System Analysis of Ranking and Assessment of Efficiency of the Construction-Investment Projects in Information Infrastructure

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Abstract

To solve the problem of selecting effective investment-construction projects, a multi-criterion expert method for ranking investment projects in information infrastructure is proposed, which should ensure the evaluation and comparison of all possible projects at the pre-investment stage, their sorting according to priorities, and finally the efficient analysis of the projects should be carried out and selected according to the company's development strategies. A qualitative system of indices for project (including IT-projects) evaluation, a quantitative evaluation scale, and a mechanism for determining the weights of indicators have been developed. The discounted methods of evaluating the efficiency of ranked investment projects in information infrastructure are analyzed.

Keywords

Project, investment project, ranking, indicator, expert system, specific weight, integral assessment, discounting method, information infrastructure

1. Introduction

Construction is one of the strongest branches of material production, which includes construction installation, design exploration, engineering organizations, scientific-research institutes with construction profiles, economic management bodies in construction, as well as small business companies. The role of construction in the system of the national economy branches is very big, as well as the impact of its features on the investment process.

Investment-construction activity is a complex of organizational, economic, and industrial measures, which is implemented by state or construction business participants (construction-installation, customer, design, scientific research organizations), for the accumulation and investment of financial resources in the main funds, to obtain profit and positive social effect. In this process, a special place should be occupied by the processes of finding, justifying, processing, and final realization of current and prospective investment projects. The purpose of the article is to evaluate construction investment projects with qualitative indicators, rank them, and select the most effective projects [1–4].

2. Main Part of Research Study

A construction-investment project is a set of organizational-technical measures implemented to create an investment object of different purposes (reconstruction, restoration) and its further exploitation, using own capital or capital raising from various sources. In the theory of investment management, as a rule, three blocks of investment decisions are considered for use with real investments:

- Project ranking and selection.
- Optimization of project exploitation.
- Formation of the investment program.

It is important to solve relevant tasks in the process of analysis and research of construction-investment projects (Fig. 1).

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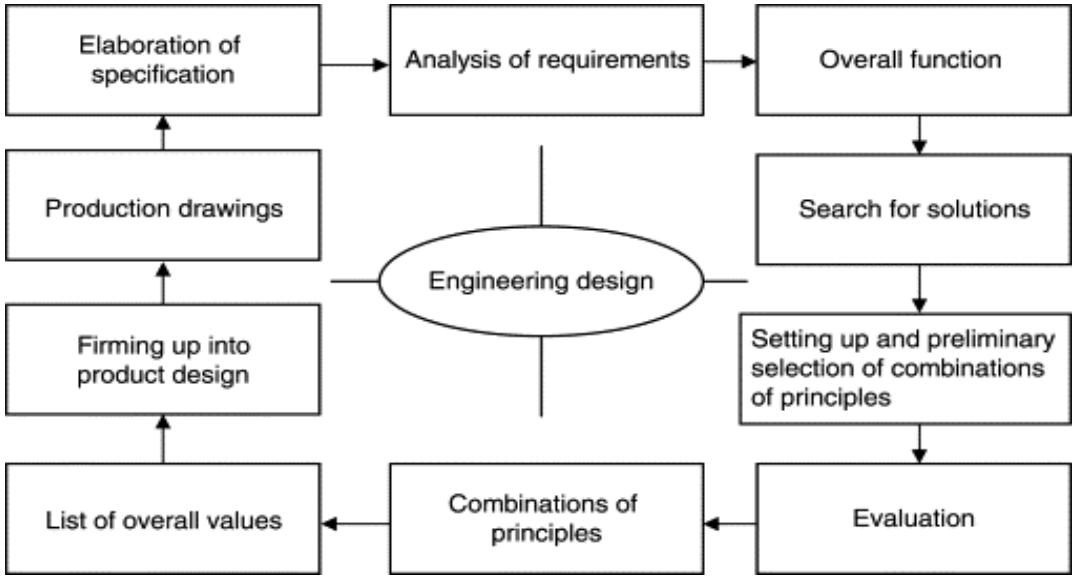

Figure 1: Construction-investment projects structure

Based on the goals of the article, we will stop only on the first block, which is important in the process of implementation, to put and solve the task of evaluating actualizing projects for the construction company and selecting more effective ranking projects.

It is advisable to carry out the project evaluation process in two stages: in the first stage, the preliminary evaluation of the projects with qualitative indicators ("express analysis") is taking place, and in the second stage, the analysis of the efficiency of the ranked projects is carried out, using discounted methods.

It should be noted that the primary assessment of construction projects is no less important and responsible than the stage of efficient analysis. The expediency of construction-investment projects in the early, pre-project stage, is determined by: the large scale of the construction processes and the high rates of expenses; the possible lack of funds needed for the realization of individual stages of the project; the need to reduce project research and technical-economic risks; with the necessary compliance of the projects with the construction company's activity strategies; with the possible existence of competing projects, etc. [5–7].

At the preliminary evaluation stage, a multi-criteria expert method is proposed, which represents a certain kind of process and involves many evaluation indicators and many experts (more than two). One of the purposes of the mentioned model is to evaluate, rank projects, and select the best projects for their investment. [5, 7]. We think it is appropriate to implement it through the following algorithm:

Step 1. Formation of an expert group.

Step 2. Gathering and analyzing the proposals of the members of the expert group to determine the project evaluation indicators, according to their characteristics and the appropriate evaluation scale.

Step 3. Revealing the individual opinion of group members on the relative importance of indicators and forming a compromise opinion. As a result, the rank of indicators and their weighting system can be determined.

Step 4. Formation of an evaluation questionnaire by experts and assessment of each project with qualitative indicators, by the chosen evaluation scale.

Step 5. Forming a total assessment for each indicator in the evaluation questionnaire.

Step 6. Using the total assessment of the indicators and the established weights, calculate the overall, integral evaluation for each project.

Step 7. Ranking of projects according to the obtained results.

Let's discuss some of the items in more detail.

There is a wide list of qualitative indicators used to evaluate investment projects [5, 7]. The article uses a system of qualitative indicators, which is relatively important for the assessment of investment-construction projects at the pre-project stage. These are compliance of the project with the current strategy and long-term plans of the construction company; scientific-technical characteristics; production indicators; environmental and technological indicators; financial indicators (criteria); level of marketing activity; level of uncertainty and risk, etc.

Table 1
The conditional scale of assessment (logical and correspondence of points)

Logical Rating	Very low	Low	Medium	High	Very high
Evaluation with points	1	2	3	4	5

The evaluation is done on a logical scale, but for simplicity, we will fit a quantitative meaning to each logical term. In our case, the assessment is done with a maximum of five points.

Calculating weights for the evaluation of indicators is a very important and meaningful stage [5, 7, 8]. At this time, the expert must decide which indicator is more important (prioritized) compared to other indicators, which also determines the final form of the result. There are different methods of determining weights for estimated figures [5–7], among the standard methods there is the analytic hierarchy process proposed by Saat [8]. The article uses a relatively simple method of calculating weights for estimated figures, which is as follows: a group of experts manages to rank the indicators according to certain rules, according to their priority and importance, after which the weights are calculated using the following formula (Fishbern's rule):

$$W_i = \frac{2(N-i+1)}{N(N+1)} \qquad (1)$$

where, W_i is the specific weight of the indicator: $\sum_{i=1}^{m} W_i = 1$, and M is the number of indicators.

The presented algorithm pertains to evaluating the state of projects and calculating the integral expert indicator of evaluation. The following formula is used to calculate the integral assessment:

$$I = \sum_{i=1}^{m} W_i C_i \qquad (2)$$

where i is integral assessment, W_i is indicator weight, $0<W_i<1$ C_i is project assessment with i criteria, and m is the number of indicators.

The use of this model allows experts to accurately express their opinion about each project, about the i-indicator and its characteristics, to discuss and evaluate the viability (state) of the project in a quantitative form.

The initial assessment of projects with qualitative indicators is a certain filter for the construction company, the main purpose of which is to prevent unpromising projects and give a way for further processing of relatively interesting and effective projects. Projects with the highest integral value.

In world practice, methods of evaluating the efficiency of investment projects are mainly used, which are based on discounted estimates (Fig. 2).

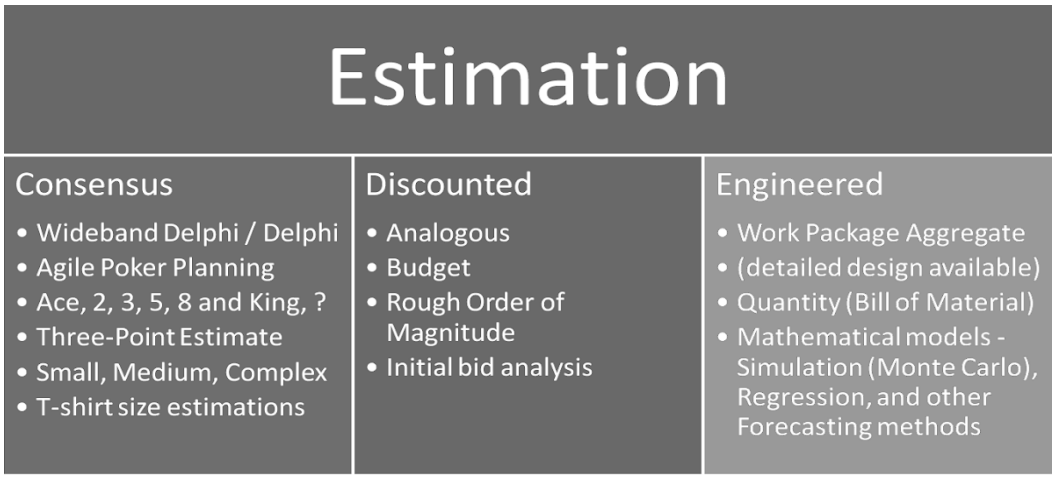

Figure 2: Estimation methods

These methods are more accurate because they take into account the types of inflation, changes in rates of interest, profitability rates, etc. These methods include the current net value method, profitability index method, internal rate of earnings yield method, and redemption period method [9].

The Net Present Value (NPV) is the difference between the finances and expenses of the reporting period, reduced to the initial year, that is, usually taking into account the discounting of the results and expenses. The point is that over time, under the influence of inflation and competition, the real purchasing ability of money changes for both: the investor and the innovator, "today's" and "tomorrow's" money are not equivalent. At this time, the corresponding rate is considered as the discount factor—α_t in different periods by the means of which the financial indicators of different periods are calculated, reduced to the corresponding meaning of the initial period. For example, if *t* is the period discounted income [10–13]:

$$PV_R = PV_{R_1} \times \alpha_1 + PV_{R_2} \times \alpha_2 + PV_{R_2} \times \alpha_2 + \cdots PV_{R_t} \times \alpha_t$$

and discounted capital expenses [14–16]:

$$PV_k = PV_{k_1} \times \alpha_1 + PV_{k_2} \times \alpha_2 + PV_{k_2} \times \alpha_2 + \cdots PV_{k_t} \times \alpha_t$$

perform in mentioned form, then the net discounted cost is

$$NPV = PV_R - PVPV_k \quad (3)$$

where (3) is the monetary flows for each financial year, *t* is the ordinal number of the financial year. Moreover, the discounted income and discounted expenses are calculated based on all incomes and expenses related to the realization of the project.

As we have already mentioned, the discounting coefficient takes into account: different forms of inflation, changes in the interest rate, rate of income, etc. It is calculated for each financial year as follows [17]:

$$\alpha_t = {}^{1}/_{(1+E)^t} \quad (4)$$

where E is the discount rate, equal to the banking norms (by reckoning a more reliable bank for choosing, for example, the state loan norm), the inflation level, and the sum of project risk [18–22].

The project is efficient at any positive value of NPV, and the larger its value, the more efficient the project (Fig. 3) [23].

The method of Profitability Index (PI) represents the ratio of discounted income PV_k to the reduced innovative costs $PVPV_k$, that is, two streams of payments are compared to each other: income and investment. In its essence, the profitability index shows the amount of income received for each unit of investment. From this, it can be seen that the project will be efficient when PI > 1. Obviously (PI) allows us to rank different projects according to decreasing profitability [24].

Internal Rate of Return method (IRR) This indicator is mainly used when there is a need to make a choice between different alternative projects, the higher the IRR, the more profitable the project [25].

Payback Period (PP) is one of the most widespread indicators of the assessed value of investment efficiency. It is the time interval beyond which the net present value NPV becomes a positive value, i.e. redemption occurs during the period when the accumulated present value equals the negative present value of all investments.

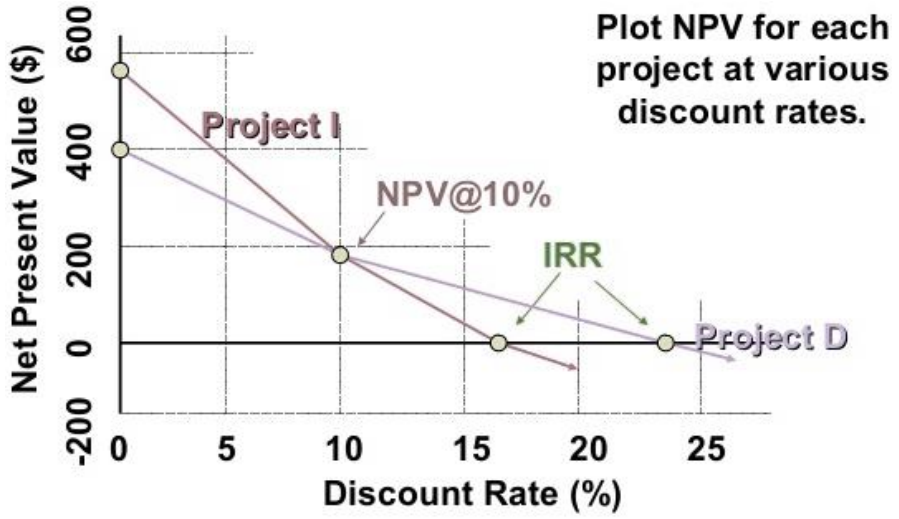

Figure 3: NPV estimation graph

In other words, the payback period is the number of years required to pay back the investment. None of the listed methods alone are sufficient for project acceptance. Each method of analysis of innovative projects allows us to consider only one of the characteristics of the reporting period, to identify important moments and details. Therefore, for the complex evaluation discussed by our project, these methods should be used jointly.

3. Conclusions

The task of ranking and selecting projects, on the one hand, is relatively simple, and on the other hand, it is the basis for other tasks related to the management of investment projects in information infrastructure. It should be noted that there is no universal model for project ranking and selection, which would apply to every specific situation. There is no good or bad model. No model can fully reflect the existing reality of projects but should be as close as possible to it. Projects should be evaluated in compliance with the company's goals. The model should be well-thought-out, flexible, easy to use, cheap, and easy to use about computer technology (IT projects).

4. References

[1] P. Anakhov, et al., Increasing the Functional Network Stability in the Depression Zone of the Hydroelectric Power Station Reservoir, in: Workshop on Emerging Technology Trends on the Smart Industry and the Internet of Things, vol. 3149 (2022) 169–176.

[2] TajDini, M., Sokolov V., Buriachok V. (2019). Men-in-the-middle attack simulation on low energy wireless devices using software define radio. Workshop of the 8th International Conference on "Mathematics. Information Technologies. Education": Modern Machine Learning Technologies and Data Science (MoMLeT and DS), vol. 2386, 287–296.

[3] V. Grechaninov, et al., Decentralized Access Demarcation System Construction in Situational Center Network, in: Workshop on Cybersecurity Providing in Information and Telecommunication Systems II, vol. 3188, no. 2 (2022) 197–206.

[4] V. Grechaninov, et al., Formation of Dependability and Cyber Protection Model in Information Systems of Situational Center, in: Workshop on Emerging Technology Trends on the Smart Industry and the Internet of Things, vol. 3149 (2022) 107–117.

[5] F. Liu, Y. Shi, Z. Chen, Smart City Ranking Reliability Analysis, 2018 International Conference on Computational Science and Computational Intelligence (CSCI), 2018, 537–540. doi:10.1109/CSCI46756.2018.00109

[6] M Wanli, et al., People Logistics in Smart Cities, Communs. of the ACM, 61(11) (2018) 54–59.

[7] K. Schmidt, Ö. Hazır, A Data Envelopment Analysis Method for Finding Robust and Cost-Efficient Schedules in Multimode Projects, IEEE Transactions on Eng. Manag. 67(2) (2020) 414–429. doi: 10.1109/TEM.2018.2888817

[8] K. Hasan, R. Preece, J. Milanović, Priority Ranking of Critical Uncertainties Affecting Small-Disturbance Stability Using Sensitivity Analysis Techniques, IEEE Transactions on Power Systems, 32(4) (2017) 2629–2639. doi: 10.1109/TPWRS.2016.2618347

[9] E. Sakrutina, Some Functions of the "Safety management system" in the Transportation Area Safety Assurance, 2017 International Siberian Conference on Control and Communications (SIBCON), Astana, Kazakhstan, 2017, 1–5. doi: 10.1109/SIBCON.2017.7998576

[10] R. Berdibayev, et al. Studies on cloud-based cyber incidents detection and identification in critical infrastructure, CEUR Workshop Proceedings 2923 (2021) 68–80.

[11] ENISA, 2020. URL: https://www.enisa.europa.eu/activities/Resilience-and-CIIP/cyber-crisis-cooperation/nis-cooperation-plans/nlra-analysis-report

[12] ENISA, 2020. URL: https://www.enisa.europa.eu/publications/ccc-study

[13] ENISA, 2020. URL:https://www.enisa.europa.eu/publications/power-sector-dependency

[14] I. Zhukov, S. Balakin, Detection of Computer Attacks Using Outliner Method, Sci. J. Young Sci. 9(36) (2016) 91–93.
[15] Building and Community, Federal Ministry of the Interrior, 2020.
[16] Kritis, URL: http://www.kritis.bund.de/SubSites/Kritis/EN/Home/ home_node.html
[17] K. Scarfone, P. Mell, Guide to Intrusion Detection and Prevention Systems (IDPS), NIST SP, 2007, 800–94. doi:10.6028/NIST.SP.800-94
[18] Federal Office for Information Security, 2020. URL: https://www.bsi.bund.de/EN/TheBSI/thebsi_node.html
[19] L. Sakovych, et al., Study on Complex Assessment of the Information and Communication Systems Efficiency, CEUR Workshop Proceedings, (2020) 680–691.
[20] Z. Avkurova, S. Gnatyuk, B. Abduraimova, Structural and Analytical Models for Early APT-Attacks Detection in Critical Infrastructure, ICTERI 2021 Workshops, Commun. Comput. Inf. Sc. 1635 (2022). doi:10.1007/978-3-031-14841-5_30
[21] S. Gnatyuk, et al., Method for Calculating the Criticality Level of Sectoral Information and Telecommunication Systems, CEUR Workshop Proceedings, 3347 (2022) 234–245.
[22] S. Gnatyuk, Critical Aviation Information Systems Cybersecurity, Meet. Secur. Challs. Thr. Data Anal. Deci. Support, IOS Press Ebooks, 47(3) (2016) 308–316.
[23] I. Zhukov, Implementation of Integral Telecommunication Environment for Harmonized Air Traffic Control with Scalable Flight Display System's, Aviat. 14(4) (2010) 117–122. doi: 10.3846/AVIATION.2010.18
[24] M. A. Hadidi, et al., Methods of Risk Assessment for Information Security Management, Int. Rev. Computs. Softw. 11(2) (2016) 81–91. doi: 10.15866/IRECOS.V11I2.8233
[25] I. Zhukov, et al., Increasing the Accuracy of the Information Load Annual Growth Evaluation on the Internet of Things, The 1st International Conference on Cyber Hygiene & Conflict Management in Global Information Networks 2019 (CMiGIN-2019), 2588 (2019) 137–142.