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COST-BENEFIT ANALYSIS AS DRIVE FOR EFFECTIVE DECISIONS-MAKING

In the article, the thematic review of the literature was conducted on the peculiarities of the impact of cost-benefit analysis when performing production tasks at the enterprise. Research papers based on generated inputs were included in the review, as well as other information materials containing useful recommendations. The article presents a comparative analysis of various definitions and approaches to their formation. It is emphasized the need to implement a methodology for integrating cost analysis and impact assessment based on SAM-CGE (principles of the social approach). Methods of determining socio-economic efficiency are proposed. The article emphasizes that the purpose of cost-benefit analysis is to help in social decision-making and more efficient distribution of limited resources. CBA is estimated using financial ratios and, in particular, with the calculation of the financial net present value, the financial rate of return of the investment, which is desirable from a socio-economic point of view. This is demonstrated by the economic result, in particular, the positive economic net present value. Emphasis is placed on the need to ensure appropriate conditions for the development of entrepreneurial activity of enterprises. It is noted that CBA is an analytical tool that will be important when using and making management decisions during the revival of the post-war economy of Ukraine.

Keywords: project; evaluation; impact analysis; cost; resource allocation; benefit

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АНАЛІЗ ВИТРАТ І ВИГІД ЯК РУШИЙНА СИЛА ПРИЙНЯТТЯ ЕФЕКТИВНИХ РІШЕНЬ

У статті було проведено тематичний огляд літератури про особливості впливу аналізу витрат і вигід при виконанні виробничих завдань на підприємстві. До огляду були включені дослідницькі статті на основі сформованих вхідних даних, а також інші інформаційні матеріали, що містять корисні рекомендації. Видання присвячене особливостям формування більш ефективного розподілу ресурсів на підставі використання аналізу витрат і вигід. У статті представлено порівняльний аналіз різних дефініцій та підходів до їх формування. Наголошується, на необхідності впровадження методології для інтеграції аналізу витрат та оцінки впливу на основі SAM-CGE (принципів соціального підходу). Наголошується на необхідності забезпечення належних умов для розвитку підприємницької активності підприємств. Запропоновано методи визначення соціально-економічної ефективності. У статті підкреслюється, що метою аналізу витрат і вигід є допомога у прийнятті соціальних рішень та більш ефективному розподілі обмежених ресурсів. CBA оцінюється за допомогою фінансових коефіцієнтів та, зокрема, з розрахунком фінансової чистої теперішньої вартості, фінансової норми прибутку інвестиції, що є бажаною з соціально-економічної точки зору. Це демонструється економічним результатом, зокрема, позитивною економічною чистою поточною вартістю. Зазначається, що аналіз витрат і вигід - це аналітичний інструмент, який буде важливим при використанні та прийнятті управлінських рішень при відродженні післявоєнної економіки України.

Ключові слова: оцінка; аналіз впливу; вартість; розподіл ресурсів; вигода

INTRODUCTION. Cost–benefit analysis (CBA), as a common instrument in the decision making process on how to allocate financial resources, has been widely used in various research areas and in almost all of countries over the world. However, the origin and the historical development of CBA have long been subject to neglect. Cost–benefit analysis (CBA) is defend as a systematic cataloguing of impacts as benefits (pros) and costs (cons), valuing in dollars with assigned weights, and then determining the proposal relative to the status quo by the net benefits (benefits minus costs) or the benefit–cost ratio (divide benefits by costs) [1]. CBA is a decision-aiding tool that quantifies in monetary terms the value of all consequences associated with a government policy (such as setting an environmental standard) or with an investment project to all members of society. The purpose of CBA is to help social decision making and to allocate scarce resources more efficiently [2]. CBA is an analytical tool to be used to appraise an investment decision in order to assess the welfare change attributable to it and, in so doing, the contribution to EU cohesion policy objectives.

Benjamin Franklin's advice about how to make decisions illustrates many of the important features of cost–benefit analysis (CBA). These include a systematic cataloguing of impacts as benefits (pros) and costs (cons), valuing the impacts in dollars (assigning weights), and then determining the net benefit of the proposal relative to the current policy (net benefit equal incremental benefits minus incremental costs).

By 2020, CBA has been widely applied to various research areas in almost all countries over the world.

The first application of CBA was published in 1951, and studies using CBA have seen significant increase since the 1990s. CBA has been used in 146 research areas, among which the most applications with over 12,000 were found in engineering, followed by environmental sciences ecology, computer science, business economics, energy fuels, health care sciences services, and internal medicine. CBA has been used in 197 countries and regions, among which the most applications with nearly 20,000 were found in the USA, followed by England, China, Canada, Australia, Germany, Italy, Netherlands, and France.

The origin of CBA can be dated back to the work of Saint-Pierre in 1708. Through the efforts by a number of French engineers, Dupuit introduces the concept of consumer's surplus in 1844 that founds the economic basis of CBA and measures benefits in terms of the reduction of production costs. However, these works are not taken seriously in France, and do not draw attention from other countries. Hence, the principle of CBA is newly proposed by the 1936 Flood Control Act in the US, and the Green Book in 1950 marks the mature of CBA by establishing cost-based methods for measuring benefits. The comparative analysis shows that the early development of CBA in France and the US is independent from four aspects. First of all, there is no considerable evidence suggesting that the American experts are familiar with the early works of French engineers. Although Charles Ellet Jr., an American civil engineer, indeed traveled to Paris in 1830 to study as an external

student at the École des Ponts, his contributions to the economic thought lie mainly in the practical problem of monopoly proft maximization of a railroad rather than CBA [3]. The cost–benefit criterion proposed by Navier and Mondot finds no mention in the American documents. And the Green Book published in 1950 still considered the benefits of navigation improvements as savings in transportation costs rather than reduction of production costs. Second, the backgrounds for introducing CBA in France and America are clearly different. The French tradition rooted in the field of transport economics, whereas the American tradition was related to water resources projects. Third, the personnel who made efforts to the development of CBA are also distinct. French engineers have formal academic background, but American professionals work in federal agencies.

Both facts result in that French engineers follow a theoretical approach and attached great importance to mathematical calculation, while American professionals adopt an empirical approach and pay more attention to practical application [4]. This divergence in approaches leads to the theoretical foundation of consumer's surplus in France and the practical guidelines of CBA in the United States, respectively. Finally, the most crucial difference lies in the attempt for standardizing this approach in America, but such a progress does not take place in France. The political rival situation among agencies with overlapping responsibility is the major driving force for the standardization in the US [5], but the French Corps has a strong administrative, institutional and legally acknowledged monopoly position, which prevented the standardization.

Cost-benefit analysis (CBA) is a systematic approach to evaluate the economic feasibility and effectiveness of projects by comparing their costs and benefits. It involves the identification, quantification, and monetization of all relevant costs and benefits, direct and indirect, tangible and intangible, and the calculation of the net present value (NPV) or benefit-cost ratio (BCR) [6]. CBA seeks to maximize social welfare by supporting rational decision-making, resource allocation, and performance assessment based on the principles of efficiency, transparency, and accountability [7]. CBA helps decision-makers select projects with the highest potential net benefits, thereby increasing the overall effectiveness and value for money of investments.

In addition, CBA can inform the prioritization and sequencing of projects, considering their costs, benefits, and resource constraints, which enhances the efficiency and sustainability of project portfolios [7]. Moreover, CBA can contribute to the identification and mitigation of project risks, uncertainties, and externalities, as well as the evaluation of alternative options and scenarios, which can improve project resilience and adaptability [6]. However, the impact of CBA on project performance may be limited by various challenges and limitations, such as the difficulties in quantifying and monetizing certain costs and benefits, the subjectivity and uncertainty of assumptions and estimates, and the distributional and ethical concerns related to the aggregation and weighting of individual preferences [7]. Therefore, it is important to recognize the limitations of CBA and combine it with other complementary methods, such as multi-criteria analysis, stakeholder consultation, and performance monitoring, to ensure more robust and inclusive decision-making and project performance evaluation. Project performance refers to the extent to which a project achieves its objectives and delivers the expected benefits within the constraints of time, cost, and quality [8]. It encompasses various dimensions, such as efficiency, effectiveness, relevance, sustainability, and stakeholder satisfaction, which can be measured using a combination of quantitative and qualitative indicators, such as schedule and budget variance, benefit realization, and stakeholder feedback. Understanding the factors that influence project performance is crucial for improving project management practices, optimizing resource allocation, and enhancing the accountability and learning of project organizations and stakeholders [8]. One of the key factors affecting project performance is the quality of decision-making, including the use of cost-benefit analysis (CBA) to inform the selection, prioritization, and design of projects based on their potential net benefits and risks.

CBA analysts focus on social costs and social benefits, and conduct social cost–benefit analysis. We usually used refer to costs, benefits, and cost–benefit analysis. Thus, CBA denotes the social benefits (the aggregate benefits to all members of society) of a policy, and CBA denotes the social costs (the aggregate costs to all members of society) of the policy. The aggregate value of a policy is measured by its net social benefit, sometimes simply referred to as the net benefit, and usually denoted NSB:

$$NSB = B - C, \quad (1)$$

The term social is usually retained in the expression net social benefit to emphasize that CBA does concern the impacts on society as a whole**.** Implicitly, the benefits, costs, and net social benefit of a policy are relative to some "benchmark."

Projects with a higher NPV or BCR, as assessed by CBA, are expected to generate greater benefits relative to their costs, which can contribute to better project performance in terms of efficiency, effectiveness, and value for money [7].

A cost or benefit that occurs in year t is converted to its present value by dividing it by $(1 + s)^t$, where s is the social discount rate. Suppose a project has a life of n years and let Bt and Ct denote the social benefits and social costs in year t, respectively. The present value of the social benefits, PV(B), and the present value of the social costs, PV(C), of the project are, respectively:

$$PV(B) = \sum B_t / (1+ s)^t, \quad (2)$$

$$PV(C) = \sum C_t / (1+ s)^t, \quad (3)$$

By definition, the net present value (NPV) of a policy alternative equals the difference between the PV of its (incremental) social benefits and the PV of its (incremental) social costs:

$$NPV = PV(B) - PV(C) \quad (4)$$

Thus, the NPV of a project or policy is identical to the present value of the (incremental) net social benefit:

$$NPV = PV(NSB) \quad (5)$$

The basic decision rule for a single alternative project (relative to the status quo policy) is simple: adopt the project if its NPV is positive. In short, the analyst should recommend proceeding with the proposed project if its

$$NPV = PV(B) - PV(C) > 0; \quad (6)$$

that is, if its (incremental) benefits exceed its (incremental) costs:

$$PV(B) > PV(C) \quad (7)$$

When there is more than one alternative to the status quo policy being analyzed and all the alternatives are mutually exclusive, and then the rule is: select the project with the largest NPV. This rule assumes implicitly that at least one NPV is positive. If no NPV is positive, then none of the specified alternatives are superior to the current policy, which should remain in place.

However, the impact of CBA on project performance may also depend on the accuracy and reliability of the underlying assumptions, estimates, and models, as well as the capacity and willingness of project managers and stakeholders to incorporate CBA results into their decision-making processes [6].

Formulation of the problem. The main goal of this article is to demonstrate approaches to defining the concepts of CBA and its practical application. Systematic approach to evaluating how well a planned action will perform. This process involves identifying, quantifying, and comparing all the costs and benefits associated with a decision. While commonly used for financial evaluations, CBAs can apply to virtually any type of decision-making, from hiring new staff to investing in equipment or launching a new product.

Currently, traditional development issues such as income inequality, depletion of natural resources, environmental pollution as well as retardation of infrastructure have occurred in China.

Since 2011, China has been the world's largest energy consumer. The industrial sector uses two-thirds of the energy consumed in China.

In the future, more pressures would be imposed on China by the continuous fast development of industrialization, and with transfer of the world manufacture center to China. Sustainable development, including its economic, environmental and social elements, is a key goal of decision makers. A methodology on cost benefits analysis of economic growth at macroscopic level to identify issues of China's sustainability. In order to address some important issues on how to make policies to improve the quality of economic growth, the CBA framework developed in this article analyses economic–ecological–social interaction. Based on the framework and methods, this paper examines the costs and benefits of economic growth in three aspects of economy, ecology and society.

The results illustrate that NPR of China's economic growth had been negative for a long time and has just became positive since year 2000 but was quite low. Even the best was only 1.6% in 2022 (the worst was − 24.2% in 1982). Based on the comparison between three accounts, we can draw a conclusion that ecological cost is the dominant factor that affects China's NPR. The empirical results show that if no other innovative measures or policies are taken in the future the costs of growth would outweigh its benefits, resulting in un-sustainability. Basically, the long-term economic growth would be unsustainable due to increasing environmental damage and depletion of natural resources. There are a few limitations that we consider need to be improved in our CBA framework and method.

The renewable energy (RE) obtain from, such as sunlight, wind, water, tides wave, and geothermal heat is a worldwide agreeable green substitute to high-polluting fossil-fuel energy. In China, implementation RE projects can bring public health benefits by improving air quality and, at the same time, satisfy its national energy demand. The increasing usage of RE in China can fulfill the growing energy demand nationally when the coal usage falls down. The share of coal in China's energy proportion shrinks from 58 percent in 2016 to less than 40 percent in 2040 as expected. Meanwhile, the RE led by hydropower, wind, and solar PV grows increasingly and consists of 60 percent of total generation capacity by 2040.

Investments in energy infrastructures are driven by specific challenges affecting the national, regional and international energy markets. The main issues that are related to security and reliability of supply, and affordable energy prices for consumers. Also, global concerns for climate change call for the need of progressively substituting fossil-based energy fuels with more sustainable sources. Related to this, another important driver is derived from the challenges posed by the growing penetration of power generation from intermittent renewable energy sources, particularly wind and solar, to the entire electrical system.

A benefit-cost analysis (BCA) is a decision making tool that attempts to balance the components of a project in order to maximize its net benefits and/or minimize its costs. In this analysis, we try to quantify the costs of project factors. These values are then incorporated into the analysis along with other financial costs. Using BCA, decision makers try to maximize benefits for a set cost, minimize costs for a set level of benefit, or find the most beneficial compromise when both costs and benefits are variable. For any project to be worthwhile, the benefits must exceed the costs.

The main factors affecting the level of energy supply associated with the project are:

- national and international socio-economic and political factors influencing the fuel price dynamics;
- political decisions about the discontinuation of certain types of energy sources and fuels;

- system of incentives on certain types of energy sources and fuels;

-environmental requirements imposing additional costs to energy production;

- structure, territorial size, degree of integration and performance quality of the energy system;

- market structure, particularly related to the number of competitors and the degree of market openness and integration into other markets.

The project's purpose of the work is the development of structural and technological solutions for the creation of a solar battery according to the CubeSat 3U standard.

Research results. Figure 1 shows the role of CBA in the appraisal of the major project.

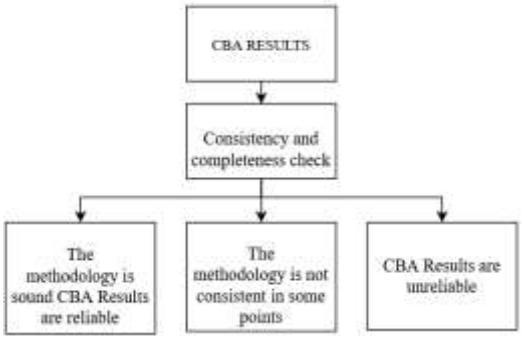

Figure 1 - The role of CBA in the appraisal of the major project

Cost-benefit analysis can significantly improve project performance, but its effectiveness depends on addressing the inherent challenges and ensuring that decision-makers have access to accurate and reliable information.

CBA is based on a set of predetermined project objectives, giving a monetary value to the entire positive (benefits) and negative (costs) welfare effects of the intervention. These values are discounted and then totaled in order to calculate a net total benefit.

Business plan must have some type of economic justification to provide executives and elected officials with financial information. It will help them know that they are doing the "right thing" by implementing the requested program. A popular economic calculation for the attractiveness of an investment is "Return on Investment" (ROI). ROI is a calculation of the most tangible financial gains or benefits that can be expected from a project versus the costs for implementing the suggested program or solution.

This allows decisions makers to see what difference the activity would make to well being. There are several basic steps involved in conducting a cost benefit analysis (Figure 2). In some cases, step 1 of cost benefit analysis (defining options) may require little effort. This would be where activities (options) are pre-determined, such as where a community or government has already decided that an activity is important or where it appears to be the only option available. However, all other steps are critical to the analysis. Steps 2 and 3 generally require the most time, effort and expertise.

Cost Benefit Analysis (CBA) is more comprehensive than ROI, and attempts to quantify both tangible and intangible (or "soft") costs and benefits.

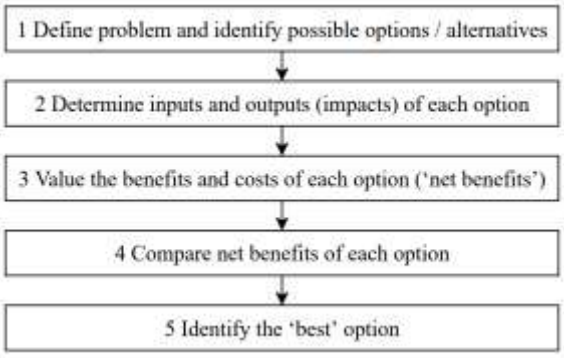

Figure 2 - Basic steps in a cost benefit analysis

It should be noted that an even greater understanding of the impact of risk and uncertainty on the expected results of project can be obtained from probabilistic modelling of the distribution of variables and their interdependencies.

In research provides evaluate of the scientific and technical effect of the scientific research work (SRW). An assessment was carried out on the applied aspects of the scientific and technical effect. The result of the SRW is the achievement of a scientific, scientific-technical, economic or social effect, indicator = 76%. The scientific effect characterizes the acquisition of new scientific knowledge and reflects the increase in information intended for internal scientific use.

ROI = ($25,000/$50,000) where the ROI is calculated to be 50% for the parcel mapping project. By adding a discount factor and calculating NPV, the economic attractiveness diminishes only slightly NPV calculated out to be $22,120).

We used effective methods for identifying costs. Information on personnel costs can be obtained from fiscal officers, there are often contracts in place (or as historical references) for certain services, and managers can turn to their counterparts in other organizations to obtain reasonable cost estimates. Include the following incremental costs when determining total cost: labor including fringe benefits, overhead (if appropriate), additional equipment cost (not including additional costs for existing equipment), additional software cost (not including additional costs for existing software), physical facilities (if additional space is required), contracting costs we should also consider the various phases of the project and account for all of the costs incurred during each phase. Sometime improperly ignore the "built-in" costs and only account for large contractual expenditures. Examples of built-in costs include: project management, contract management, quality assurance and control, personnel training, project maintenance, security (if appropriate).

Calculating Benefits is the most difficult part of completing an economic justification.

Conclusions. We concluded that CBA is valuable tool for increasing the economic efficiency of management decision- making in enterprise activities, contributing to the improvement of activity efficiency in

general. The relationship between CBA and cost-effectiveness in infrastructure projects was also studied and concluded that the use of CBA contributed to increased cost-effectiveness and increased social value, leading to better efficiency. The study also noted that CBA helped project managers identify and prioritize the most cost-effective and socially beneficial alternatives, leading to more successful enterprise outcomes.

The article paid attention to the social discount rate, which is used in the economic analysis of investment projects to discount economic costs and benefits, and reflects the opportunity cost of capital from an intertemporal perspective for the enterprise as a whole. In other words, it reflects a social view of how future benefits and costs should be assessed against current ones. In this sense, each discount rate involves a judgment about the future and affects the weight of future benefits or costs.

Cost benefit analysis involves comparing the values (costs and benefits) of an activity by assessing the benefits and costs faced by a community with the activity compared to without the activity.

Project managers, decision-makers, and stakeholders should focus on establishing accurate data collection methods, developing strategies to quantify intangible benefits, and addressing potential biases in the decision-making process

It was also noted, that the presented CBA methodology was developed in the 2014–2020 programming period for the preliminary analysis of infrastructure investments and applied to many types of projects, from science parks and innovative production facilities to university business centers.

It was also concluded that the CBA is most applicable to strategic infrastructure projects in R & I, including those that may be funded by the InvestEU Fund. The methodology should also be relevant for research funding programmes and other non-infrastructure investments funded from Horizon Europe and other funding mechanisms.

Thus, CBA is an analytical tool used to assess the economic advantages or disadvantages of investors when making effective management decisions.

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