REVISTA ESPACIOS

Performance evaluation of the electronic commerce systems

Evaluación del desempeño de los sistemas de comercio electrónico

Sergei Vladimirovich SHAYTURA 1; Yuri Pavlovich KOZHAYEV 2; Konstantin Vasilyevich ORDOV 3; Albina Viktorovna ANTONENKOVA 4; Nataliya Albertovna ZHENOVA 5

Contents

ABSTRACT:

The article presents a review of works devoted to technology creating online stores, portals and services, as well as describes two methods of performance evaluation of the e-commerce systems. The first method is based on creating mathematical model of the online store. Based on the mathematical apparatus, the authors estimated the efficiency of this method for the enterprise. The second method is based on the practical use of e-commerce systems, their search engine optimization (SEO) and creation of a purchase funnel. Present article, suggesting methods of evaluating e-commerce systems, can be used by experts of economic planning and engineering-technological services engaged in labor organization and management, as well as software developers of the online stores.
Keywords: marketing, e-commerce, e-business, network economy, portals, online stores, e-commerce systems, mathematical model, SEO, sales funnel, data mining, data processing, data processing technology, web analytics, key performance indicators.

RESUMEN:

El artículo presenta una revisión de las obras dedicadas a la creación de tiendas en línea, portales y servicios, así como describe dos métodos de evaluación del desempeño de los sistemas de comercio electrónico. El primer método se basa en la creación del modelo matemático de la tienda online. De acuerdo con el aparato matemático, los autores estimaron la eficacia de este método para la empresa. El segundo método se basa en el uso práctico de los sistemas de comercio electrónico, su optimización de motores de búsqueda (SEO) y la creación de un embudo de compra. El presente artículo, que sugiere métodos para evaluar los sistemas de comercio electrónico, puede ser utilizado por expertos de planificación económica e ingeniería-servicios tecnológicos dedicados a la organización y gestión del trabajo, así como a los desarrolladores de software de las tiendas en línea.
Palabras clave: marketing, e-commerce, e-Business, red Economy, portales, tiendas online, sistemas de comercio electrónico, modelo matemático, SEO, embudo de ventas, minería de datos, procesamiento de datos, tecnología de procesamiento de datos, analítica web, indicadores clave de rendimiento.

1. Introduction

Designing e-commerce systems always begins with the definition of the project goals (Germanov and Shaytura 2013a). The task of any successful project consists in providing at the time of start-up and

during the entire time of system's operation of the following functions:

- the required functionality of the system and its adaptation level to the changing functioning conditions;
- the required system capacity;
- the required system response time to the query;
- fail-safe functioning of the system in the desired mode, in other words, the readiness and availability of the system for processing of user queries;
- easy operation and maintenance of the system;
- relevant security.

At the formation stage of the general e-commerce system requirements, customer specifies general requirements to the system, such as the industry affiliation and business area, the preliminary characteristics of the target group, and expected sources of income (Germanov and Shaytura 2013b; Dick, Kokoreva and Shaytura 2013). The customer also declares constraints that are known at this stage, related to the characteristics of the current infrastructure, operation specificity, timing requirements, and financial capabilities.

The next step involves conducting the competition analysis, review of analogues, and the study of the target audience, as well as defines a set of consumer's and marketing characteristics of the designed e-commerce system that forms the basis of the technical specifications for creating e-commerce system.

The following stages in creating e-commerce unit, such as online store, involve creation of the site, placing it on the Internet, promotion, support, and evaluation of its characteristics.

 With the right approach to business development, based on the use of the network, the created site will continue growing and developing. Thus, after summarizing the first results of the project on the development of the Internet site, it is possible to adjust the overall goals and objectives. This in turn often entails revision of the marketing program issues implemented at the first stage. When identifying insufficient commercial impact from the web resource that is associated with the failed design from the perspective of the end user, or unreasonably low number of visitors, there appears a need to reconstruct the website, i.e. to go back to the second or third stage of the web development project to undertake the necessary corrective actions and make proper changes.

The successful development of e-commerce system throughout the whole life cycle needs continuous assessment of its efficiency as described in this article.

The first section of the article raises the issue concerning creation of Internet system model, while the second section evaluates its operation efficiency.

2. Methods and materials

The first part of the article is written using analytical algorithms. For conducting specific assessment on this method, we can use electronic spreadsheet, or mathematical software packages. The second part describes the performance evaluation of the e-commerce unit based on traditional SEO techniques, such as sales funnel, number of clicks, etc. (Christophersen, and Konradt 2011; Lee, Podlaseck, Schonberg, and Hoch 2001). Methods and materials used in the current article are based on existing descriptions of information systems' applications and practical experience of the authors (Nedelkin, Stepanova, and Shaytura, 2016; Shaytura S.V., Stepanova, Shaytura, Ordov, and Galkin 2016.; Shaytura, 2016). The used methods include a systematic analysis, dichotomous analysis, cost analysis, quality analysis, and impact analysis (Tsvetkov, and Lobanov, 2014; Tsvetkov, 2014a; Tsvetkov, 2014b; Tsvetkov, 2014c; Kudzh, and Tsvetkov 2014; Tsvetkov 2014d; Tsvetkov 2014e; Tsvetkov 2014f)

3. Results

The outcome of the current research is the description of two approaches to assess economic efficiency of e-commerce enterprises (on-line stores) selling the goods necessary for the full or partial satisfaction of buyer's needs in a particular area of human activity. The article considers created model of the online store and evaluates its operation based on traditional SEO techniques.

3.1. A mathematical economic model of an online store

The proposed mathematical economic model of enterprise, operating in the Internet sector, considers decisions of the company, which in the course of its activity generates profit described by stochastic processes (Zhenova 2017). The enterprise takes decision on the cost and profit structures. The model is built in discrete time with a finite horizon, time is indicated by the index at variables t = 1, 2, ... , N.

All cash flows are discounted at the rate r.

It is expected that the enterprise resorts to external financing to cover investment costs IC.

The cumulative profit of the company at a time t is denoted by the stochastic variable Xt. The profit of the store is taxable at a rate of Y.

The online store model significantly differs from the standard models of other types of commercial activities because of the enterprise operation specificity. When classifying expenses into constant and variable costs, most of the costs should be attributed to the constant expenses (FC), since the performance analysis shows that it is impossible to flexibly change these indicators depending on changes in sales volumes. These costs include expenses for the rental of offices and warehouses, means of communication (phone and Internet), development and support of store website, transportation costs, and labor costs.

Marketing costs (M) should be allocated separately as dynamically changing parameter, which, in addition to the market situation, is significantly dependent on the marketing strategy of competitors.

Prices are formed dynamically based on the underlying price, i.e. current supplier price (PP) and a given trade margin (TM). Production cost refers to the variable costs.

The store makes a profit per unit time in the framework of a single direction

$$X_t = PP * (1 + TM) * V_t - PP * V_t - FC - M_t \quad (1)$$

where V_t is the sales volume at time t,

FC is fixed costs.

Let CF be the cash flow, which includes income and expenses. Then CF_t is the cash flow at time t, which can be calculated by the formula:

$$CF_t = \begin{cases} X_t * (1 - Y), & X_t > 0 \\ X_t, & X_t \leq 0 \end{cases} \quad (2)$$

Normally, each online store works in several areas, with various types of goods, and range of articles in stock. At that, FC is common for all areas, while marketing campaign for each area should be carried out separately. Formula (1) for the area k looks as follows:

$$X_k = PP_k * (1 + TM) * V_k - PP_k * V_k - FC - M_k \quad (3)$$

Formula (2) for the area k is converted respectively to

$$CF_k = \begin{cases} \sum_{k=1}^{K} X_k * (1 - Y), & \sum_{k=1}^{K} X_k > 0 \\ \sum_{k=1}^{K} X_k, & \sum_{k=1}^{K} X_k \leq 0 \end{cases} \quad (4)$$

A general model of the online store that takes into account time factor and trade line can be written as:

$$_T \left[\sum_{k}^{K} X_{kt} * (1 - Y), \quad \text{for those t, where} \sum_{k}^{K} X_k > 0 \right.$$

$$CF = \sum_{t=1}^{\overline{k=1}} \left\{ \begin{array}{ll} \sum_{k=1}^{K} X_{kt}, & \text{for } t\sum_{k=1}^{K} X_k \leq 0 \end{array} \right. \quad (5)$$

at that

$$X_{kt} = PP_{kt} * (1 + TM) * V_{kt} - PP_{kt} * V_{kt} - FC - M_{kt}$$

The values CF calculated by (5) for each year CF_t we substitute in the formula 1 to obtain the net present value (NPV) of the project.

Similarly as in the offline sales, sales volume V_{kt} of many products depends on the season. Sale rises in high season, while falls in low season. However, even here the Internet imposes its specifics. If in high season we do not increase marketing spending M_{kt}, then the sales volume V_{kt} may not be growing, because the buyer will go to competitors' stores. At that, in the case of online store the buyer doesn't have to go anywhere physically. The online shopper is rapidly changing his preferences, and only continuous marketing job will allow holding the sale at the proper level.

At that, the M_{kt} value depends on many factors and is discussed in detail in the next section.

Schematic diagram of the online store functioning includes attracting site visitors using mechanisms such as search engines and social media, as well as offline traffic sources (advertising placed on TV, radio, and in print media). Site visitors make orders through an external/internal call center or directly on the website via special forms or virtual shopping carts. Data on visitors as well as the progress of orders are recorded in customer relationship management (CRM) system and other accounting systems.

The online store marketing is a set of tools and techniques that allow promoting the website of the company. It is of particular importance and is needed to:

make the website visible to customers;

attract the target audience;

engage and keep visitors.

Among the tools of Internet marketing we highlight:

search marketing, including:

contextual advertising, i.e. ads placement using the selected words/phrases in the search engines;

SEO, i.e. a combination of actions to change the site aimed at obtaining high rankings in the course of customer search results for given queries;

media advertising and its particular case – banner advertising;

promotion in social networks, including:

social media optimization (SMO);

social media marketing (SMM); e-mail marketing.

Studies have shown that marketing budget of the online store is distributed mainly on SEO, and is divided between SEO and contextual advertising. SEO is required to raise the site rank in the search engines' results in response to certain queries of users for the purpose of site promotion. Its necessity is due to the fact that the higher is the website rank in the search results, the more visitors go to this particular website from search engines.

At that, SEO of web pages for specific search queries is a long-term process that requires long-term investment and does not give guarantees of result. For example, if the site is new, then the probability of its promotion is very small. The age of the site has a serious impact on the search results; however, it is impossible to change it independently.

Search engines take into account many parameters of the site, when assessing its relevance (quality of conformance to the entered query). Search engine techniques are based on the calculation of keywords density and the site citation index, which depends on the number and credibility of web resources linked to this website.

Search-engine marketing starts with learning a semantic kernel of the website. The semantic kernel consists of those keywords that should be indexed on the site. Keywords of the semantic kernel, which are users' search queries, are selected by analyzing goods available at the store, as well as search engines, site statistics, and data about competitors in the market. Queries in the semantic kernel should correspond to the views of visitors about the website store as much as possible.

When compiling the semantic kernel, search queries are divided by the frequency. This idea underlies the choice of search engine marketing strategy. In terms of frequency, search queries within the same subject are divided into high-frequency (HF), mid-frequency (MF), low-frequency (LF), and "long tail". The division is performed using a logarithmic scale, as is done, for example, to scale the frequency of the sound. The number of queries per day may be more than 1000, or range from 100 to 1000, from 10 to 100, and from 1 to 10. Specific figures may vary depending on the popularity of the subject. Depending on the goals and objectives of the website promotion or contextual advertising campaign, the number of search queries can be adjusted towards the prevalence of certain queries.

The HF-query is usually composed of 1-2 words. It is often used, though as a rule has informational focus rather than trade-related or purchasing orientation. The query is of a general nature without any specification. Because of this, the HF-query has low conversion, while the webpage does not match user expectations. Usually, the HF-queries are the most competitive and the most expensive because they are promoting many companies associated with the same business area. In order to get higher ranking based on these queries, it is necessary to spend a lot of time and money. It is logical to use HF-queries, when promoting the brand, when website needs a large number of visitors having no particular purpose.

The MF-queries usually specify HF-queries. Visitors making mid-range search queries are in the intermediate stage of information gathering that precedes a decision about making a purchase. The MF-queries are moderately competitive. This again suggests that first and foremost we have to consider the competition, and then the number of impressions. The MF-queries will bring a lot of visitors that will allow the company to become a leader.

Website promotion of small online store is usually built on LF-queries, because they are trade and product oriented. Ads with LF-queries enable bringing to the website ready to purchase visitors. They are maximally concretized and consist usually of a large number of words.

In search engine, buyers who have already decided on the choice and currently are looking for a specific seller or vendor, enter exactly LF-queries. Although LF- queries are used less often, due to the exact wording they have high conversion, low competition, and therefore low cost of promotion. Visitors, who came to the website through the LF-queries, show great conversion, because they came into the store not by accident, but for a particular product.

The "long tail" is a search query, which is used very rarely, but more than zero times per unit of time. The long-tail queries should not be confused with LF-queries. Sometimes web designers think that creating a webpage specifically for "long-tail" query does not make sense, since the number of visitors will be very small. But, we can just expand the query phrase, i.e. specify it in the headers, text, address, and links to pages.

Competitive query is a query, which can hardly be used to reach leading position because of the competition. Though, in the highly competitive commercial niches the LF-queries can be highly competitive. Therefore, we always need to analyze each query and the sites that are found by this query among the top ranked sites.

First, if a visitor comes to the site upon query, he will make a purchase. Such keywords are used by the most targeted visitors, which in most cases become buyers.

Second, there is almost no competition, and it is very easy to get the top position. It is enough to enter the query just once and put a few internal links with the anchor.

Third, about 60-90% of all visitors arrive at the site through these queries. They provide more than half of the search traffic.

The context is a public resource definitely requiring the availability of a good website and marketing strategy; though if the site evokes a desire to buy, then the cost of context quickly pays for itself through the influx of visitors, and this happens quickly.

In general, search marketing is characterized by the following features:

> specific search queries (key words);
>
> communication with a search system;
>
> attention to the subject of the advertising site.

In terms of impact, Internet marketing can be divided on the direct, viral and guerrilla marketing. The online store can also use offline advertisement for marketing purposes. However, small enterprises almost do not use it. E-mail marketing is automated through CRM systems and does not require virtually any additional cost.

It follows from the above that the operating costs of the online store consist mainly of costs for contextual advertising. Therefore, exactly this type of activity requires certain simulation.

Contextual advertising is a separate block of ads with a pay per go to the store page. It is located above the search results, below, as well as to the right of it.

The contemporary system of contextual advertising placement includes users' pay-per-click to the specified webpage. The payment is implemented for the result, i.e. attracting targeted visitor. Only the user transitions (clicks) are paid, at that the price per click is specified by advertiser. Advertiser also selects the regions, where ads will be shown to people. This allows achieving the necessary targeting, i.e. the links are clicked only by the engaged audience.

The advertiser creates advertisements and specifies the queries that will lead to these advertisements. The user sees the ad, when entering one of these queries in the search engine. The interested user goes to the store's website.

In the acting auction, ad position in the ad unit is directly related to the price of a click. The advertiser sets their own acceptable cost. The main task is to reach a certain position.

It is revealed that one-third of advertising funds in 2016 was used in the Internet, at that contextual advertising made up more than half of them. This shows the importance of studying contextual advertising.

It is also worth noting that contextual advertising does not generate demand, but uses already generated demand. Improving the efficiency of contextual advertising is a priority area in the marketing strategy of any online store. At that, the construction of a pricing strategy may differ for different time of day and days of the week.

3.2. Performance evaluation of e-commerce systems

Currently, Internet advertising is the main source of attracting the target audience to the website (Bazhanov and Shaytura 2013; Sumzina, Maximov, Golubev, Litvinenko and Golubev 2015; Scholz, Franz and Hinz 2016; Nedelkin, Titov, Tikhomirova and Romanova 2016; Maximov, and Khalikov, 2016; Kosorukov, and Maksimov, 2016). Attracting quality traffic that brings the desired actions in the form of orders, requests or calls is the main task of any Internet marketer and the legitimate desire of the business owner. Often, increase in the budget and the incoming traffic volume does not result in a significant increase in conversions. The reason for this may consist in both choosing the wrong communication strategy with the target audience, and error of technician in the course of the advertising campaign. Therefore, the question arises about the increase of qualitative component of the resulting traffic rather than quantitative component. Understanding the degree of quality of the resulting traffic can be achieved by introducing the concept of target actions. Target action on the site is an operation that is tracked by web analytics' systems and is paired with the specific aim of the business: purchasing a product, filling out purchase requisition, phone call, and many others. Thus, this contributes to formation of key performance indicators (KPI). For each internet project, we can set particular KPI; however, it is always possible to trace similarities of measurements.

Conventionally, all of the KPI metrics can be divided into the following categories: 1. "Business" metrics; 2. "Traffic" metrics; 3. "Conversion" metrics; and 4. "Audience involvement" metrics. For different types of projects we can include a variety of monitored indicators presented in Table 1.

Table 1
Key performance indicators (KPI)

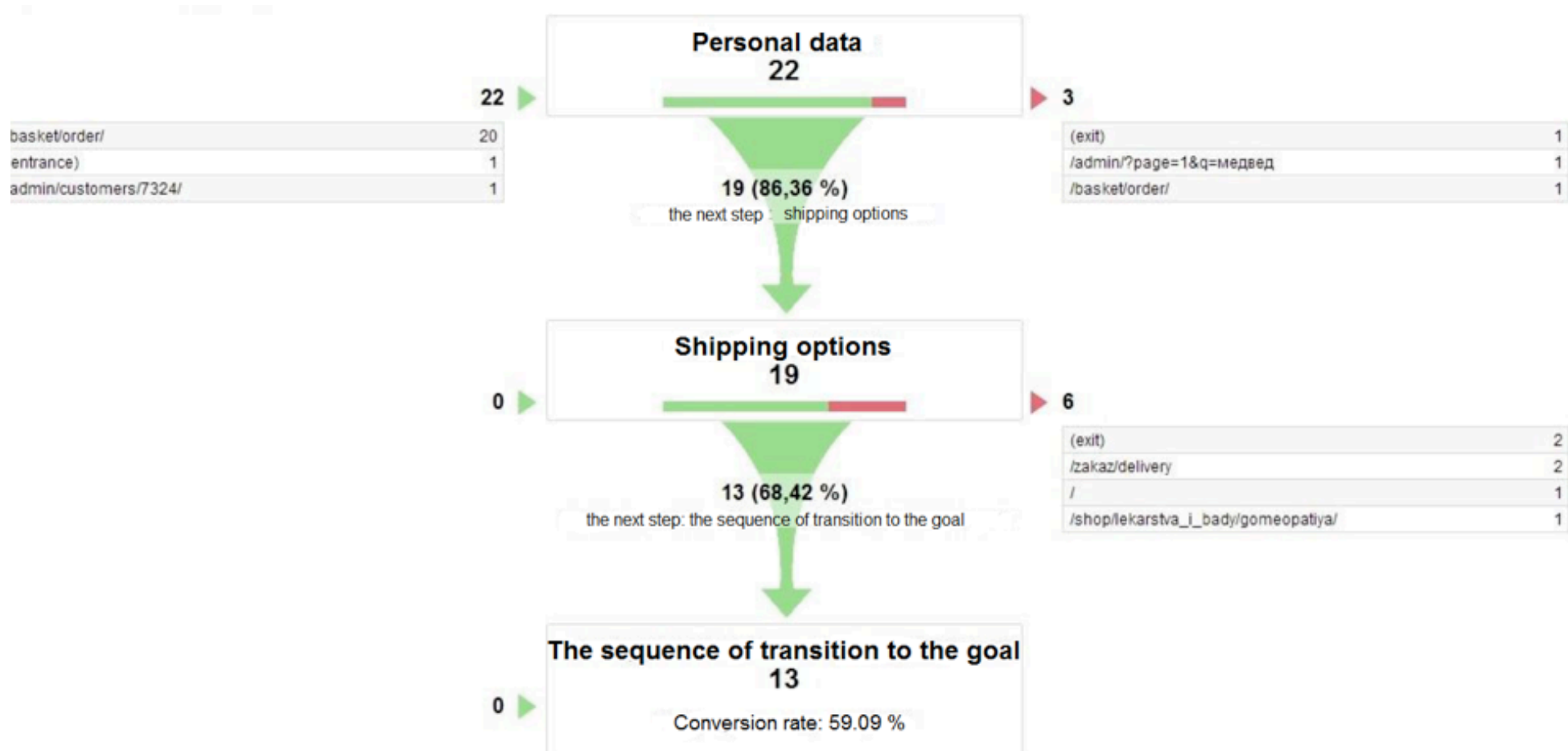| Type of site	The main goal of the Internet project	KPI
Online stores	Selling goods or services through the website	*"Business" metrics:* - Gross sales in units and money; - The cost of the buyer; - Average basket; - Average revenue per visitor (RPV); - Average revenue per customer (RPC); - Sale from each channel attracting visitors; - Return on investment (ROI). *"Traffic" metrics:* - The number of visitors on the site; - The number of pages viewed and average time spent on the website; - The cost per visitor (CPV) - Refusals; - All of the above metrics as per the channel of attraction. *"Conversion" metrics:* - Conversion for each target type and each channel of visitor attraction; - The number of registrations. *"Audience involvement" metrics:* - The number of posted ratings and reviews; - The number of repeat visits; - Time before purchase; - The geographical spread of visitors; - Visit depth of the website sections; - Viewing time per section; - Percentage of those used search through the website, percentage of those exiting after search.
Corporate business card website	Increase in company sales, increase in number of regular customers	*"Business" metrics:* - The number of calls\purchase requisitions coming from website; - Gross sales in units and money; - The cost of one reference; - Return on investment (ROI). *"Traffic" metrics:* - The number of visitors on the site; - The number of pages viewed and average time spent on the website;

		- The cost per visitor (CPV)
		- Refusals;
		- All of the above metrics as per the channel of attraction.
		"Conversion" metrics:
		- Conversion of each target type and each visitor attraction channel to calls/purchase requisitions from the site.
		"Audience involvement" metrics:
		- Views of "Contacts" webpage;
		- Familiarization with the products and services, downloads of price lists, catalogs, and other matter;
		- Assistance in product selection; use the calculator or consultant;
		- The number of repeat visits;
		- The geographical spread of visitors;
		- Visit depth of the website sections;
		- Viewing time per section;
		- Percentage of those used search through the website, percentage of those exiting after search.
Image business card website	Increase of brand awareness	*"Business" metrics:*
		- The number of visitors on the site;
		- Increase in "branded" traffic;
		- The number of pages/clips viewed and the average website visiting time;
		- Refusals.
		"Audience involvement" metrics:
		- The number of repeat visits;
		- Familiarization with the products and services, downloads of price lists, catalogs, and other matter;
		- The use of interactive components;
		- Audience involvement rate;
		- The geographical spread of visitors;
		- Visit depth of the website sections;
		- Social activity: reposts, likes, tweets.
Information traffic Internet project	On-site sale of advertising (banner and contextual advertising)	*"Business" metrics:*
		- The number of visitors on the site;
		- The number of pages viewed and average time spent on the website;
		- The cost per visitor (CPV);
		- Refusals;
		- All of the above metrics as per the channel of attraction.
		- The number of clicks on advertising materials
		- Click-through rate (CTR) of ads.

All key indicators should be measurable using the web analytics tools. To implement this opportunity, the concept of purpose was introduced to the web analysis system. The goal in web analytics is the achievable action of the visitor that is taken as the basis for calculation of KPI. Goals are set for each type of the Internet site depending on the KPI network that has to be monitored. For the online store, the main business metric of which is the number of sales, the goal will be to achieve the final page of the product ordering form that confirms the sending of the data about the completed order. Using analytics system tools we can track the whole purchase funnel: from product selection to its confirmation and payment. The visualization tool of this process is called "sales funnel" and can be configured in the main statistics systems such as Yandex Metrics and Google Analytics. The entire sales funnel for a particular source of attraction, shown in Fig.1, speaks to its overall efficiency.

Figure 1
Sales funnel for an online store.

	Personal data	
	22	
22 ▶		▶ 3
basket/order/ 20		(exit) 1
entrance) 1		/admin/?page=1&q=медвед 1
admin/customers/7324/ 1	19 (86,36 %)	/basket/order/ 1
	the next step: shipping options	
	Shipping options	
	19	
0 ▶		▶ 6
		(exit) 2
		/zakaz/delivery 2
	13 (68,42 %)	/ 1
	the next step: the sequence of transition to the goal	/shop/lekarstva_i_bady/gomeopatiya/ 1
	The sequence of transition to the goal	
	13	
0 ▶		
	Conversion rate: 59.09 %	

The quantity of the goods put into the cart, and their range can also be tracked through analytics tools, with the help of special "events" that are set up programmatically in the website code. Creation of a core of regular customers and repeat purchases are also one of the monitored metrics for the online stores. Here the tracking goal is the achievement of registration and confirmation of the user credentials. Development of the site through user ratings and reviews is also a significant metric of social activity of the target audience and its involvement in the product selecting and purchasing process. In this case, the tracking goal is the number of posted reviews and ratings. Tracked goals for image and corporate websites (card websites) may include the following:

1. Compellations, i.e. filling in the product ordering form and arriving at thank you page;

2. Calls to phone number. Modern analytics systems allow tracking calls via third-party scripts and services.

3. Sale at the office, review of the "Contacts" page with the corporate address, and its subsequent printing;

4. Familiarization with products and (or) services. To do this, the user can carefully browse the entire

catalog or download the necessary materials (price lists, catalogs, manuals, and case studies). This is tracked by means of events.

5. Assistance in product selection, i.e. use of the calculator and (or) virtual consultant. This is tracked by means of events. Content projects (Internet magazines, electronic mass media) pursue the following objectives:

> 1. The consumption of content, i.e. a certain number of page views.

> 2. The creation of a core audience. The total number of registrations is tracked by means of goal setting to the thank you page.

> 3. Tracking the content quality by measuring the number of polls, opinions, and comments. This is implemented by means of "events".

4. Discussion

The article describes two examples of e-commerce performance evaluation. The e-commerce systems can be customizable depending on the market condition; that is why, it is so important to monitor projects' efficiency. The structure of the reported data is a very important issue, when designing electronic commerce system. Data can be very miscellaneous and semistructured. The amount of data can be huge. When developing system, we should choose uniform data representation and solve the problem concerning the possibility of their aggregation and congression.

5. Conclusion

Evaluation of the electronic commerce system efficiency, in the end, gives an idea about conversion ability of one or another traffic source, about its efficiency taken together with marketing communication with the target audience. After receiving the data, measures are defined and the required solutions are developed that contribute to the possibility of increasing the efficiency. These solutions may be as follows: optimizing the advertising budget, changing the list of key words, searching for alternative traffic sources, which give the maximum conversion result. Measuring the efficiency of traffic channels and conversion capability of the site is implemented by means of special methodologies, which just begin to be formalized.

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1. Russian State University of Tourism and Services, Russia, Moscow region, Pushkin district, Cherkizovo, Glavnaya; E-mail: swshaytura@gmail.com

2. Russian State University of Physical Education, Sport, Youth and Tourism, 105122, Russia, Moscow

3. Plekhanov Russian University of Economics, 117997, Russia, Moscow

4. Plekhanov Russian University of Economics, 117997, Russia, Moscow

5. Plekhanov Russian University of Economics, 117997, Russia, Moscow

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