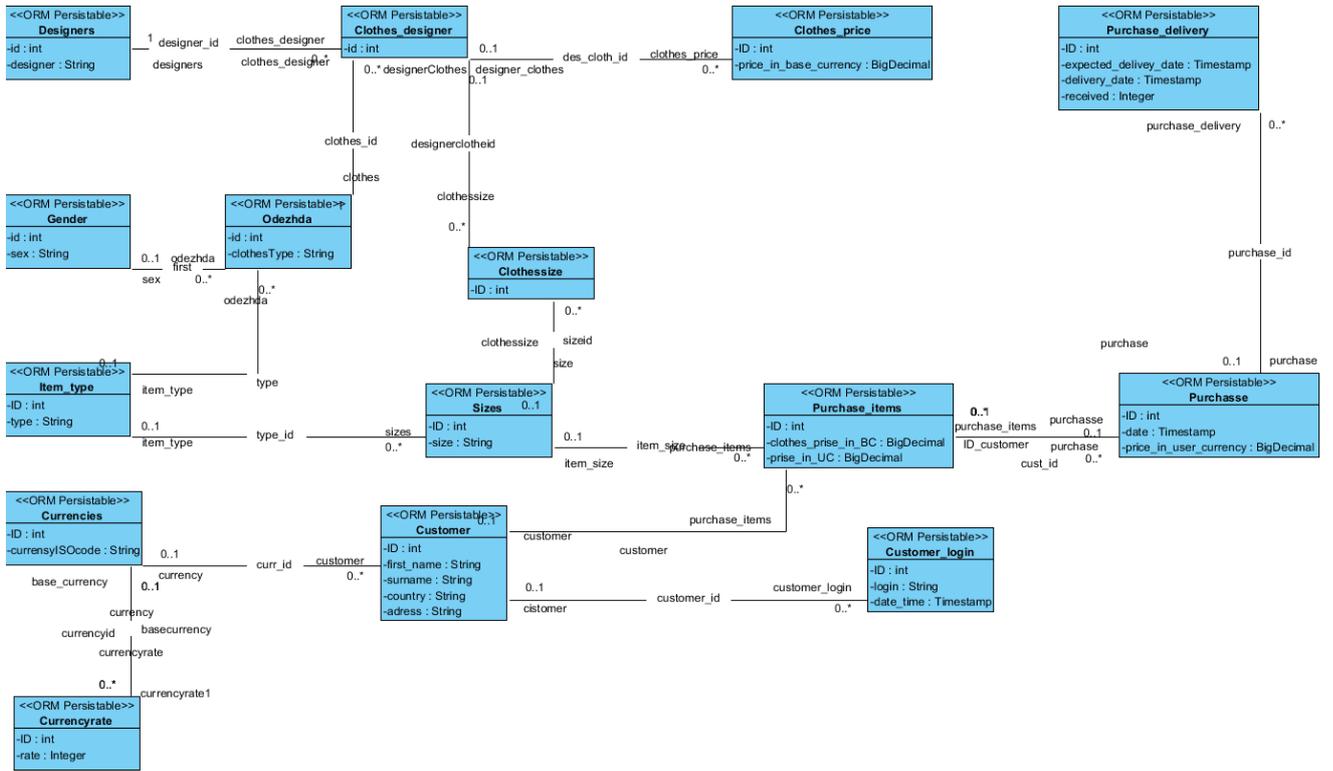
Fig.4: *UML class diagram of the on-line rent clothes system*

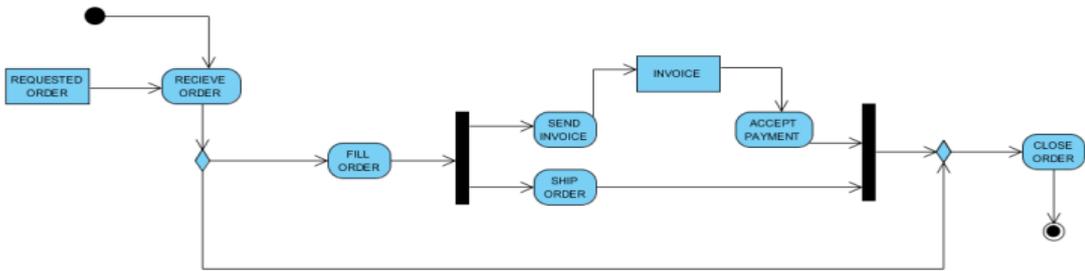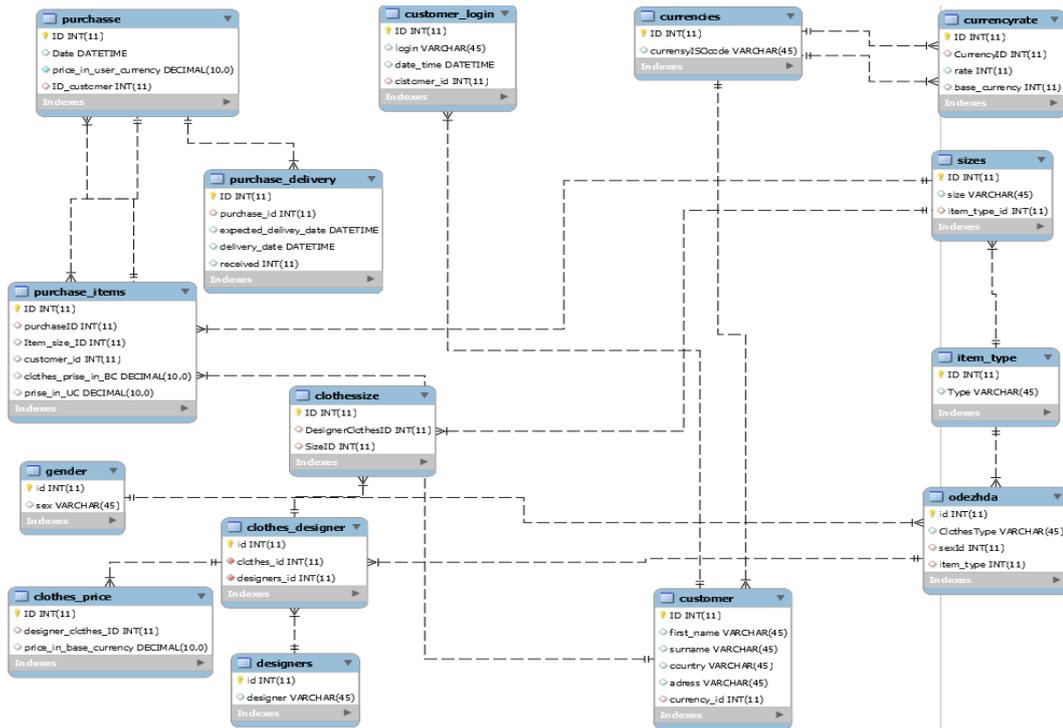Fig.5: Activity diagram of the Order making process

Fig.6: *ER diagram of the on-line rent clothes system*