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USING FUZZY MODELING WHEN CALCULATING THE NET PRESENT VALUE (NPV) OF PROJECT

ВИКОРИСТАННЯ НЕЧІТКОГО МОДЕЛЮВАННЯ ПРИ РОЗРАХУНКУ ЧИСТОЇ ПРИВЕДЕНОЇ ВАРТОСТІ (NPV) ПРОЕКТУ

ANNOTATION

There was elaborated software of simulation model in C ++ Builder 6 environment, which allows calculating the net present value (NPV) criterion according to the set parameters, displaying the new data at the change in indicators, rates, primary investments. There was also carried out the statistical analysis of the results of experimenting with the simulation model, including the construction of charts and confidence intervals.

Keywords: fuzzy modeling, economic efficiency, NPV criterion, innovative project, LTE-technology, mobile operator.

АНОТАЦІЯ

У статті розроблено програмне забезпечення імітаційної моделі в середовищі C ++ Builder 6, яке дає змогу розраховувати чисту наведену вартість критерію NPV за заданими параметрами, відображаючи нові дані при зміні в показниках, ставках, первинних інвестиціях, а також проводити статистичний аналіз результатів експериментування з імітаційною моделлю, у тому числі побудову графіків і довірчих інтервалів.

Ключові слова: нечітке моделювання, економічна ефективність, критерій NPV, інноваційний проект, LTE-технології, оператор мобільного зв'язку.

АННОТАЦИЯ

В статье разработано программное обеспечение имитационной модели в среде C ++ Builder 6, которое позволяет рассчитывать чистую приведенную стоимость критерия NPV по заданным параметрам, отображая новые данные при изменении в показателях, ставках, первичных инвестициях, а также проводить статистический анализ результатов экспериментирования с имитационной моделью, в том числе построение графиков и доверительных интервалов.

Ключевые слова: нечеткое моделирование, экономическая эффективность, критерий NPV, инновационный проект, LTE-технологии, оператор мобильной связи.

Introduction. The main problem of the development of innovative activity of mobile operators in Ukraine is the low level of funding from the introduction of new technologies that can generate significant revenues to the budgets of the mobile operators and the state as a whole. The introduction of 4G LTE-technologies by the domestic enterprises is an effective mechanism for transforming the quality of mobile services to innovative development of the telecommunications sector.

An important contribution to the study of the theoretical and practical aspects of innovative developments of the telecommunications sector was made by such prominent scientists as V.N. Orlov, V.M. Granaturov, E.A. Knyazeva, G.A. Otlivanskaya, N.S. Bobrovnichaya, I.Y. Lebedeva, S.I. Gritsulenko. At the present stage of market reforms of the telecommunication industry, new organization and economic issues, related to global market integration, appear.

In Ukraine the traditional kinds of 4G technology, adopted to domestic climate and very popular at the world telecommunication industry. 4G and LTE-technology demand regular complex scientific monitoring of economic aspects of their products in unstable market conditions. This actual problem defined and theme, logical structure and results of the submitted research.

Problem Statement. Of the article is to determine possible ways of LTE-technology introduction of Ukraine telecommunication industry as a precondition for development of clear and transparent state policy. Such as should serve as the basis for regional organizations activities taking into account experience of other counties in 4G development regulation. Future research in this area will contribute to more accurate models of calculate the net present value (NPV) of project with LTE-technology introduction in Ukraine telecommunication industry.

Results. By now there have been proposed several dozens of methods for the calculation and analysis of the economic effect of innovative projects of the enterprise development. The evaluation of economic efficiency of the introduction of new technologies in the enterprise is an essential part of its feasibility study [1, p. 18–36]. Thus, there can be distinguished four main groups of methods that allow determining the effect of the introduction of technologies: financial, qualitative, quantitative, probabilistic.

One of them is the criterion of the net present value (NPV), which shows the amount of money that an investor expects to receive from the project after the cash inflows recoup his initial investment costs and the recurring cash outflows related to the implementation of the project upon the introduction of new technologies on the enterprise in future [2, p. 33–38].

The NPV criterion is the most important criterion of economic efficiency of projects and represents the difference between all the cash inflows and outflows at the present moment of the investment project assessment [3, 76 p.]. This criterion also has several drawbacks and cannot be the only means of investment evaluation. NPV determines the absolute value of the return on investment

and most likely, the bigger investment the greater the net present value will be. All cash payments are estimated taking into account the risks and their time value, it means that NPV is the value that is added by the project itself [4, 22–29 p.]. Obviously, each project on innovation technologies requires investment Inv. The corresponding range of activities after their implementation will lead to the sale of products or services. As a result of these services sale there appears discounted cash flow CF. Typically, the entire process is seen at certain times throughout the project life cycle from the time of its implementation [5, 48–51 p.; 6, 121–127 p.].

In order to calculate the net present value of the project on the implementation of LTE – technologies by the Ukrainian mobile operators there was developed a simulation model in the environment of C ++ Builder 6 allowing to automatically calculate the absolute and relative risk values of investment project [7, 132–139 p.]. Where the absolute indicator is the standard deviation of the project (shows the amount of potential losses on this investment project). In this case, the relative indicator of the project is the probability coefficient determining what kind of risk threatens investment to the future of the investment project. It also shows the evaluation of the effectiveness of the investment project based on the indicator of risk-priority, which allows making justified decisions on the feasibility of the future project implementation.

Based on the central limit theorem, it can be stated that the probabilistic distribution of the net present value of the project has normal distribution. It can be verified by constructing a histogram of the obtained values with the help of the developed software system of simulation model in C ++ Builder 6 environment is represented in Figure 1.1.

Normally distributed random variable of economic phenomena is continuous, and its differential distribution function determines the density of the probability distribution for each x. The diagram of function of the normal distribution is determined by the normal curve or the Gaussian curve. An important property of the diagram of the differential function of normal distribution is its area restricted by the normal curve and the x-axis, always equal to 1.

Using the density of the normal distribution allows reflecting the probability of the appearance of random variable. To estimate the probability that the random variable gets into the integral, the integrated density function is used:

$$f(x) = \int_{-\infty}^{x} f(t)dt,$$

where f(t) – differential function of the normal distribution

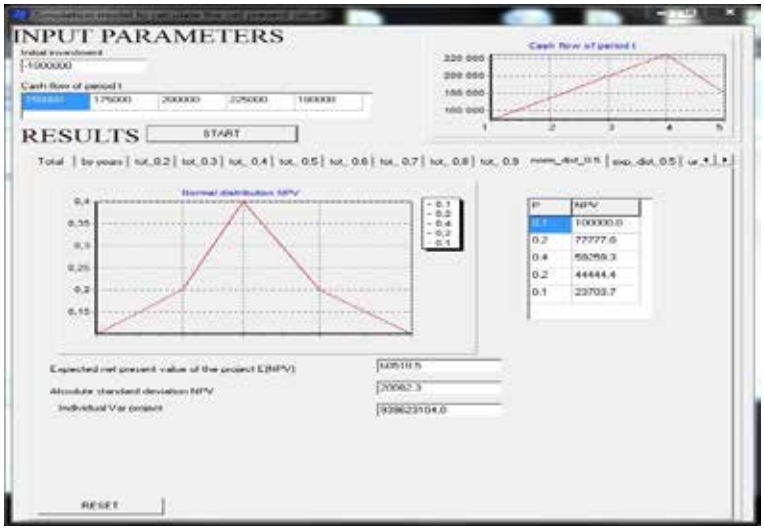

Fig. 1. 1 Calculation of the NPV criterion for normal law of distribution

Assuming that the NPV is normally distributed value p with expectation E (NPV) and the standard deviation σ (NPV), we can find the probability that the NPV > 0. At the same time this becomes likely that the damage of the project will be less than the 10% (discount rate), and when NPV = 0 the project profitability is equal to the discount rate.

We also assign each j-th scenario the likelihood of its implementation P. The sum of the probabilities on all the presented scenarios equals to one.

The model of calculation of the net present value for normal law of distribution showed that the expected net present value of the project E is 60518,5.

The primary investments of the project amounted to UAH 1000000.

The absolute standard deviation is 20082,3.

The individual variation coefficient of the project on the implementation of LTE– technologies in Ukraine is 939623104,0.

The changes of the values of the standard normal distribution parameter kα are reflected in table. 1.1.

Table 1.1

Confidence level,%	Parameter k_α
90	-1,31
95	-1,68
98	-2,07
99	-2,28

Table 1.1 shows the changes of the values of the standard normal distribution parameter kα, at the confidence level of 90%, the value is -1,31, while increasing the probabilistic threshold to 98% kα equals to -2,07 and 99% equals to -2, 28.

Consequently, the probability that the loss of the planned project on the implementation of innovations, such as4G LTE – technologies in Ukraine is less than 10% equal to 28% accord-

ing to this assessment. This amount indicates positive net present value and shows the growth of the value of invested capital as a result of the project implementation. Thus, the value of NPV> 0, which means that the project is profitable for the investor and the enterprise as a whole [8, 176–178 p.].

Model for calculating the NPV criterion using the exponential law of distribution is shown in Fig. 1. 2. The case where the gamma of distribution is with parameters a = 1, b = λ> 0.

Fig. 1.2 shows the change of the values depending on the set parameters, such as probability:

P 0,40 exp (NPV) = 0,02024
P 0,35 exp (NPV) = 0,04815
P 0,25 exp (NPV) = 0,09915
P 0,20 exp (NPV) = 0,17669
P 0,10 exp (NPV) = 0,39675

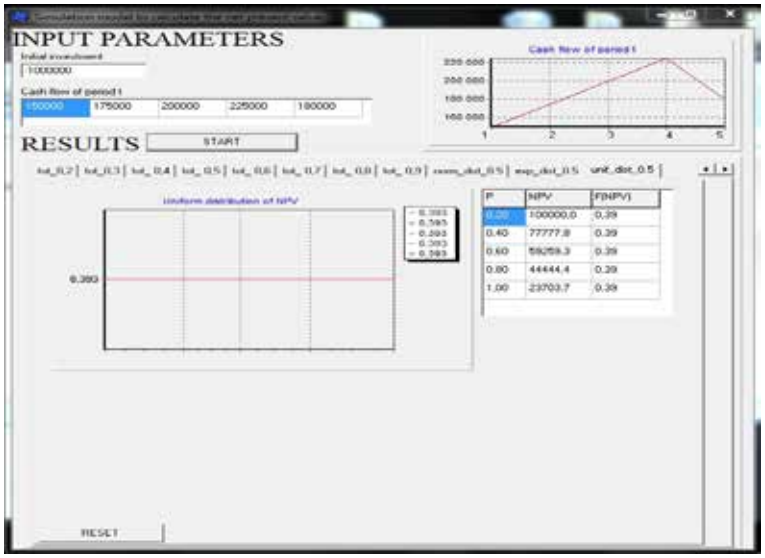

Fig. 1. 3 Calculation of the NPV criterion for uniform law of distribution

The corresponding results of the calculations are represented in the diagram in Fig. 1.2. The continuous uniform distribution of the random variable in the probability theory takes the value belonging to interval [a, b] indicating where the probability density is constant in this interval. The model for calculating the NPV criterion using the uniform law of distribution is shown in Fig. 1. 3.

Random variable X is distributed in interval [a, b], when its density in the distribution interval is constant. Uniform distributions is applied in those cases where the point is randomly related on interval [a, b], then X is the abscissa of the set point.

The diagram of density of the uniform law of distribution is shown in Fig. 1.3. which represents the changes of value depending on the set parameters, for example with probability: at P 0,20, (NPV) = 100000,0 in each case F (NPV) is equal to 0,39; when P 0,40, (NPV) = 77777,8; when P 0,60, (NPV) = 59259,3 and with the probability when P 1,00 (NPV) = 23703,7.

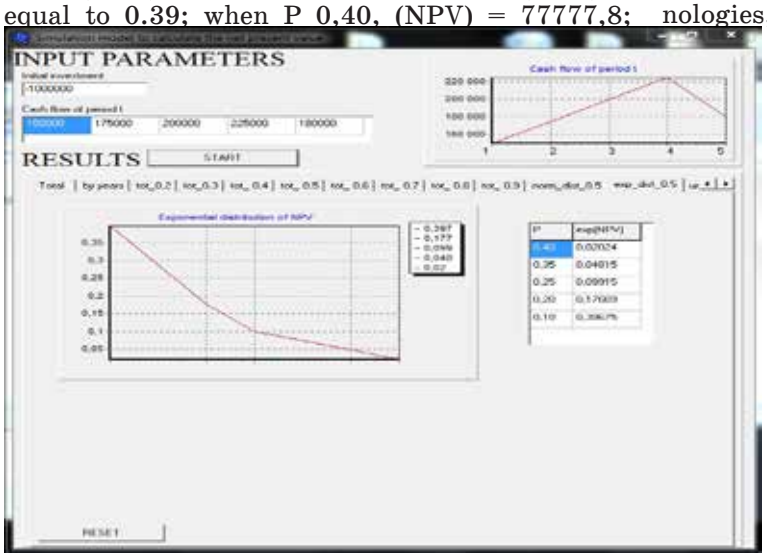

Fig. 1. 2. Calculation of the NPV criterion for exponential law of distribution

Conclusions. However, having analyzed the amount of damage and profit for innovative project, we can single out that the expected net present damage was E (NPV) = 60518,5 UAH, and the expected net present value was EL = 181117,16 UAH upon the project deviation. It follows that the damage is minor compared to the revenues that can be obtained by the mobile operators of Ukraine upon the introduction of LTE – technologies. In general, having analyzed the obtained calculations it should be noted that the specific value is a special case and for the credibility it is necessary to conduct a series of experiments with the model.

Future development of telecommunication industry of Ukraine and fuller realization project potential and domestic producers should be associated with the introduction of innovative technologies, including using high-tech of mobile operators.

In further research it is planned to calculate Monte–Carlo analysis risk for project with 4G LTE–technology introduction in Ukraine, identify their weaknesses and justify measures to increase the efficiency of innovative production in Ukraine market.

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