Software implementation of e-trade business process management information system

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Abstract. In this study we present the software development method for e-trade business process management information system. As a software platform for implementation of the e-trading business process management system has been selected MSSQL database and software component implemented with the use of ASP.NET MVC Framework. The developed Web-application includes the following functional blocks: user authentication module; administration module; block implementing the functions of domain mathematical model and information processing procedures; database intended to store initial data, trading activity indicators and calculation results, as well as the content of the Web-application interface components; logistics module; server end, which implements the procedures for the database access, the formation of the view modes of the models and functions of the domain mathematical model; interface that provides an interactive user access to the Web-application features. The connection between the Web-application and the database is performed on the basis of the GET http-protocol method and is provided by generating database queries and query results. The developed e-trade business process management information system has a three-level software and hardware structure and is designed to manage the processes of interaction between the online store and on-line consumers.

Keywords: e-trade, business process, software development, management system.

1   Introduction

Information technology is a reality of modern economy, and an entrepreneurship is inconceivable without electronic trading methods, without sales promotion on the Internet. The use of the Internet radically transforms the processes of economic cooperation between the companies and their customers, partners, suppliers and even competitors. Methods and means of carrying out commercial transactions in e-trade are somewhat different from those carried out in the real economy [14].

Socioeconomic subject matter of e-trade, its features, and innovative role in the modern economy relate to new, understudied areas of economic science [2]. This fact determines the need for an objective study of organizational and economic

foundations for the development of e-trade to solve practical issues of increasing the efficiency and competitiveness of business.

Electronic trading markets operation has caused significant changes in the modern economy. The basic relations and business models have changed: from the manufacturer's domination, and then to the intermediary – to the leading role of the consumer; from mass production – to manufacturing products to order; from the value of material resources – to the value of information. At the same time, electronic trading markets have not changed the basic concepts of market relations, but have identified new mechanisms for their implementation. The electronic trading market is a prevailing electronic trading environment and a set of its participants, products, services and processes of their interaction, characterized by certain regularities in the context of a developed network of information and communication features. E-trade, as compared to traditional business, has substantial advantages. In particular, the use of new electronic communication channels significantly reduces costs related to organization and support business infrastructure, and the possibilities of e-trade allow re-designing business strategy at any moment [13].

An important circumstance that ensures the electronic trading markets operation is the availability of a fully-fledged electronic trading environment. The electronic trading environment is formed in the presence and direct interaction of such factors: modern information and communication tools for e-commerce, a wide range of consumers with full access to information and communication facilities (with Internet access), sellers, using information and communicative means for the sale of goods and services. Information and communicative tools for electronic trading are the modern information technologies and systems that provide effective implementation of procedures for reading, processing, storing and transfer of information resources based on computer networks.

The effectiveness of the electronic trading markets operation depends on the number of potential consumers of products and services presented on the market. An electronic trading environment cannot be formed without a wide range of consumers. Their presence is determined by the level of development and the degree of implementation of information and communication facilities in all spheres of socio-economic activity. Without providing users with Internet access, it's difficult to talk about the availability of an electronic trading environment. The presence of vendors using computer network resources for the sale of goods and services is a proactive factor in the electronic trading environment formation, since sellers are interested in making profits through the use of new, electronic trading mechanisms. At the same time, in order to have an electronic trading environment, sellers have to inform potential buyers in virtual space, while they bear the appropriate promotion expenses and market entry [12]. The cost of electronic trading market entering, it is by definition the financial and material costs to ensure the operation of the Internet store (website creation, delivery of goods organization, electronic payment systems connection, etc.). Promotion expenses in electronic trading are related to the creation of mechanisms for influencing consumers' preferences, by forming the priority consumer goods value. Since there is little or no cost of obtaining information about a particular product or service in an online environment, the role of informative

advertising in electronic commerce is significantly restricted, that is, the overwhelming part of advertising is a manipulative advertising, which increases the readiness of potential buyers to buy goods and services [13]. Promotional expenses in electronic trading primarily relate to the arrangement and placement on various electronic resources (own websites and other areas providing advertising) the banners about services and products and various incentive measures. Thus, potential buyers will get information about sellers and can interact with sellers through information and communication tools.

The electronic trading markets operations are associated with the interaction between sellers and buyers. Interaction of the electronic trading market participants is carried out whiles the procedures for the purchase and sale of goods and services implementation. Electronic trading market participants include sellers, buyers and intermediaries, as well as organizations that provide infrastructure and market rules. Regarding the intermediaries, we have not distinguished them separately for the reason that the main purpose of their activity is, as in the direct salesmen, in providing sales of goods and services in order to generate profits. The process of buying and selling goods and services in electronic commerce is much more complicated than in traditional trade, since even the structure and interface of an online store site can affect the specifics of this process. The purchase and sale of goods and services in electronic commerce begins with the search and acquaintance of a potential buyer with the range of products and services he or she needs in the virtual environment. After the final choice, the buyer makes an application for the selected product or service. The Internet seller carries out the order processing specifies the buyer's choice and, if confirmed, forms an account for payment. Then, checking the availability of the desired product or agreeing on the procedure for providing the services selected by the buyer take place. In the case of availability of goods or the buyer's agreement on the proposed procedure for the provision of services, the buyer is sent an invoice for payment. Payment is made with the mutual consent of the buyer and the seller and can be executed pre-payment (prepayment) or on the fact of delivery of the goods and performance of the service (post payment). After the payment procedure is agreed, the service is performed or the goods are sent to the buyer. Delivery of goods can be carried out both at the address of residence and to the nearest to the buyer pickup point (for example, "FedEx" or "DHL Express"). Payment for goods and services in electronic trading is usually carried out after the delivery of the goods or the performance of the service, this increase the buyers' confidence.

It should be noted that all the elements of the electronic trading market are present both in the real, physical environment, and indirectly, in a virtual trading environment based on the use of information and telecommunication technologies. This means that, depending on the type of merchandise product on the electronic trading market, it can be presented in the process of purchase and sale as either a real product or as a product presented in digital format (for example, a software product or information service provided using the Internet).

The technological aspects of the electronic trading market are extremely important factors that ensure the effectiveness of its operation. The reliability, safety of technological solutions is the basis of e-commerce, which depends on the

participation in procedures of purchase and sale. The current level of technology development allows creating high-performance, protected from external interference information and communication means of ecommerce. There is also a certain list of organizations that support the reliable operation of computer networks, the main means of e-commerce. The organizations providing the World Wide Web are represented by three types of ISPs (Internet Service Provider), IPP (Internet Presence Provider) and PCP (Private Content Publisher). They have rights to different types of servers, including host-computers (full-time operating equipment), and provide the following main service (services): E-mail, FTP (File Transfer Protocol), WWW (World Wide Web – customers hosting).

Automation of large-scale business processes vital for e-trading systems efficiency remains one of the most complicated problems in large enterprises. Known theoretical and practical solutions for small and medium businesses do not comply with large companies' requirements, their functions and development tools, as well as the level of integration of Web-environment and enterprise management systems [15]. The efficient IT support for e-trading is deterred with architecture and capabilities of informational systems not focused on creating an interconnected e-trading network [4]. An urgent need arises for developing new conceptual approach focused on integration of e-trade business processes with informational management systems. The problem of deep integration of informational environment as a basis for building efficient e-trading systems is complicated with technological discontinuity in typical informational systems stipulated by the wide range of software and network solutions during their creation. Therefore, a significant interest of scientists in the management software development in e-commerce, which allows increasing the efficiency of economic activity of enterprises, is quite reasonable. In this research we present the method for software implementation of e-trade business process management information system.

2 Results and discussion

Preliminary studies of the mechanisms of the electronic trading markets development and operation [12; 13] allowed determining the structural components arrangement and the functional use of core information flow processing modules of the e-trade business process management system and provided the opportunity for the transition to its software implementation.

The business processes accompanying the e-trade have been taken into account in the course of the software Web-based application development. The software implementation of the e-trade business process management system has been performed based on the developed transaction and advertising cost models [13]. Important aspects of the developed e-trading business process management system are the automation of all calculation mechanisms and framing procedures for the products delivery routes and cross-browser support for a computer Internet network, providing access to all its resources for geographically spread users, regardless of the location. The developed Web-application includes the following functional blocks:

‒ user authentication module;
‒ administration module;
‒ block implementing the functions of the domain mathematical model and information processing procedures;
‒ database intended to store initial data, trading activity indicators and calculation results, as well as the content of the Web-application interface components;
‒ logistics module;
‒ server end, which implements the procedures for the database access, the formation of the view modes of the models and functions of the domain mathematical model;
‒ interface that provides an interactive user access to the Web-application features.

User authentication module. This module provides functional differentiation of access modes to the Web-application controls and its resources according to the user's role and performs verifying the correctness of the registration data entered by the user. To access the application functions, it is required to enter the login and password stored in the system after the registration procedure in the e-trade business process management system. This module verifies the compliance of the user-entered data with the records stored in the database. In the case of the correct data entry, the module provides an access to the Web-application functionality and resources in accordance with the user access level specified by the system administrator.

Administration module. The module is designed to specify the levels of user access to the Web-system resources. The module regulates access modes to the Web-application functions on the basis of the work with three user groups (administrators, managers, and users).

Database. In the course of the domain conceptual model development, its entity and the relationship between them have been determined. Each entity with the database development is converted into a table, each entity attribute corresponds to the field in the database table. Figure 1 show the database model used in the interaction management Web-system. Designing data arrays involves defining their composition, content, structure, and choice of rational way of their provision. The database has been developed with the use of DBMS MSSQL [1]. Its logical structure can be seen in figure 1. The database contains the following tables:

‒ *Addresses table* – is used to store the information about buyers' addresses;
‒ *AspNetRoles table* – is used to store the information about user access modes;
‒ *AspNetUserRoles table* – is used to store the information about the correspondence of access modes and users;
‒ *AdvertisingCosts table* – contains information on the size of the local e-trade market (number of sellers and potential buyers) and on the level of consumer awareness and the degree of saturation of the market by advertising;
‒ *AspNetUsers table* – is used to store the information about registered users of the system;
‒ *AverageValues table* – is an auxiliary table for saving the averaged values of the domain mathematical model;
‒ *MarketEvents table* – is used to store the information about marketing activities;
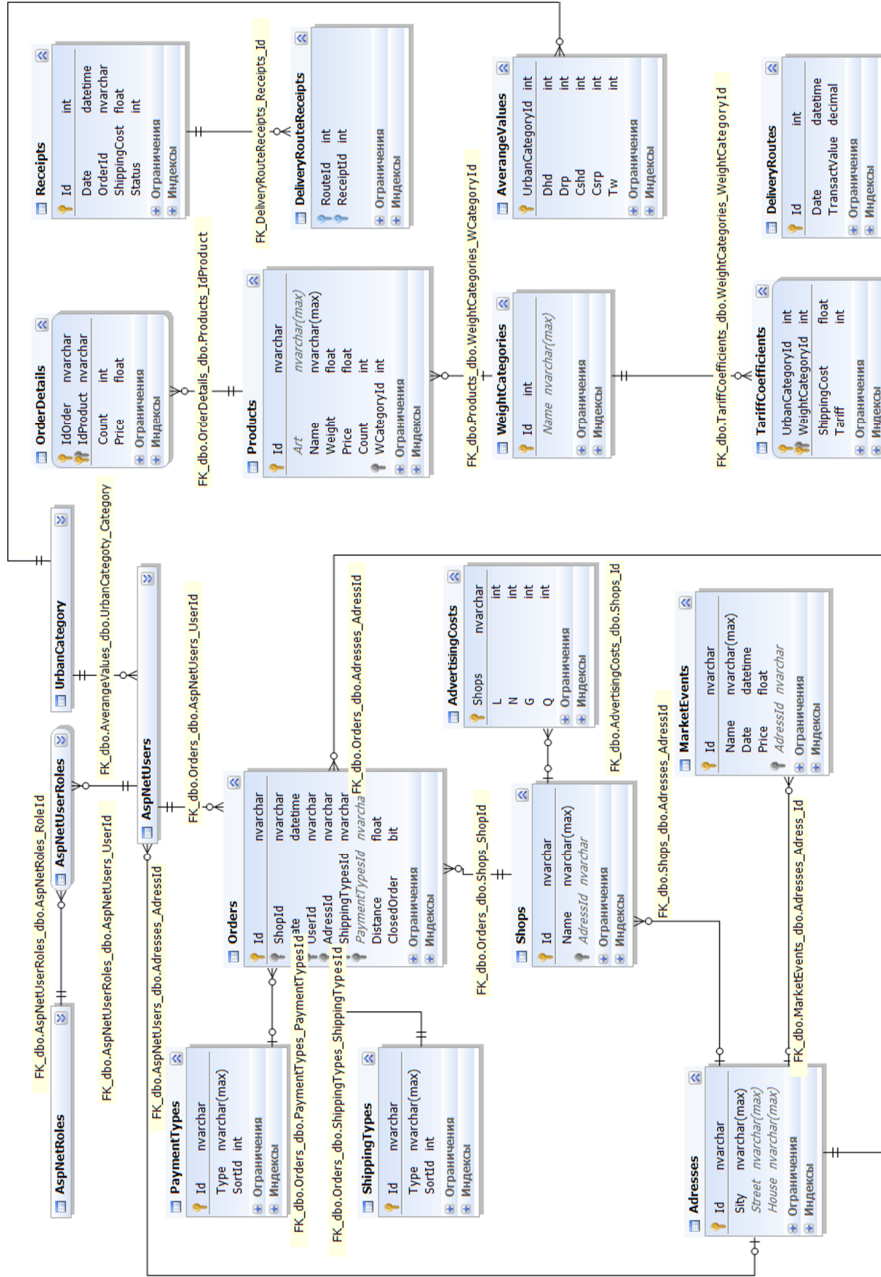‒ *Orders table* – is used to store information about the order;

Fig. 1. Database model.

─ *PaymentTypes table* – is used to store the information about different forms of payment for products and services;

— *Products table* – is used to store the information on the products;
— *Receipts table* – is used to store the information on payment receipts for products and services;
— *ShippingTypes table* – is used to store the information on delivery methods;
— *Shops table* – is used to store the information about the online store;
— *TariffCoefficients table* – is used to store the information for determining the tariff coefficient;
— *DeliveryRouteReceipts table* – is used to store the information about the correspondence of the route and receipts on orders in the route of goods delivery;
— *DeliveryRoutes table* – is used to store the information about products delivery routes;
— *WeightCategories table* – is used to store the information on weight categories of products;
— *UrbanCategory table* – contains information about urbanization categories.

The connection between the Web-application and the database is performed on the basis of the GET http-protocol method and is provided by generating database queries and query results [8; 11]. The resulting samples are serialized in the *.JSON format for transmission to the Web-application [1]. If it is necessary to save data to the database, the Web-application generates an object in the *.JSON format; the deserialization of the object obtained by the POST http-protocol method, as well as the generating of the corresponding database queries (REPLACE or UPDATE) takes place in the PHP gateway [5].

The block implementing the functions of the domain mathematical model and information processing procedures. The block implements computational algorithms for determining transaction and advertising costs [13] and performs automation the procedures for processing information on sales and delivery of goods.

Logistics module. The module consists of two functional parts - an interactive map and a list of routes with the order structure on the route. The main purpose of the module is to automate the mechanisms of transport logistics for the products delivery to customers and to ensure the visualization of procedures for the delivery routes development with a graphical visualization of the route pattern on the interactive map.

Functionally, the module also provides calculation and visualization (by data transfer to the block of the trade indicators analysis) of transaction costs of consumers with the ordered product individual delivery, when delivering products via a collective route and calculated in accordance with the developed economic-statistical model of transaction costs. There are four main elements in the module structure: *the access block to the functions of the Logistic module; OrdersController control block; Visualization block by applying LogisticViewModel view model; OrderManager providing a block*. The structure of its blocks and interconnections between them are determined, first of all, by the functional requirements for the processes of the sold commodity products delivery to customers in electronic commerce. The operation of the logistics module is carried out as follows:

— *OrdersController* generates a list of *Routes*, based on the data on placed buyers' orders for delivery, which are formed by the *GetReceiptsListAsync* and

GetTariffModel methods, and also transmits a completed list for its visualization using L*ogisticViewModel* tools;

— In the *LogisticViewModel* view model, the calculation of the distances for each route based on the list of products delivery addresses and transferring these data to the *OrdersController* is performed with the use of Yandex.Maps API;

— The *Calqulate method* performs the calculation of the consumer transaction costs based on the delivery route data and the *CalqulateTariff* method that provides the data on the tariff coefficients and returns the calculated data to the *LogisticViewModel* view model;

— After the products delivery route confirmation by the manager and the printout of the corresponding route documents, the *OrdersController* transfers control to the *OrderManager* provider, which changes the order status using the *SetOrderShipping* method and stores the information in the database using the *Save method*.

Server end and Web-application interface. As a software platform for the implementation of the e-trading business process management system the following components has been selected: MSSQL database, the software component implemented with the use of ASP.NET MVC Framework [6] – a framework for creating Web-applications that the Model-View-Controller template generates.

The ASP.NET MVC platform is based on the interaction of three components: controller, model, and view. The controller accepts queries, processes the information entered by a user, interacts with the model and view, and returns the results of the query processing to the user. The query processing generator is used to control the markup and code insertion.

The Razor view generator is used to control the markup and code insertion in the view. The C# programming language [9] is used as the language of the software implementation of the e-trade management Web-application. To provide the interconnection of the interface interactive components of the e-trade business process management system with the Database, the ADO.NET Entity Framework [10; 7] – an object-oriented data access technology is used. The interface of the developed Web-system in e-commerce includes the following parts:

— controls that provide user authentication, verification of the entered data and providing access to the Web-application functions, according to the level of user access;

— controls that provide the Web-application user registration;

— administration module for editing account parameters and assigning user access modes to the Web-application functions;

— menu of the interaction management Web-system in e-commerce, which provides navigation for Web-application users, including the following menu items: homepage, products, documents, marketing, logistics, analysis;

— information block with the viewing of the information on the developed integrated e-trading business process management Web-system and the technology for its use;

— interactive map of the region showing the location of the shoppers of the on-line store with the availability of graphic viewing of the selected route for the products delivery;
— module for viewing the routes for the products delivery and the structure of the orders on the route with the availability of the route documentation printing (delivery route, route task, list of orders on the route, payment receipts and delivery costs);
— block for filing and viewing of the operational and reporting documentation for describing business processes in e-commerce;
— block for viewing the list and characteristics of marketing activities and the results of the advertising costs calculating in e-commerce;
— block for viewing the results of the transaction costs calculations of consumers in electronic commerce;
— block for viewing analytical information on trade activity indicators in the form of diagrams and charts.

Technical requirements. To ensure the Web-application functioning on the server end, the following software is required: MS IIS 7.0 and higher; ASP.NET MVC 5.0 and higher; MSSQL 2008 and higher. A modern system and application software (operating system and browser) should be installed on a client's computer for the reliable functioning of the business process management system in electronic trade. The homepage of e-trade business process management system is given in figure 2.
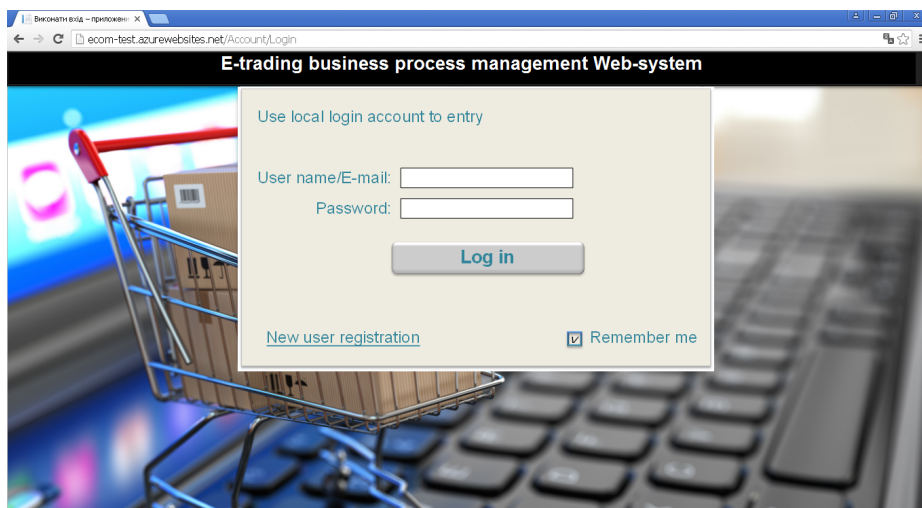

Fig. 2. E-trade business process management system homepage.

The e-trading business process management system interface is designed to work with three groups of users (administrators, managers, and users) and provides the use of the Web-application functionality and controls, depending on the particular user access level.

Administrators – have access to editing the e-trading business process management system context and can distribute user access rights to Web-application features.

Managers – have access to all Web-application features, with the exception of the above-mentioned administrator rights. Managers can edit tables with the information on the product range and trading procedure characteristics and initiate and regulate all calculation and reporting procedures. In essence, the access mode of the manager provides the full use of all functions of the e-trading business process management system in order to automate the trading activity of the online store.

Users – have access to the selection procedures of the products and the order placement for the purchase of commercial products.

The Web-application has been implemented with the use of the Model-View-Controller pattern (MVC) [3; 6] – a usage pattern of several design patterns through which the application model, user interface, and the interaction between the application and the user are divided into three separate components, so that the modification of one of the components has a minimal impact on the other. The developed e-trade business process management information system has a three-level software and hardware structure and is designed to control the processes of interaction between the online store and on-line consumers. The e-trade system does not require specialized user training and can be used regardless of the trading activity specifics of a certain online store.

3   Conclusion

The developed e-trade business process management information system provides management of the trading activity of an electronic enterprise in the framework of B2C and B2B interaction models. Modern software tools such as MSSQL, ASP.NET MVC Framework and the C# programming language have been selected as the tools for the Web-application software implementation. The Web-application is designed to work with three groups of users (administrators, managers, and users) and provides access to interaction controls depending on the level of a particular user access. For each group of the Web-system users, the measures have been taken to ensure the security and reliability of trading operations procedures, regardless of their territorial distribution. Important aspects of the developed interaction management Web-system in e-trade are the automation of all calculation mechanisms and framing procedures for the products delivery routes and cross-browser support for a computer Internet network. The Web-system provides calculation of advertising and transaction costs and graphic visualization of the transaction costs of consumers with the ordered product individual delivery, with the product delivery on a collective route, which allows an Internet seller to track decrease in the level of transaction costs of consumers as a result of the collective routes introduction for the products delivery.

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References

1. Assaf, W., West, R., Aelterman, S., Curnutt, M.: SQL Server 2017 Administration Inside Out. 1st edn. Microsoft Press, Redmond (2018)
2. Caporale, G.M., Plastun, A., Oliinyk, V.: Bitcoin fluctuations and the frequency of price overreactions. Financ. Mark. Portf. Manag. **33**(2), 109–131 (2019)
3. Chadwick, J., Snyder, T., Panda, H.: Programming ASP.NET MVC 4. Developing Real-World Web Applications with ASP.NET MVC. O'Reilly Media, Sebastopol (2012)
4. Chaffey, D.: E-business and E-commerce Management. 5th edn. Prentice Hall/Financial Times, New Jersey (2011)
5. Forta, B.: MySQL Crash Course. 1st edn. Sams Publishing, Indianapolis (2004)
6. Frimen, A.: Pro ASP.NET MVC 5. 5th edn. Apress, New York (2013)
7. Jennings, R.: Professional ADO.NET 3.5 with LINQ and the Entity Framework. 1st edn. Wrox, Birmingham (2009)
8. Kromann, F.: Beginning PHP and MySQL: From Novice to Professional. 5th edn. Apress, New York (2018)
9. McDonald, M.: Pro WPF in C# 2010: Windows presentation foundation in NET 4. 3rd edn. Apress, New York (2010)
10. Mueller, J.: Microsoft ADO.NET Entity Framework Step by Step. O'Reilly Media, Sebastopol (2013)
11. Nielsen, P., Delaney, K., Machanic, A., Tripp, K., Randal, P., Low, G.: SQL Server MVP Deep Dives. 1st edn. Manning Publications, New York (2009)
12. Pursky, O., Dubovyk, T., Moroz, I., Buchatska, I., Savchuk, A.: The price competition simulation at the blended trading market. In: Kiv, A., Semerikov, S., Soloviev, V., Kibalnyk, L., Danylchuk, H., Matviychuk, A. (eds.) Proceedings of the Selected Papers of the 8th International Conference on Monitoring, Modeling & Management of Emergent Economy (M3E2-EEMLPEED 2019), Odessa, Ukraine, May 22-24, 2019. CEUR Workshop Proceedings **2422**, 15–26. http://ceur-ws.org/Vol-2422/paper02.pdf (2019). Accessed 14 Sep 2019
13. Pursky, O.I., Grynyuk, B.V., Shestopal, D.A.: Planning of advertising costs and vendor number at e-trade market. Actual Problems of Economics **177**(3), 407-413 (2016)
14. Schneider, G.: Electronic Commerce. 12th edn. Cengage Learning, Boston (2016)
15. Shaw, M.J.: E-business Management: Integration of Web Technologies with Business Models. Springer, New York (2002)