ECONOMIC AND MATHEMATICAL MODELS OF CASH FLOWS FOR E-COMMERCE ENTERPRISES

ЕКОНОМІКО-МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ ГРОШОВИХ ПОТОКІВ НА ПІДПРИЄМСТВАХ ЕЛЕКТОРННОЇ КОМЕРЦІЇ

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The article is devoted to economic and mathematical models of cash flows at Ukrainian e-commerce enterprises. Nowadays, the best financial management practices use the models of cash flows aimed at determining the optimal stocks of working capital. This study deals with two economic and mathematical models that have been created to assess the effectiveness of investing in the growth of e-commerce enterprises. The first model determines the appropriateness of investments in an advertising campaign based on contextual advertising. The second model defines the feasibility of website optimization activities aimed at increasing the conversion rate of visitors to customers provided a constant number of visitors. The combination of these two models allows choosing the right direction of financial management at e-commerce enterprises, which is based not only on increasing turnover but also on improving the efficiency of the funds' exploitation.
Key words: *economic and mathematical model, cash flows, conversion, contextual advertising.*

Статья посвящена экономико-математическому моделированию денежных потоков на предприятиях электронной коммерции Украины. На сегодня в практике финансового менеджмента используются модели денежных потоков, нацеленные на определение оптимальных запасов оборотного капитала. В данном исследовании созданы две экономико-математические модели, которые позволяют оценить эффективность инвестирования в развитие предприятий электронной коммерции. Первая модель определяет целесообразность вложений в рекламную кампанию. Во второй модели определяется целесообразность оптимизации работы сайта, в результате которой увеличится показатель конверсии посетителей в клиентов при неизменном количестве посетителей. Сочетание данных моделей позволит выбрать правильное направление финансового управления на предприятиях электронной коммерции, в основе которого стоит не только увеличение оборотов, но и повышения эффективности использования денежных средств.
Ключевые слова: *экономико-математическая модель, денежные потоки, конверсия, контекстная реклама.*

Стаття присвячена економіко-математичному моделюванню грошових потоків на підприємствах електронної комерції України. На сьогодні у практиці фінансового менеджменту використовуються моделі грошових потоків, націлені на визначення оптимальних запасів оборотного капіталу для здійснення поточної діяльності. У даному дослідженні створено дві економіко-математичні моделі, які дозволяють оцінити ефективність інвестування у розвиток підприємств електронної комерції. Основна мета розвитку – не тільки зростання обсягу надходжень від реалізації товарів, робіт чи послуг, але і покращення ефективності грошового потоку. Основним показником для вимірювання ефективності грошового потоку є вільний грошовий потік, що показує суму коштів, яка утворилася після фінансування поточних потреб підприємства та вкладень у розширення капіталу. Збільшення вільного грошового потоку у часовому вимірі говорить про те, що підприємство матиме кошти для розвитку і в майбутньому. Перша модель базується на визначенні доцільності вкладень у рекламну кампанію, в основі якої є контекстна реклама. Ця реклама передбачає оплату за приведення зацікавлених відвідувачів на сайт. Відповідно, зі збільшенням вартості рекламного бюджету, зростатиме кількість відвідувачів, які можуть стати потенційними покупцями та підвищити обсяги надходжень грошових коштів від реалізації товарів, робіт, послуг чи сервісів на підприємствах електронної комерції. У другій моделі визначається доцільність проведення заходів із оптимізації роботи інтернет-магазину чи інтернет-сервісу, у результаті яких збільшиться показник конверсії відвідувачів у клієнтів, що також призведе до зростання обсягів надходжень грошових коштів від реалізації товарів, робіт чи сервісів на підприємствах електронної комерції. Поєднання даних моделей дозволить обрати правильний напрям фінансового управління на підприємствах електронної комерції, в основі якого стоїть не тільки збільшення оборотів, але і покращення ефективності використання грошових коштів. Модель апробовано на прикладі діючого підприємства електронної комерції ПП "Інтелект-Нова".
Ключові слова: *економіко-математична модель, грошові потоки, конверсія, контекстна реклама.*

The essence of the problem. E-commerce enterprises that operate in the modern business environment experience an urgent need in the high-quality financial management of cash flows. Managers need to receive information on how well they manage their own funds, that is, how effective the investment in maintaining and developing the website is.

Managers can choose any of three possible options for making investments in the website's support and development. They are as follows:

1. Promotion of the website in the search results by placing external links to the Internet store's commercial pages;

2. Purchasing of context (Google AdWords, Yandex Direct) or other advertising that attracts visitors interested in purchasing goods or services;

3. Improving the website's usability, which increases the level of conversion (hereinafter – the sales conversion).

It is very important to choose the right strategies for using the funds and skilfully combine them to achieve the most effective result. Economic and mathematical models are specially designed for such tasks. They allow defining the change of the ultimate indicator under the influence of various factors. In our case, the ultimate indicator is represented by the free cash flow of the e-commerce enterprise.

When it comes to cash flows in e-commerce, some factors exert a direct impact on them. These are usually internal factors. For example, using simple formulas one can easily calculate the

amount of money generated by the sales due to the increased rate of attendance.

Analysis of recent research and publications. A lot of scientists were engaged in the modelling of cash flows. There were developed such tools as the logistic models of cash flows by Baumol, Miller-Orr, Stone [1], the model of integrated management of financial and material flows, method of chain distribution, the financial model of cash flow management [3], etc. Most models are aimed at optimizing inventory stocks and measuring the required amount of funds to maintain the viability of the enterprise.

Article goals. The main task of creating an economic and mathematical model of cash flows for an e-commerce company is to determine the correct way of the funds' exploitation, as well as the optimal amount of investments to increase both the volume of proceeds from sales and the free cash flow.

Presentation of the main material. Elaboration of economic and mathematical models is possible in terms of the direct influence of factors on the ultimate indicator. Only some internal factors exert a direct impact on cash flows. Let's consider them in Figure 1.

This figure shows two sectors of influence affecting the cash flows of e-commerce companies. Sector 1 describes the impact of internal factors on incoming cash flows of e-commerce companies. Sector 2 reflects the impact of internal factors on the outcoming cash flows of e-commerce companies. Additionally, the figure shows the relationship between the factors affecting outcoming and incoming cash flows (point 3 and 4). Let's consider each of the influence types in more detail.

1. Incoming cash flows from operating activity, i.e. the receipt of cash from the sale of goods or services are influenced by:
   - visitors;
   - return of visitors;
   - conversion rate;
   - average order total.

The basis of the direct four-factor dependence between the volume of sales and various factors is the definition of the sales volume, which is determined by multiplying the quantity of goods sold by their price. In the case of e-commerce, to determine the number of sales, one needs to multiply the number of website visitors by the sales conversion rate. The number of customer returns should also be considered. Website's statistical information may provide the necessary figures.

$$P = V \cdot RV \cdot CR, \quad (1)$$

where

P – purchases;

V – website visitors;

RV – return of visitors;

CR – conversion rate.

The average check is the average value of purchases made on the website. This indicator can be considered as the average price. Thus, the multiplica-

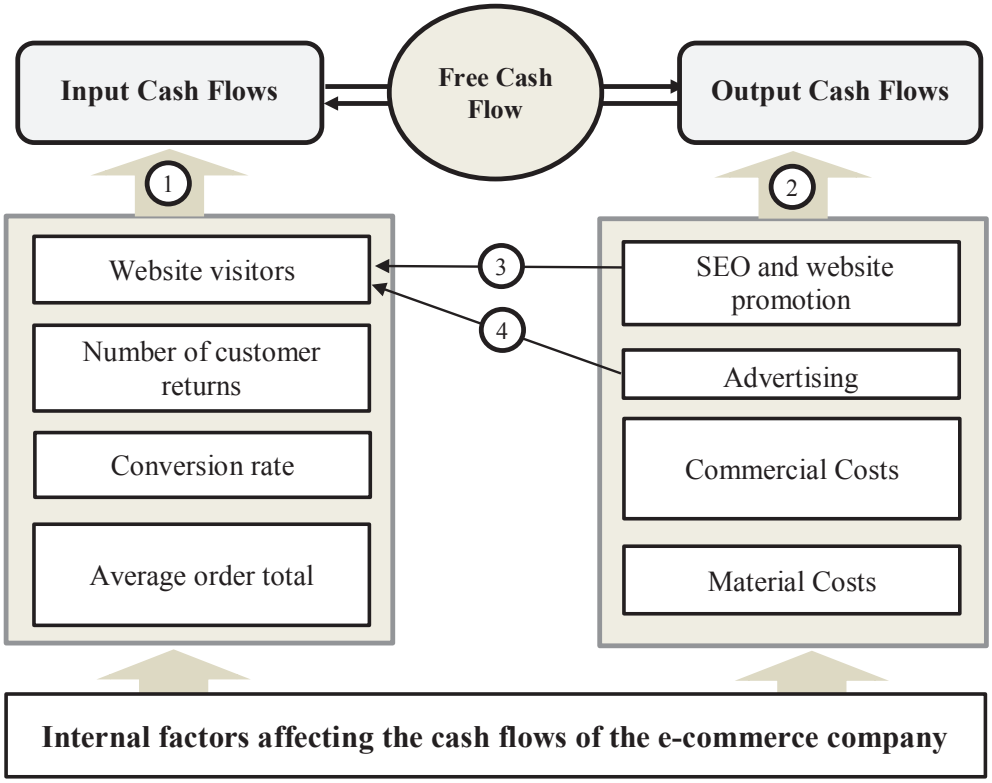

Fig. 1. Influence of factors on cash flows of e-commerce companies

Source: developed by the author

tive dependence model of cash proceeds from sales is as follows [3, p. 9]:

$$S = V \cdot CR \cdot RV \cdot O, \quad (2)$$

where

S – sales;

O – average order total.

If any of these components demonstrate a growing trend, the cash proceeds from sales will finally grow. An enterprise is interested in the growth of any of the above components.

In order to increase the number of website visitors, one needs to permanently allocate significant advertising costs that may not always return. To optimize cash flow, first of all, it's necessary to pay attention to the level of sales conversion, average check, and the number of customer returns. These factors reflect how well organized and convenient for the customers the website is. One-time (or non-systematic) expenses on the online store's audit by independent SEO experts may improve the values of these factors. After the audit, the owners receive information on how user-friendly the website is. Besides, having implemented the audit recommendations, one should expect an improvement in conversion rate, an increase in the average check and the number of customer returns.

2. The following factors have a direct impact on the costs from operating activity of e-commerce companies (C):

- Costs of purchase of materials and services that are included in the cost of goods sales (MC);
- Organizational expenses related to payroll payments, office space maintenance and included in sales and commercial costs (CC);
- Costs of contextual advertising that can lead customers at a fixed price for the transition (AC);
- Website promotion expenses that include SEO optimization costs and an increase in the number of external website links. These expenses refer to the depreciation cost, therefore, the money spent on the promotion of goods is considered for the purposes of analysis (WP).

All these costs form outcoming operational cash flows of e-commerce companies. To understand better the way the indicators affect outcoming cash flows, let's review the formula of the additive model of influence on the outcoming cash flows:

$$C = MC + CC + AC + WP, \quad (3)$$

where

C – costs;

MC – material costs;

CC – commercial costs;

AC – advertising costs;

WP – SEO and website promotion.

Changes in any of these components lead to the appropriate change in the ultimate indicator, i.e. the outcoming cash flows from operating activity and website development expenses (outcoming investment cash flows). These factors have a direct impact on outcoming cash flows because they affect their volume.

Advertising costs only have a direct impact on incoming cash flows. SEO-optimization costs also influence incoming cash flows, but even experienced professionals cannot predict how much money is needed to bring the website to the top of the search engine rankings. This effect can be tracked only after the changes in the sales volume took place provided the invariability of other factors of influence.

The company influences the amount of advertising expenses on its own initiative. These costs include contextual advertising, expenditures on social networks, etc. Such costs are a must if the online store is below the 10th position in the search engine according to the commercial search phrases. The same advertising costs may help increase sales revenue if the online store is below the 4th position in search results. The average price for bringing one customer is formed by advertising services and varies from UAH 0.5 to UAH 28 [4] depending on the level of competition. Developing advertising budgets, it should be kept in mind that advertising services lead visitors to the website, and not the customers. Therefore, the sales volume depends on the sales conversion rate.

Let's consider how the managers can obtain information on the choice of development strategy on the example of the website Intellect-Nova.com (Table 1).

Table 1

Cash flows' formation of Intellect-Nova.com considering the factors of influence

№	Influence factors	2015	2016	2017	2018
1	Conversion rate	0,017	0,015	0,01	0,01
2	Website visitors	36874	47319	87649	101929
3	Return of visitors	1,005	1,005	1,004	1,005
4	Average order total	0,12	0,12	0,12	0,12
5	Sales of goods and services (1*2*3*4)	75,6	85,6	105,6	122,3
6	SEO and web promotion	5	7,5	10,2	13
7	Advertising costs	0	0	0	0
8	Material costs	0	0	0	0
9	Commercial costs	6,5	6,5	8	8
10	Costs (6+7+8+9)	11,5	14	18,2	21
11	Free cash flow (5-10)	64,1	71,6	87,4	101,3

Source: developed by the author

Let's consider search engine results for the website (Table 2).

According to the sample results in Table 2, the average position of the website in Google search output is 3.3. These results allowed receiving UAH 122.3 thousand in 2018. Taking into account the data from Table 3, this Internet service can potentially receive another 61 thousand visitors which is 60% ((18.2 – 7.2) / 18.2).

To occupy the first position on all queries, one can purchase external site links that will eventually lead it to higher positions (with no guarantee though). Having no guaranteed effect, it is impossible to elaborate a mathematical model defining the dependence of the cash flow on the website's promotion. Therefore, let's make use of two possible directions to construct a model describing the impact of investments on free cash flow.

1. Contextual advertising that will bring the website to the 1st position in search results and allow to take away the maximum number of clients (about 60% more);

2. Conducting works on a website's internal optimization with an increase in sales conversion rate. Since the average conversion rate in the industry is 3.5% [6], and as of 2018, the current conversion rate is 1%, the website has a chance to improve the service level and attract more buyers.

Two economic and mathematical models may be helpful when looking for the right decision on the ways of financing:

1. A model describing the impact of advertising costs on free cash flow.

2. A model describing the influence of website's internal optimization on free cash flow.

Let's consider the model describing the impact of advertising costs (AC) on the free cash flow (FCF) of the e-commerce company (Figure 2).

Table 3 provides data on the potential site visitors based on the current position in the search engine. In order to get this potential number of visitors, it's necessary to plan the advertising costs (AC). If the funds for contextual advertising are not allocated, then the volume of proceeds from the sale of goods or services will remain unchanged. In case the funds are allocated, the sales proceeds will grow to their potentially possible level. The expediency of these costs will be evidenced by the figures of free cash flow, which will remain after the advertising campaign's financing. If it exceeds the advertising costs, then the advertising campaign makes sense and it should be continued to obtain the maximum amount of cash proceeds from the sales. If the cash flow is lower than the cost of the advertising campaign, then there is literally no sense in it.

Table 2

Search engine ranking of Intellect-nova.com

№	Key words	Position in Google search results
1	Financial analysis online	10
2	Analysis of financial condition online	4
3	Analysis of financial condition calculator	3
4	Financial analysis calculator	5
5	Online calculator for financial analysis	3
6	Financial analysis calculator online	4
7	Business plan calculator	3
8	Business plan online	2
9	Financial plan calculator	4
10	Financial analysis online	2
11	Analysis of financial condition online	1
12	Financial analysis calculator	1
13	Analysis of financial condition calculator	1

Source: developed by the author based on Google search results

Table 3

Dependence of the number of website visitors on the website's position in search results

Position in search results	Number of referrals from Google search	Number of referrals from Yandex search
1	18.2%	18.6%
2	10.1%	16.2%
3	7.2%	12.4%
4	4.8%	4.9%
5	3.1%	5.97%
6	2.8%	5.93%
7	1.9%	4.12%
8	1.8%	4.76%
9	1.5%	4.81%
10	1%	4.44%

Source: [5]

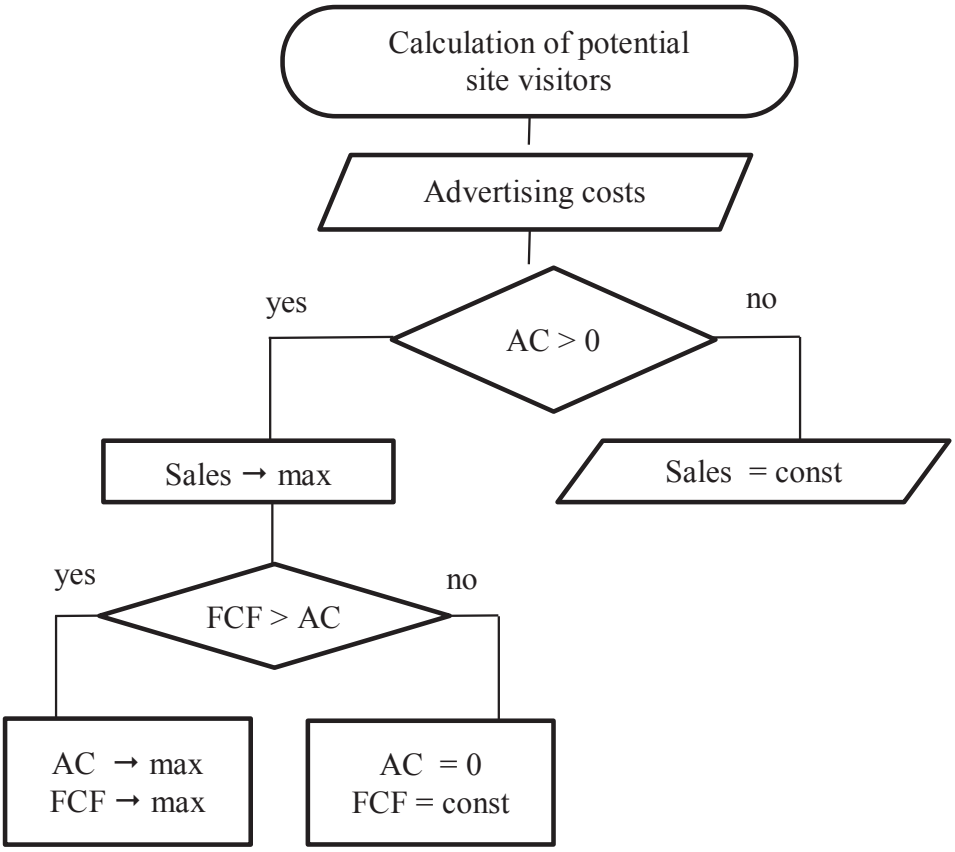

Fig. 2 Flowchart of the advertising costs' impact on free cash flow

Source: developed by the author

Let's elaborate a model describing the impact that contextual advertising exerts on free cash flow. Cash flows of the website Intellect-nova.com for 2018 will serve as the input data.

The cost of attracting one visitor is the main factor that affects the size of an advertising budget. The higher the competition on queries, the higher the price. The minimal price is UAH 0.28 but it's impossible to attract the desired 60 thousand visitors under such rate. To attract additional 160 visitors a day, it's necessary to have the price of UAH 3. Advertising services offer the manager an optimal price for which it's possible to get the desired customers. Thus, in order to bring 60 thousand additional visitors (100% of the possible quantity), UAH 180 thousand should be spent (see Table 4).

We take into account that it's necessary to invest UAH 180 thousand to execute 100% of the advertising campaign. This amount allows attracting 167,025 visitors. Given the unchanged conversion rate, the number of customer returns and the average check, potential sales revenues amount to UAH 200.4 thousand. At the same time, the free cash flow amounts to UAH 0.6 thousand.

Even if trying to implement a plan for attracting customers and investments in advertising by 20% or

Table 4

Results of modelling the impact of advertising on the free cash flow of Intellect-nova.com

Percentage of the advertising campaign's completion	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**
Cost of advertising budget, thousand UAH	**0**	**36**	**72**	**108**	**144**	**180**
Number of website visitors	107 025	119 025	131 025	143 025	155 025	167 025
Conversion rate, coefficient	0,01	0,01	0,01	0,01	0,01	0,01
Number of customer returns, coefficient	1,01	1,01	1,01	1,01	1,01	1,01
Average check, thousand UAH	0,12	0,12	0,12	0,12	0,12	0,12
Revenues from sales, thousand UAH	128,4	142,8	157,2	171,6	186,0	200,4
Fixed costs, thousand UAH	21,00	21,0	21,0	21,0	21,0	21,0
Advertising costs, thousand UAH	0	36,0	72,0	108,0	144,0	180,0
Outcoming cash flows, thousand UAH	21,00	57,0	93,0	129,0	165,0	201,0
Free cash flow, thousand UAH	107,42	85,8	64,2	42,6	21,0	-0,6

UAH 36 thousand, the free cash flow will decrease (as Figure 3 shows). This means it is unprofitable to advertise under such a price.

Let's build a second model describing the influence of the website's internal optimization on the free cash flow (FCF) of e-commerce company (Figure 4).

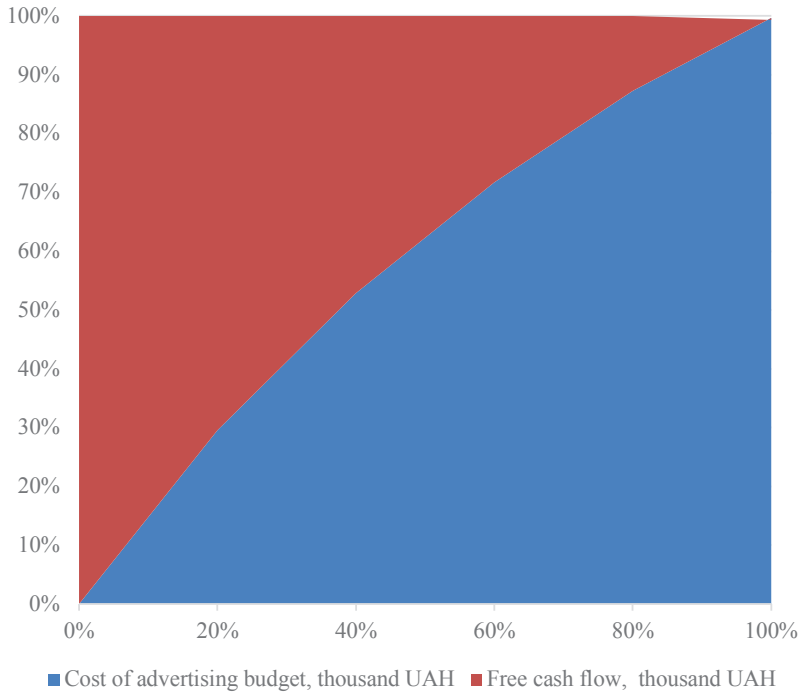

Fig. 3. Dependence of free cash flow of Intellect-nova.com on the costs of contextual advertising

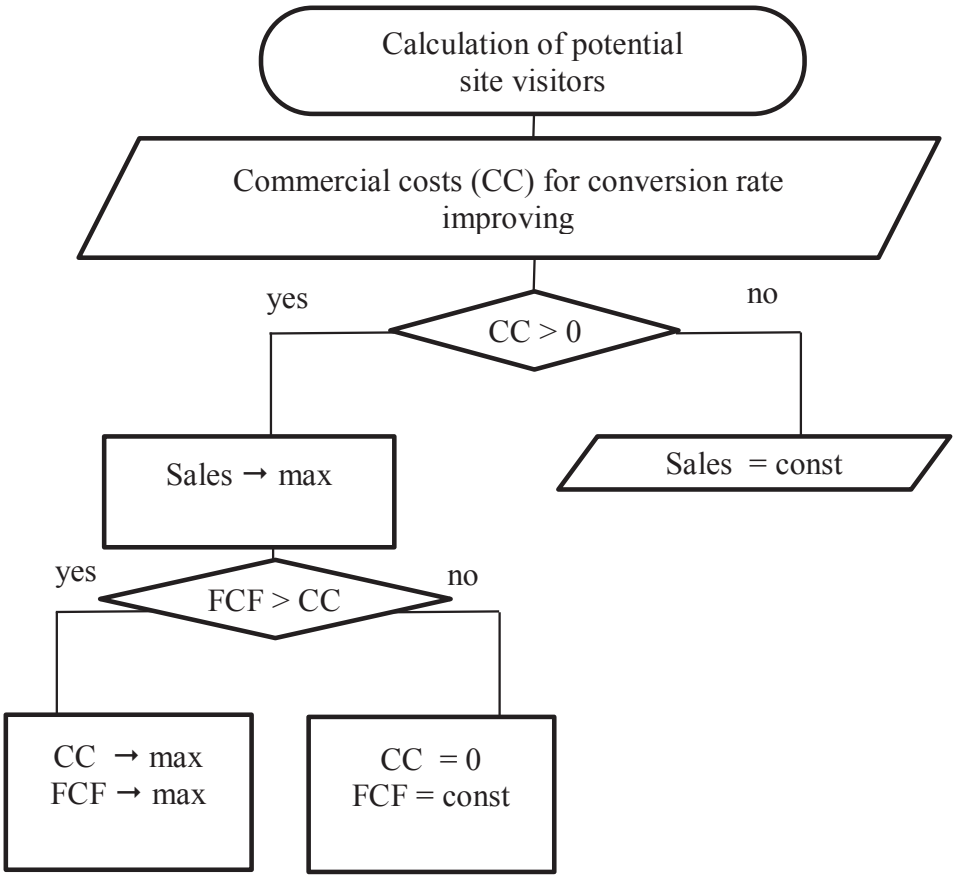

Fig. 4. Flowchart of the influence of the website's internal optimization

Source: developed by the author

At the preparatory stage, the website's potential conversion volume is determined.

For Intellect-nova.com, the average industry indicator is 3.5%, while the current conversion rate is 1%. Thus, it's possible to conduct certain measures to improve the service, as well as the convenience of making purchases, which would result in an increase in the conversion rate. These measures require one-time expenses on programming, design, and staff remuneration. If these measures are not carried out, the volume of proceeds from the sale of goods or services will remain unchanged. In case of success, the increased volume of conversions will lead to an increase in the volume of proceeds from the sale of goods or services. If the costs are higher than the result, then they are inappropriate. If they are lower compared to the ultimate result, then these measures should be taken to obtain the maximal free cash flow (see Figure 4).

Let's perform the modelling of the impact of a website's internal optimization on the cash flow and determine the profitability of the investments. To begin with, let's set a goal to improve the conversion level by 25% so that the conversion rate is 1.25%. Provided a constant number of visitors of 107025 users per year and unchanged rates of both customer returns and the average check, the potential revenue from the sale of goods or services will amount to UAH 160.5 thousand (see Table 5).

The cost of work on improving the website's functioning is estimated at UAH 18 thousand. The calculations show that these investments are feasible for an enterprise only along with an increase in the conversion rate from 15%, that is, the conversion rate should be at least 1.15%.

Accordingly, in order to increase the volume of proceeds from the sales of goods and services, it's necessary to invest in increasing the level of conversion and not in advertising.

Conclusions. Free cash flow is one of the most important effectiveness indicators of e-commerce companies. It shows the amount of money that should

Table 5

Results of modelling the impact of internal website optimization on the free cash flow of Intellect-nova.com

Percentage of conversion change	**0,00**	**5%**	**10%**	**15%**	**20%**	**25%**
Conversion, coefficient	**0,01**	**0,0105**	**0,0110**	**0,0115**	**0,0120**	**0,0125**
Number of website visitors	107025	107025	107025	107025	107025	107025
Number of customer returns, coefficient	1,01	1,01	1,01	1,01	1,01	1,01
Average check, thousand UAH	0,12	0,12	0,12	0,12	0,12	0,12
Revenues from sales, thousand UAH	128,42	134,8	141,3	147,7	154,1	160,5
Fixed costs, thousand UAH	21,00	21,0	21,0	21,0	21,0	21,0
Administrative costs on improving conversion, thousand UAH	0,00	18,0	18,0	18,0	18,0	18,0
Outcoming cash flows, thousand UAH	21,00	39,0	39,0	39,0	39,0	39,0
Free cash flow, thousand UAH	107,42	95,8	102,3	108,7	115,1	121,5

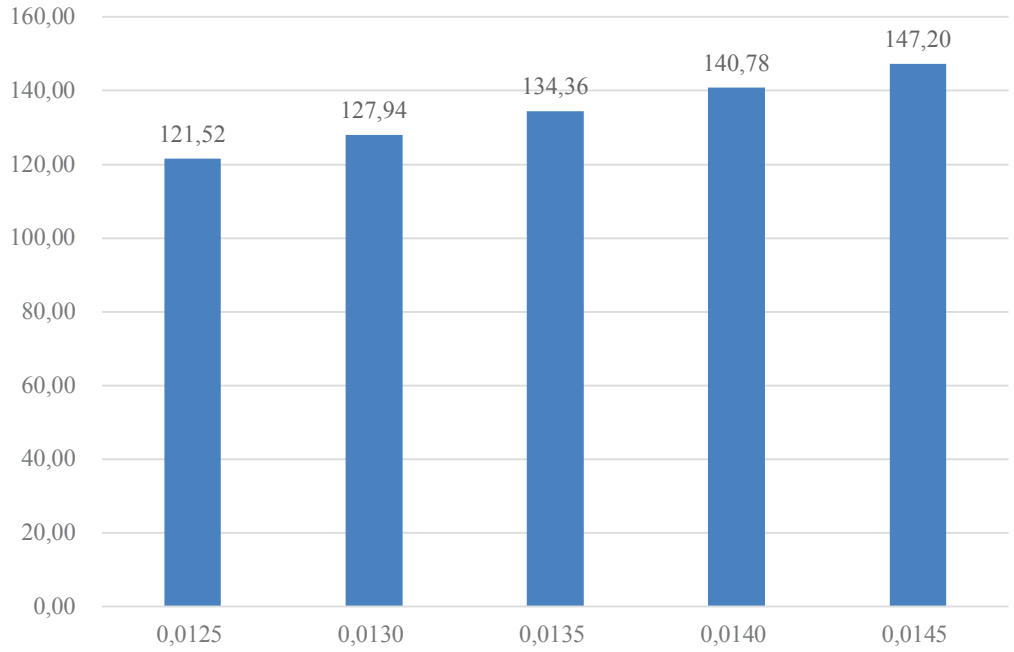

Fig. 5. Dependence of free cash flow on the conversion rate

remain to finance not only current activities but also growth opportunities. For enterprises with traditional forms of sales, the growth implies investments in fixed or working capital. But for e-commerce companies, the growth means an increase among the positions in search engines' results and improvement of the level of service for their clients. If the managers resort to these measures, the volume of revenues can be increased to the maximum possible level and the efficiency of the cash flow will also be the highest. It is necessary to conduct economic and mathematical modelling to determine correctly the possible ways of investments, as well as their volume. The model describing the impact of advertising costs on the free cash flow allows determining the terms, under which the advertising campaign is worth conducting. The model describing the influence of the website's internal optimization on the free cash flow is able to show the potential amount of free cash flow that an enterprise can obtain and enables to determine the volumes of investments, under which internal optimization measures will be effective.

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ECONOMIC AND MATHEMATICAL MODELS OF CASH FLOWS FOR E-COMMERCE ENTERPRISES

The article is devoted to economic and mathematical models of cash flows at Ukrainian e-commerce enterprises.

The main task of creating an economic and mathematical model of cash flows for an e-commerce company is to determine the correct way of the funds' exploitation, as well as the optimal amount of investments to increase both the volume of proceeds from sales and the free cash flow.

Nowadays, the best financial management practices use the models of cash flows aimed at determining the optimal stocks of working capital to perform the operational activity. This study deals with two economic and mathematical models that have been created to assess the effectiveness of investing in the growth of e-commerce enterprises.

1. A model describing the impact of advertising costs on free cash flow.
2. A model describing the influence of website's internal optimization on free cash flow.

The first model describes the impact of advertising costs on the free cash flow of the e-commerce company. You can calculate potential attendance based on the current position in the search engine. In order to get this potential number of visitors, it's necessary to plan the advertising costs. If the funds for contextual advertising are not allocated, then the volume of proceeds from the sale of goods or services will remain unchanged. In case the funds are allocated, the sales proceeds will grow to their potentially possible level. If the cash flow is lower than the cost of the advertising campaign, then there is literally no sense in it.

The second model describes the impact of the conversion rate on the free cash flow of the e-commerce company. You can calculate the sites conversion rate and compare its volume with the average industry. Thus, it's possible to conduct certain measures to improve the service, as well as the convenience of making purchases, which would result in an increase in the conversion rate. These measures require one-time expenses on programming, design, and staff remuneration. If these measures are not carried out, the volume of proceeds from the sale of goods or services will remain unchanged. In case of success, an increased volume of conversions will lead to the increase in the volume of proceeds from the sale of goods or services. If the costs are higher than the result, then they are inappropriate. If they are lower compared to the ultimate result, then these measures should be taken to obtain the maximal free cash flow.

The main purpose of growth is not only to increase the volume of proceeds from the sales of goods or services but also to improve the efficiency of cash flows.

The combination of these two models allows choosing the right direction of financial management at e-commerce enterprises, which is based not only on increasing turnover but also on improving the efficiency of the funds' exploitation.