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ASSESSING THE IMPACT OF INFORMATION TECHNOLOGIES ON THE TARGET INDICATORS OF CONSULTING ENTERPRISE'S STRATEGIC DEVELOPMENT

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ОЦІНКА ВПЛИВУ ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ НА ЦІЛЬОВІ ПОКАЗНИКИ СТРАТЕГІЧНОГО РОЗВИТКУ КОНСАЛТИНГОВОГО ПІДПРИЄМСТВА

In terms of the aim of the paper, that consisted of the investigation the impact of information technology as a factor of globalization on the amount of revenue from the services' sales for enterprises in the field of management consulting on the example of their potential participation in tender procedures (open tenders) for the purchase of services, which are specialized in all the studied

consulting enterprises, a statistical model for assessing the impact of information technology on the amount of revenue from the services' sales of consulting enterprises was built. As initial data, the data from the Prozorro system were used: on the results of the participation of consulting companies operating within the codes 79410000-1 Consulting services on business and management and 79430000-7 Crisis management services in accordance with the classifier DK 021:2015, during the period from March seventeenth to April nineteenth, 2021. To obtain the research results, the method of regression analysis, graphical method, elements of probability theory, methods of analysis and synthesis were used. In the process of studying the relationship, the null hypothesis regarding the geometric law of probability distribution was rejected in accordance with the purpose. Instead, the highest values of statistical criteria were obtained for the hypothesis that the possibility of obtaining high revenues from consulting services using the Prozorro system follows an exponential distribution. The main coefficients of the mathematical equation describing the model and statistical criteria were also determined. The obtained criteria indicate that the model can be considered acceptable, but there are probably additional factors that affect the result and require additional research. Taking into account the results obtained, it was also found that the probability of increasing twice revenue for management consulting companies from the minimum level of the range, for example, the required frequency of participation should be about twenty times, and the probability of obtaining the planned revenue will still remain low. The model obtained as a result of the study can be recommended for use in strategic management in assessing the probability of implementing various scenarios of potential development and the possibility of achieving the enterprises' strategic goals. At the same time, the model also has the potential for further research, in particular, to establish a list of factors that additionally affect the possibility of increasing income from consulting services' sales.

Відповідно до мети, яка полягала у дослідженні впливу інформаційних технологій як чинника глобалізації на розмір виручки від реалізації послуг для підприємств у сфері управлінського консалтингу на прикладі їх потенційної участі у тендерних процедурах (відкритих торгах) по закупівлі послуг, на яких спеціалізуються усі досліджувані консалтингові підприємства, було побудовано статистичну модель оцінки впливу інформаційних технологій на

розмір доходу від реалізації послуг консалтингових підприємств. В якості вихідних даних було використано дані системи Prozorro щодо результатів участі консалтингових підприємств, які провадять діяльність в межах кодів 79410000-1 Консультаційні послуги з питань підприємницької діяльності та управління та 79430000-7 Послуги з управління в умовах кризи відповідно до класифікатора ДК 021:2015, протягом періоду з сімнадцятого березня по дев'ятнадцяте квітня 2021 року. Для отримання результатів дослідження було використано метод регресійного аналізу, графічний метод, елементи теорії імовірності, методи аналізу та синтезу. В процесі дослідження зв'язку відповідно до мети було відхилено нульову гіпотезу щодо геометричного закону розподілу імовірностей. Натомість найвищі значення статистичних критеріїв отримала гіпотеза про відповідність можливості отримати високу виручку від надання консалтингових послуг з використанням системи Prozorro експоненційному розподілу. Також було визначено основні коефіцієнти математичного рівняння, яке описує модель, та статистичні критерії. Отримані критерії, свідчать, що модель можна вважати прийнятною, але, імовірно, існують додаткових факторів, які впливають на результат і потребують додаткового дослідження. З урахуванням отриманих результатів було також встановлено що імовірність збільшення виручки для підприємств сфери управлінського консалтингу з мінімального рівня діапазону, наприклад, удвічі необхідна частота участі має бути близько двадцяти раз, а імовірність отримання запланованої виручки при цьому все одно залишиться низькою. Отриману в результаті дослідження модель можна рекомендувати для використання в стратегічному менеджменті при оцінці імовірностей реалізації різних сценаріїв потенційного розвитку та можливостей досягнення стратегічних цілей підприємств. Водночас, модель також має потенціал для подальших досліджень, зокрема, встановлення переліку чинників, які додатково впливають на можливість збільшення доходу від реалізації консалтингових послуг.

Keywords: information technology, Prozorro, revenue from sales, management consulting, statistical model.

Ключові слова: інформаційні технології, Prozorro, дохід від реалізації продукції, управлінський консалтинг, статистична модель.

Problem statement. In the process of forming a competitive development strategy, upon completion of the stage of formulating a list of strategic goals and objectives, decision makers related to the development of enterprises need to take into account all factors that affect or may affect the ability to achieve the goals. To assess the impact, there is a need for a certain range of indicators. Among them are indicators that can be mathematically calculated and used to quantify the degree of potential achievement of goals. Among the indicators that allow to assess the degree of achievement of the goals of competitive strategic development of the enterprise, in particular, are the amount of revenue from the sale of products, works, services [1, p.112; 2, p.1; 3, p. 54-58].

At the same time, globalization is undoubtedly one of the important factors influencing the enterprise [4, p. 6-14; 5, p. 95-98]. In turn, globalization affects the activities of enterprises through various factors, one of which is information technology. Therefore, when assessing the prospects of various scenarios of strategic development of an enterprise, it is important for modern strategists to understand the relationship between the use of information technology and the possibility of increasing revenue from the sales.

Analysis of recent research and publications. The issue of the impact of information technology as a factor of globalization on the possibility of increasing the company's revenue has been studied in the scientific works of both domestic and foreign experts. In particular, we can identify the works of Fellows C. [1], Markgraf B. [2], Hiebl M. [4], Shkonda V. [6], Kalyanov A. [6], Voronkov V. [7] and other researchers whose works explore various aspects of the issues in question. At the same time, the issue of the impact of information technology on the revenue, in particular, of consulting companies, remains poorly understood.

The purpose of the article. The purpose of the article is to study the impact of information technology as a factor of globalization on the amount of revenue from the sale of services for consulting enterprises on the example of their potential participation in tender procedures (open bidding) for the purchase of services, which are specialized in all the studied consulting enterprises. The

research was conducted using the method of regression analysis, graphical method, elements of probability theory, methods of analysis and synthesis.

Summary of the main material. To assess the impact of information technology on the efficiency of increasing revenue from the sale of services of a management consulting company, the article uses the Prozorro electronic public procurement system, which is sometimes cited as an example of successful application of information technology in Ukraine [8].

Prozorro is an online platform where tenders are announced to business representatives for the procurement of goods, works and services by state and municipal enterprises and institutions [9]. As a basic electronic service for obtaining information on the size of price offers for the procurement of management consulting services, which according to the Classifier DK 021:2015 are represented by the codes: 79410000-1 Consulting services on business and management; 79430000-7 Management services in crisis, the next website was chosen: zakupivli24.pb.ua [9].

According to the completed procurements, as of the period of the study from March 17 to April 19, 2021, one thousand offers for the purchase of services for the entire period were available. That is, each offer can potentially be income from the sale of services for management consulting companies.

Based on the obtained sample of 1000 cases of potential income from the sale of consulting services, intervals for the distribution of the distribution of income from sales were formed. The number of intervals is determined by the Sturgis formula [10]:

$$n = 1 + 3,322 \times \ln N, \quad (1)$$

where n is the number of intervals; N is the sample size.

For a sample of 1000 observations, the number of intervals (formula 1) will be rounded to 11 (mathematical rounding is 10.97). One interval step is determined by the following formula 2 [10]:

$$h = \frac{x_{max} - x_{min}}{n}, \quad (2)$$

where x_{max} , x_{min} are the maximum and minimum values of revenue; n is the number of intervals.

Thus, one interval step will be $(500000-1)/11=45454$ UAH (formula 2). The results of the distribution of revenue by intervals are shown in Table 1. The frequency was determined using the corresponding Excel function.

Table 1. Results of cluster formation for determining financial indicators for assessing the effectiveness of the enterprise's competitive strategy of development

№ of interval	Interval limits		Frequency	
	Lower	Upper	Units	%
1	1	45 455	942	94,20%
2	45 456	90 910	49	4,90%
3	90 911	136 365	1	0,10%
4	136 366	181 820	1	0,10%
5	181 821	227 275	6	0,60%
6	227 276	272 730	0	0,00%
7	272 731	318 185	0	0,00%
8	318 186	363 640	0	0,00%
9	363 641	409 095	0	0,00%
10	409 096	454 550	0	0,00%
11	454 551	500 005	1	0,10%

Source: compiled by the author using formulas 1; 2.

Based on the data in Table 1, a histogram and a frequency distribution polygon were constructed (Fig. 1; 2).

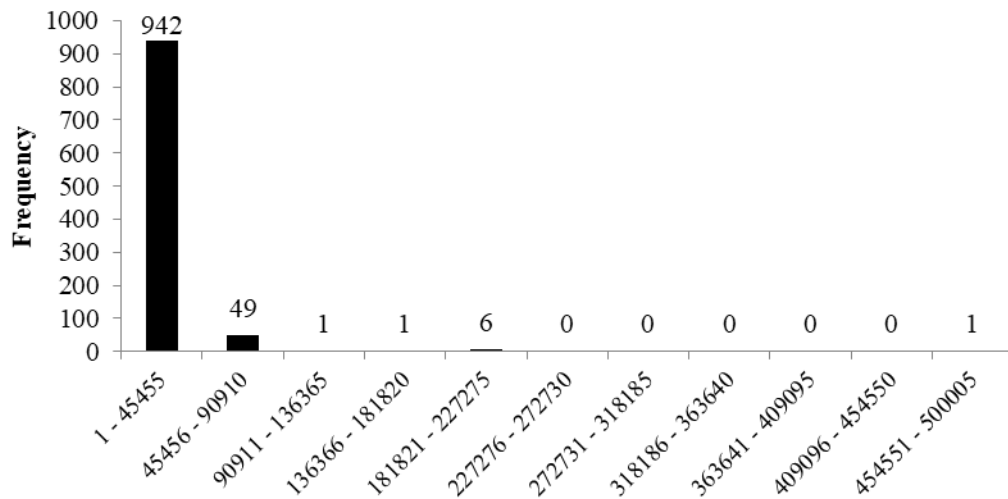


Fig. 1. Histogram of frequency distribution

Source: compiled by the author on the basis of Table 1.

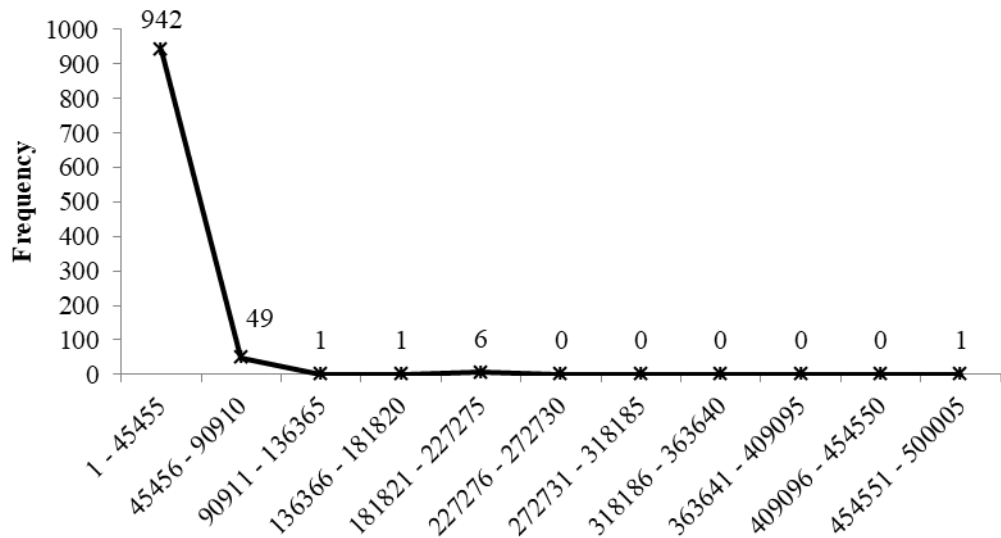


Fig. 2. Distribution polygon of empirical frequencies

Source: compiled by the author on the basis of Table 1.

The obtained histogram and polygon graphs suggest that the possibility of obtaining high revenues from the provision of consulting services using the Prozorro system, as an example of modern financial and other information technologies, follows a geometric distribution law [11].

To test the hypothesis about the geometric law of distribution, the Pearson's criterion χ^2 was used. It is determined by the formula 3 [12]:

$$\chi^2 = \sum \frac{(n_i - n'_i)^2}{n'_i}, \quad (3)$$

where n_i – empirical frequency; n'_i – theoretical frequency.

For further calculations, a sample average was determined using formula 4 [12]:

$$\bar{x}_B = \frac{\sum x_n \times n_i}{n}, \quad (4)$$

where x_n is the middle of the interval.

The sample variance is determined by the formula 5 [12]:

$$D_B = \frac{\sum x_i^2 \times n_i}{n}. \quad (5)$$

The sample standard deviation is determined by the formula 6 [12]:

$$\sigma_B = \sqrt{D_B}. \quad (6)$$

Based on the results of using formulas 4-6, the average value for the sample ($\bar{x}_B$) became 29 592 UAH, sample variance (D_B) became 1083059987 UAH, the standard deviation (σ_B) became 32910 UAH.

Next, the theoretical frequency is determined by formula 7 [12]:

$$n'_i = \frac{h \times n}{\sigma_B} \times f(z_i), \quad (7)$$

where h is the length of each interval; $f(z_i)$ is the Gaussian function; z_i is the argument of the Gaussian function, which is calculated by the formula 8:

$$z_i = \frac{x_i - \bar{x}_B}{\sigma_B}. \quad (8)$$

As a result of the calculations using formulas 1-8, a table of initial data for calculating the Pearson's criterion was formed (Table 2). Since to comply with χ^2 -allocation it is necessary to have at least 5 observations in each interval, when forming the intervals of Table 2, the second, third and fourth intervals of Table 1 were combined into one and the fifth to eleventh intervals into another.

Table 2: Data for determining the Pearson's criterion to confirm the hypothesis of the law of distribution

No of interval	Interval limits		Empirical frequency (n_i)	The middle of the interval (x_i)	z_i	$f(z_i)$	Theoretical frequency (n'_i)	Interval length (h)	$n'_i - n_i$
1	1	45455	942	22728	-0.21	0.3902	507.67	45454	434
2	45456	181820	51	113638	2.55	0.0154	3.25	45454	50
3	181821	500005	7	340913	9.46	0.0001	1.00	45454	6

Source: author's calculations based on Tables 1 and 2.

The frequency range is shown in Figure 3.

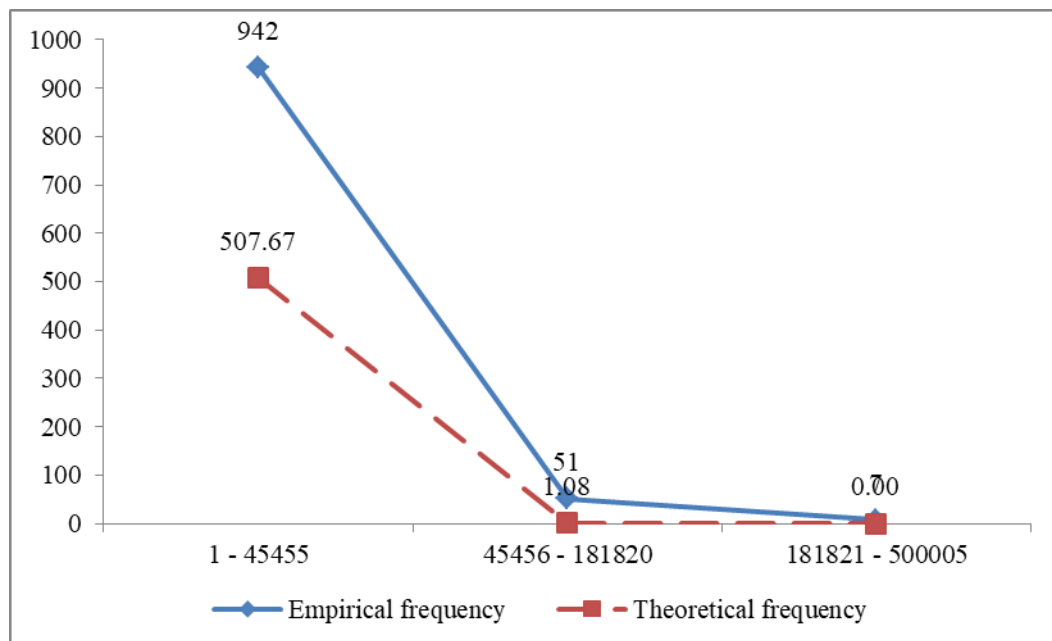


Fig. 3. Empirical and theoretical frequencies' polygon of allocation

Source: compiled by the author on the basis of the data in Tables 1; 2.

Taking into account the data of Table 2 and using formula 3, the calculated Pearson's criterion was 2722, which is significantly higher than the critical value of the Pearson's criterion of 3.84, determined for freedom levels 1 using Excel

«ХИ2.ОБП», where the number of intervals is assumed to be three, according to Table 2, and the number of estimated parameters of the distribution law is 1. Since the calculated Pearson criterion is higher than its critical value, the null hypothesis about the geometric distribution law is rejected at the accepted significance level $\alpha = 0.05$.

To determine another variant of the distribution law, the Matlab software package was used. Thus, the highest values of statistical criteria were obtained for the hypothesis that the possibility of obtaining high revenues from the provision of consulting services using the system is consistent with a transparently exponential distribution, which can be described by the following formula:

$$f(x) = a \times \exp(b \times x) + c * \exp(d \times x), \quad (9)$$

where with the level of significance $\alpha=0,05$ the formula coefficients are determined in accordance with the information in Fig. 4:

```
General model Exp2:
f(x) = a*exp(b*x) + c*exp(d*x)
Coefficients (with 95% confidence bounds):
a = 2.363e+05 (-1.083e+05, 5.808e+05)
b = -0.2086 (-0.9917, 0.5745)
c = 9.126e+04 (-2.415e+05, 4.24e+05)
d = -0.001608 (-0.01823, 0.01502)

Goodness of fit:
SSE: 1.058e+11
R-square: 0.5347
Adjusted R-square: 0.3353
RMSE: 1.229e+05
```

Fig. 4. Model coefficients and statistical criteria of the exponential distribution determined using the software package Matlab

Source: Matlab calculations using the results of calculations.

Thus, the obtained value of the coefficient of determination (R-squared) of more than 50% indicates that the model is acceptable, but probably requires the study of additional factors that affect the result.

As a result of the data obtained, it can be noted that the larger the amount of revenue to be obtained as a result of bidding, the lower the probability of obtaining it. The probability of obtaining the target revenue can be determined by the formula 10 [13; 14]:

$$P(A) = \frac{m}{n} , \quad (10)$$

where $P(A)$ is the event probability A ; m is the number of elementary consequences favorable to the event A ; n is the number of all possible elementary consequences.

Thus, using formula 9 in Excel, we can say that to double the revenue from the minimum level of the range of 45454 UAH, the required frequency of participation should be about 20 times, and the probability of obtaining the planned revenue (taking into account formula 10) will be $20/1000 = 0.02$ or 2% (where 20 is the number of tenders to be participated in to double the revenue from the minimum level of the range of 45454 UAH, and 1000 is the total number of tenders offered per month according to the initial data [9]). The resulting low probability of winning orders with a significant value is also possible due to the fact that the study sample rarely has tender offers with the value of services above the minimum level of the range (Tables 1; 2).

Thus, it can be concluded that the use of information technologies to increase sales revenue for consulting companies has a rather low probability of obtaining the planned amount of increased revenue. At the same time, according to the obtained statistical criteria, it should be noted that taking into account additional factors when participating in electronic bidding may well increase the probability of winning and increase the efficiency of implementing a competitive strategy for enterprise development.

Conclusions and prospects for further research in this area.

Summarizing the results, we can draw the following conclusions. Firstly, the use of information technologies to increase sales revenue for consulting companies has a rather low probability of obtaining the planned amount of increased revenue.

Secondly, according to the obtained statistical criteria, it should be noted that taking into account additional factors when participating in electronic bidding may well increase the probability of winning and increase the efficiency of implementing a competitive strategy for the development of an enterprise.

Thus, in general, the study modeled the process of assessing the impact of information technology as a factor of globalization on the amount of revenue of a consulting company, based on the results of a regression analysis of the relationship between the number of cases of its participation in open electronic auctions of the Prozorro public procurement system and the amount of revenue, which will allow using the indicator of the probability of obtaining the target revenue for an objective assessment of the adequacy of resources by a consulting company in order to choose the best one. At the same time, the issues of factors that could additionally affect the increase in potential revenue from the sale of consulting services as a result of participation in electronic bidding systems remain open for further research.

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