N.S. Medzhybovska, Dr. Sci. (Econ.), Associate Professor

Odessa National Economic University, Odessa, Ukraine, e-mail: nmedzh@oneu.edu.ua

ANALYSIS OF ECONOMIC EFFICIENCY OF THE ELECTRONIC PROCUREMENT SYSTEM APPLICATION AT AN INDUSTRIAL ENTERPRISE

Н.С. Меджибовська, д-р екон. наук, доц.

Одеський національний економічний університет, м.Одеса, Україна, e-mail: nmedzh@oneu.edu.ua

АНАЛІЗ ЕКОНОМІЧНОЇ ЕФЕКТИВНОСТІ ВИКОРИСТАННЯ СИСТЕМИ ЕЛЕКТРОННОГО ПОСТАЧАННЯ НА ПРОМИСЛОВОМУ ПІДПРИЄМСТВІ

Purpose. To develop the arguments for the electronic procurement systems implementation at industrial enterprises. To prove the dependence of electronic procurement systems implementation results from the level of profit of an industrial enterprise. To find the perspective directions for development of electronic procurement systems in Ukraine.

Methods. For this purpose we used the cross-correlation-regressive analysis method. To study the influence of information systems on industrial enterprise activity, namely, estimation of methods of Internet connection, we used the expert estimations and analysis method.

Findings. We have proved the economic efficiency of the electronic procurement system implementation at industrial enterprises and the dependence of its results on the level of enterprise profit.

Originality. To prove the dependence of electronic procurement system implementation results from the level of industrial enterprise profits a new complex of indices was used. This complex includes the level of automation and level of technical equipment of the industrial enterprise. The economic efficiency is calculated on the basis of influence of the electronic procurement systems on the enterprise profit margin. It intends reduction of expenses and revenue increase due to operating savings and funds release because of inventory decreasing.

Practical value. We have found the strategic directions for the electronic procurement systems development in Ukraine. Large enterprises which have a wide network of business partners should become the initiators of electronic procurement systems implementation in Ukraine. The role of facilitator of electronic procurement systems implementation can be undertaken by the government bodies.

Keywords: *electronic procurement system, information and communication technologies, information systems, industrial enterprise, economic efficiency, cloud computing*

Problem setting. Economic efficiency is fundamental principle of business enterprises, which must comply with implementation of any innovation. The complexity of evaluating of the information systems implementation effectiveness is explained by the specificity of socio-technical systems, and includes, in addition to information and communication technologies (ICT), the social and organizational aspects, hence suggest complex interaction of people and technology. That is why the information systems have specific requirements for the assessment of their economic efficiency. Therefore, the implementation of information systems requires careful analysis of all consequences, both economic and social issues.

Analysis of the recent research and publications. The fundamental problem in evaluating of the effectiveness of information systems is that "IT investments do not meet the standard situation considered in the theory of business economics. In the case of investments, such as in new production equipment, we are talking about the decision in a structured situation, which scope of implementation – except in rare cases – is clearly limited. Any investment can be viewed as a sequence of earnings and disbursements of funds. Their value is determined by the proceeds from the sale of products and the residual value of the equipment, cost of acquisition and maintenance of equipment, as well as the given time interval. In addition, the "classic" investment often affect only to the one unit of the enterprise. To assess their profitability it is enough to use the appropriate methods of calculating return on investment" [1]. Opposite to this example, the implementation of information systems involves many departments of enterprise, their impact on the company is diversified and is connected with the presence of a number of side (hidden) effects. Thus the evaluation of their effectiveness is more complex and multifaceted.

This idea is confirmed by the apologists of balanced scorecard R. Kaplan and D. Norton: ICT investments generally have third-rate impact on financial performance. In general, they offer to balance the company performance system by the four groups. The first group includes the traditional financial indicators, the second group describes the business environment, especially the company relationship with customers, the third group describes the internal business processes, and the fourth group describes the ability of company to learn and develop [2].

Van Grembergen and Van Bruggen developed the traditional balanced scorecard system and designed it for the needs of IT departments. It is based on the idea that since the IT department has provided the internal needs of the enterprise, the group of indicators for the assessment of its performance should be formed from this point of view, namely the impact on the company, the focus on the consumer/user, operational excellence, focus on development [3].

Unsolved aspects of the problem. Practically, there are many applications based on the idea of the balanced scorecard for specific groups of information systems. They all emit different groups of indicators to assess the complex impact of the information systems on the overall enterprise performance. However, the implementation of the inter-organizational information systems that do affect not only the interests of particular enterprise but the group of business partners, brings some difficulties in assessment of their effectiveness.

Purpose. This paper evaluates the economic efficiency of the e-procurement implementation systems at the industrial enterprises. Since the e-procurement system is the inter-organizational information systems, its efficiency should be calculated on both the buyer and the supplier side. In this context, it requires the detailed analysis of the expected results and the estimation of costs associated with its implementation and use.

The main research. Neef indicates the examples of the possible impact of e-procurement system on the enterprise operating results. First, e-procurement helps to reduce transaction costs using the process automation, replacing manual labor, etc. Second, e-procurement promotes the elimination of functional limitations of separate enterprise departments in the direction of horizontal processes and cross-functional teams. Third, e-procurement promotes the integration between supply chain members. Thus, the "e-procurement means a giant leap forward in the long-sought-after development of the extended enterprise, where the supply chain becomes a continuous, uninterrupted process extending from buyer through selling partners" [4].

We have formulated the hypothesis about the dependence of the results of the e-procurement system implementation on the level of enterprise income. This hypothesis is based on the calculation of cost-effectiveness of e-procurement system for 105 industrial enterprises of Odessa and Odessa region. To prove this hypothesis we undertook the detailed research at 12 Odessa industrial enterprises, which included the procurement policies and rules, the company structure and its interaction hierarchy, the financial and accounting reports, the level of ICT use, etc. These enterprises are presented by 5 machine-building companies, 3 food industry companies, 2 metal product manufacturing companies, one cable industry company and one company producing plastic products.

This study was carried out in 2 ways:
- analysis of the primary accounting data to determine the items of logistics costs, which were used for the calculating the cost-effectiveness value;
- studying of the level of information systems implementation with the aim of identifying the factors which

can affect the efficiency of e-procurement system implementation, and carrying out the correlation and regression analysis on this basis.

Calculation of cost-effectiveness of e-procurement systems is shown in table 1. This calculation considers the reduction of the various items of operating costs and increasing profits or reducing losses by the reducing of inventory levels. For the cost of obtaining named result we used the cost of implementation and use of e-procurement system according the SaaS cloud computing model from the Coupa company. This is the business model of the software selling and implementation, in which the vendor develops Web-based application and run it on their own, and provides customers with access to the software via the Internet. The main advantage of the SaaS model for the consumer is the absence of costs associated with the installation, upgrading and support of the equipment and the software. In contrast to the classical software licensing scheme, the client spends relatively low recurring costs, and does not need to invest funds in the acquisition of software and hardware platform for deployment, and then maintains its efficiency.

The data for enterprises income and e-procurement system economic efficiency is shown in table 2.

Analysis of the data led to the conclusion that for all these enterprises efficiency of the e-procurement system implementation is above 1 with the distribution of values presented at the table 3.

It is important that the implementation of e-procurement system allows realizing a number of very important reserves which have influence to the efficiency of the industrial enterprise and its competitiveness, namely:

1. Reserve of rationalization of floating assets turnover. It is realized by reducing the inventory levels, and consequently, the cost of its transportation and storage. It can be achieved by the optimal choice of suppliers – participants of the e-procurement system and establish with them clear contractual terms.

2. Reserve of material resources price reduction. It is realized by obtaining the economies of scope, organization of the competition between the suppliers with the use of reverse auction and the dealing at electronic markets for the dynamic pricing.

3. Reserve of shortening of transactional function of the procurement department employees. It is realized by reducing the documentary transaction and associated with its labor costs, complexity and duration of operations, number of errors, by the automation of control under the operations and documents correspondence. This reserve can reduce the administrative costs of procurement function.

4. Reserve of empowerment of procurement department employees. It is realized by reducing the number of transactional tasks and implementation of proactive/preventive actions aimed to improve the efficiency of the enterprise.

5. Reserve of increasing of human potential initiatives. It is realized by granting to the procurement department employees the opportunities to apply practically their research, analytical, organizational, etc. abilities.

6. Reserve of cross-functional interaction. It is realized by involving the target business units of employees

to the process of formation and/or authorization of requests for the material resources purchasing.

7. Reserve of deepening cooperation with suppliers. It is realized through the establishment of close rela-

tionship between partner business processes which is necessary for successful implementation of the inter-organizational information system, i.e. the e-procurement system.

Table 1

Calculation of cost-effectiveness of e-procurement systems

Enterprise	The reduction of the purchasing prices	The reduction of the logistics costs	The overall reduction of the operational costs	The release of the funds from the turnover (due to destocking)	The increasing of profit/the decreasing of losses due to the release of funds from the turnover	Total impact on profit	Economic efficiency
LLC "Holding Company Micron"	840.88	52.96	893.84	535.50	0.99	894.83	3.93
CJSC "OZOM"	574.08	70.69	644.77	543.13	4.29	649.05	2.57
OJSC "Odespishchekombinat"	1460.64	56.65	1517.29	1124.88	-59.71	1 577.00	6.02
OJSC "Odessa Oil and Fat Plant"	7384.88	228.38	7613.26	1219.75	-318.57	7 931.83	26.85
OJSC "Chernomorpoligrafmetal"	744.56	55.48	800.04	125.38	2.28	802.32	2.91
OJSC "Odessa plant radial and drilling machines"	515.68	21.58	537.26	348.13	-49.07	586.33	2.30
PJSC "Odessa cable factory" Odeskabel "	32370.1	761.44	33131.52	10368.5	65.07	33 196.60	121.94
Odessa plant for food manufacturing "ProdMash"	582.48	55,94	638.42	968.50	41.56	679.99	2.86
OSC "Odessa Mechanical Plant"	286.80	17.01	303.81	1.50	0.00	303.81	1.06
PJSC "Production Association" Stalkanat-Silur"	56097.3	970. 30	57067.58	5641.50	-87.09	57 154.67	203.65
LLC "Gidroprom"	1932.08	482.72	2414.80	1846.38	309.22	2 724.02	9.91
LLC "Odessa oil extraction plant"	1493.76	255.96	1749.72	456.38	-7.37	1 757.09	6.40

Table 2

Values of the enterprise's income level and economic efficiency of the e-procurement system

Enterprise	Income, th. UAH	Efficiency
LLC "Holding Company Micron"	43 217.00	3.93
CJSC "OZOM"	9 400.00	2.57
OJSC "Odespishchekombinat"	27 216.00	6.02
OJSC "Odessa Oil and Fat Plant"	127 948.00	26.85
OJSC "Chernomorpoligrafmetal"	21 212.00	2.91
OJSC vOdessa plant radial and drilling machines"	8 588.00	2.30
PJSC "Odessa cable factory" Odeskabel "	588 858.00	121.94
Odessa plant for food manufacturing "ProdMash"	9 405.00	2.86
OSC "Odessa Mechanical Plant"	5 909.00	1.06
PJSC "Production Association" Stalkanat-Silur"	973 436.00	203.65
LLC "Gidroprom"	44 601.00	9.91
LLC "Odessa oil extraction plant"	93 312.00	6.40

Table 3

Distribution of values of economic efficiency of the e-procurement system implementation

The range of economic efficiency values	Number of enterprises	Part in the total number of enterprises, %	Income Level
1–5	6	50,00	5–45 mln. UAH
5–10	3	25,00	25–100 mln. UAH
25–30	1	8,33	125 mln. UAH
more than 100	2	16,67	500–1000 mln. UAH

We have performed correlation and regression analysis of the e-procurement system efficiency dependence from the number of factors to prove the dependence of the e-procurement system implementation results from the industrial enterprise income level. These are income (revenue) from the sale of goods (services) and 17 factors that characterize the level of information systems implementation at the industrial enterprise. Factors that characterize the information use level of systems at the enterprise are allocated on the survey data basis of employees and state statistical data (form № 1-ICT "Information and communication technologies and e-commerce in enterprises").

Correlation analysis shows the high dependence of the e-procurement system efficiency from the 8 indicators (more than 50%) (table 4).

The table 4 shows that the highest correlation for the e-procurement system efficiency has the income (revenue) index. For more detailed analysis we selected the "part of transactions with suppliers that are realized with the use of the EIE" index. We made this choice due to several significant reasons. First, this indicator has the greatest logical connection with our research, although it has lower coefficient of correlation than "part of transactions with other organizations that are realized with the use of EIE" indexes and "part of material resources

which are purchased with the help of computer networks" indexes. Secondly, the "part of material resources which are purchased with the help of computer networks" index, which also has a logical connection with the research and higher coefficient of correlation presents

non-zero value for only one company. Third, indicators of intranet and extranet availability, which also have a logical connection with the research area, presented by Boolean values that are not commonly used in the regression analysis.

Table 4

Dependence of e-procurement system efficiency from the number of factors

Index	The correlation coefficient
Income (revenue) from the sale of goods (services)	0.998026
Part of transactions with suppliers that are realized with the use of the electronic information exchange (EIE)	0.529891
Part of transactions with clients that are realized with the use of EIE	0.523885
Part of transactions with other organizations that are realized with the use of EIE	0.710609
Part of transactions, which are realized by the Web-site	0.681362
Part of material resources which are purchased with the help of computer networks	0.846448
Intranet availability	0.522798
Extranet availability	0.522798

As a result of the regression analysis was constructed the regression equation in the form (1)

$$y = 0{,}22 * x_1 + 7{,}00 * x_2 \quad , \qquad (1)$$

where y – the economic efficiency of the e-procurement system; x_1 – the income (revenue) from the sale of goods (services), mln. UAH; x_2 – the part of transactions with suppliers that are realized with the use of the EIE.

The economic interpretation of this equation is as follows: efficiency of the e-procurement system depends on the income (revenue) of the enterprise and scale of the already implemented activities for automation of interaction with suppliers.

This dependence is characterized by the squared $R2 = 0.997691$. This means that 99.77% of the variation in the response (the level of economic efficiency) caused by the variations of defined factors and only 0.23 % – by other factors. Hence we can come to conclusion as for the completeness of assessment of explanatory factors.

Further, the evaluation of the statistical reliability of simulations using the Fisher F-test showed the significance of the regression equation. For the 0.05 significance level the calculated Fisher's test value is $F_{obs}=1944.31$, which is more than its table value $F_{cr}=19.38$ for 12 cases ($n = 12$) and 2 factors ($m = 2$).

To assess the significance of the regression coefficients we use the Student's t-test. The critical value of the t-test from the Student's t distribution table for the significance level of 0.05 for 12 cases ($n = 12$) and 2 factors ($m = 2$) is $t_{cr} = 2.26$. We compare this number with the observed values of the t-test, calculated by sampling (in absolute value). Value t_{obs1} (52.86) for x_1 and t_{obs2} (-2.52) for x_2 exceed t_{cr} in absolute value. It means that factors x_1 and x_2 are significant. It is important to note that the importance of the factor x_1 (income) significantly exceeds the significance factor of x_2.

The free term of regression t_{obs3} = -0.07 does not exceed the critical value, thus the constant term is not significant and can be ignored.

Research conclusions and recommendations for further research. Thus, this paper proved the hypothesis is about the dependence of the e-procurement system results from the industrial enterprise income level. In other words, the initiator of the e-procurement system implementation should be the large enterprise that has income (revenue) from the sale of goods (services) at least 5 mln. UAH per year.

Thus, the initiators of the e-procurement system implementation should be large company with an extensive network of business partners. They should incur the initial costs for the designing and realization of information system and electronic interaction, thereby reducing costs of other participants of the supply chain. Participants of the e-procurement system should ensure that the level of their internal information systems is sufficient to the fulfillment of electronic interaction.

The initiator of the electronic procurement system can become the government body. First, the government is one of the largest consumers of industrial goods and services, and secondly, the government has the ability to develop and disseminate the standardized platforms for e-procurement (to avoid situations in which businesses have to use the different e-procurement system for the different vendors).

From our point of view, the public electronic procurement system can not only provide a fair procedure for public procurement and tendering for the government bodies, but also bring a number of very important benefits. First, the government can initiate the development of communication standards that will allow participants to share information in accordance with the common rules and single formats of information, and secondly, to become a guarantor of honesty and integrity of the electronic interaction between the participants. In addition, the government can play decisive role in the promoting of this progressive way of business.

As the directions of further research we plan to research named directions of e-procurement systems dissemination in Ukraine.

References / Список літератури
1. Bekker, Y., Vilkov, L. and Taratoukhine, V. (2010), *The Process Management,* Eksmo, Moscow, Russia.
Менеджмент процессов / [Беккер Й., Вилков Л., Таратухин В. и др.]. – М. : „Эксмо“, 2010. – 384 с.
2. Norton, D. and Kaplan, R. (1996), *The Balanced Scorecard: Translating Strategy into Action*, Harvard Business Press, pp. 336.
3. Van Grembergen, W. and Van Bruggen, R. (1997), "Measuring and improving corporate information technology through the balanced scorecard technique". Proceedings of the 4th European Conference on the Evaluation of Information Technology, Deflt, October, pp. 163–171.
4. Neef, D. (2001), *E-Procurement: From Strategy to Implementation,* Upper Saddle River, Prentice-Hall, pp. 207.

Мета. Обґрунтування доцільності впровадження систем електронного постачання на промислових підприємствах. Підтвердження гіпотези щодо залежності результатів використання системи електронного постачання від рівня доходу промислового підприємства. Формулювання перспективних напрямів розвитку систем електронного постачання в Україні.

Методи. Для досягнення поставленої мети був використаний метод кореляційно-регресійного аналізу. У ході дослідження впливу інформаційних систем на діяльність промислових підприємств, а саме оцінки способів Інтернет-з'єднання, застосовувався метод експертних оцінок і аналізу.

Результати. Обґрунтована економічна ефективність впровадження систем електронного постачання на промислових підприємствах, доведена залежність результатів використання системи електронного постачання від рівня доходу підприємства.

Наукова новизна. Для доказу залежності результатів використання системи електронного постачання від рівня доходу підприємства вперше використаний комплекс показників, що включають рівень автоматизації та рівень технічної оснащеності промислових підприємств. Розрахунок економічної ефективності, зроблений на підставі визначення впливу системи електронного постачання на розмір прибутку підприємства, що враховує збільшення прибутку або зменшення збитків за рахунок, з одного боку, скорочення операційних витрат, з іншого боку, вивільнення коштів з обігу внаслідок скорочення рівня виробничих запасів.

Практична значимість. Сформульовані можливості розвитку систем електронного постачання в Україні. Ініціаторами впровадження систем електронного постачання повинні стати великі підприємства, що мають широку мережу бізнес-партнерів. Роль ініціатора впровадження систем електронного постачання може взяти на себе держава.

Ключові слова: *система електронного постачання, інформаційно-комунікаційні технології, інформаційні системи, промислове підприємство, економічна ефективність, хмарні обчислення*

Цель. Обоснование целесообразности внедрения систем электронного снабжения на промышленных предприятиях. Подтверждение гипотезы о зависимости результатов использования системы электронного снабжения от уровня дохода промышленного предприятия. Формулирование перспективных направлений развития систем электронного снабжения в Украине.

Методы. Для достижения поставленной цели был использован метод корреляционно-регрессионного анализа. В ходе исследования влияния информационных систем на деятельность промышленных предприятий, а именно оценки способов Интернет-соединения, применялся метод экспертных оценок и анализа.

Результаты. Обоснована экономическая эффективность внедрения систем электронного снабжения на промышленных предприятиях, доказана зависимость результатов использования системы электронного снабжения от уровня дохода предприятия.

Научная новизна. Для доказательства зависимости результатов использования системы электронного снабжения от уровня дохода предприятия впервые использован комплекс показателей, включающих уровень автоматизации и уровень технической оснащенности промышленных предприятий. Расчет экономической эффективности произведен на основании определения влияния системы электронного снабжения на размер прибыли предприятия, что учитывает увеличение прибыли или сокращение убытков за счет, с одной стороны, сокращения операционных затрат, с другой стороны, высвобождения средств из оборота вследствие сокращения уровня производственных запасов.

Практическая значимость. Сформулированы возможности развития систем электронного снабжения в Украине. Инициаторами внедрения систем электронного снабжения должны стать крупные предприятия, имеющие широкую сеть бизнес-партнеров. Роль инициатора внедрения систем электронного снабжения может взять на себя государство.

Ключевые слова: *система электронного снабжения, информационно-коммуникационные технологии, информационные системы, промышленное предприятие, экономическая эффективность, облачные вычисления*