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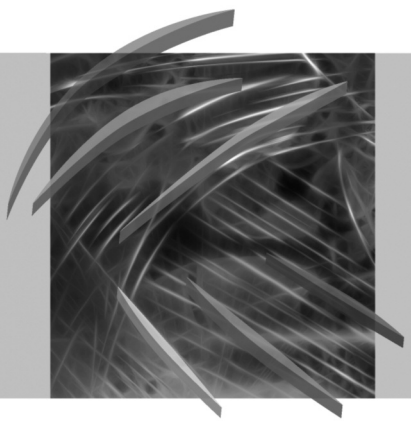

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CREATING THE PORTFOLIO OF INVESTMENT PROJECTS USING FUZZY MULTIPLE-CRITERIA DECISION-MAKING

Summary: This paper is about methods of creating the portfolio of investment projects using fuzzy multiple-criteria decision-making (e.g., ANP). The Analytic Network Process (ANP) provides a way to input judgments and measurements to derive ratio scale priorities for the distribution of influence among the factors and groups of factors in a decision. Because the process is based on deriving ratio scale measurements, it can be used to allocate resources according to their ratio-scale priorities.

Keywords: fuzzy multiple-criteria decision-making, investment projects, investment evaluation.

1. Introduction

The changes in external and internal conditions in management, economy, law, credit and financial operations happening in the Republic of Belarus require complex research studies concerning investment activity. The creation of a new organisational-economic model of investment process is a necessary condition of engaging both internal and external investment resources.

In modern conditions, economic practice stipulates a necessity of acceptance of administrative solutions to some extent uncertainties that present increased requirements to support stability of functioning of modern firms. In the market conditions characterised by any instability of the development of economic events and processes, it is industrial-economic activities that stipulate occurrence of the crisis phenomena that largely reduce economic security of firms.

More often the process of the creation of an investment portfolio or the investment programme of the managing subject is researched out of system business of planning and strategic development of firms that, unconditionally, does not promote framing comprehensively well-founded practical and methodical guidelines on the effectivisation of usage both own and extra investment resources of domestic firms.

Firm investment activity assumes creation and implementation of the perspective capital investment projects consolidated in investment portfolios or investment programmes of firms, realised within the limits of their strategic development.

Investments represent a resource pool (assets) directly invested in objects of an enterprise or another activity in a certain period for acquisition of the potential rights to reception of economic or other benefits. In this case, it is necessary to take into consideration that the result of investment process is potential, expanded in time as it does not give the absolute warranty for reception of this or that benefit for an investor. Besides, investments is the major factor of development of any modern firm, which directly defines possibility of its stable functioning in a durable perspective. Thus, not only simplification, but also saving stable functioning of a firm in the market environment is impossible without the realisation of investments as it requires duly replacement of main funds, perfecting the "know-how" and system of quality of made production.

Investments are one of the main paths of the implementation of the economic and financial strategy of the firm routed on growth of efficiency and the extension of its activity, rise of competitiveness and market value increase.

2. The common scheme of an estimation of the capital investment projects in the Republic of Belarus

There is a set of rules concerning the procedures of acceptance a capital investment projects that are paid from budgetary funds in the Republic of Belarus. The main criteria of an estimation of capital investment projects at the realisation of the state complex expertise are:

- urgency of a capital investment project and its correspondence of development strategy of branch;
- organisation-investor financial circumstances;
- technical, technological, financial possibility and expediency of the implementation of a capital investment project in proposed conditions of the realisation of investment activity;
- validity of investment outlay on a capital investment project and a state participation in this project;
- scientific and technical level of involved and/or created technologies;
- competitiveness of production (jobs, services) and perspectivity of seller's markets, efficiency of the strategy of the marketing of an organisation-investor;
- comparative metrics of efficiency and stability of a capital investment project.

The state complex expertise of capital investment projects is grounded on the following materials and conclusions:

1. Represented by an investor (the initiator of a capital investment project) a written statement with the application.

1.1. A business plan.

1.2. For a foreign investor who is not the resident of the Republic of Belarus – the legalised statement from the trading register of the country of its establishment.

1.3. The conclusions of the republican state body in which submission there is an investor (the initiator of a capital investment project). In the submission of the investor it is specified to which competence of the proposed production (jobs, services concern) the investor belongs.

1.4. An audit report about financial circumstances of an investor (the initiator of a capital investment project).

1.5. The conclusions of the State committee on science and technologies of the Republic of Belarus about scientific and technical level of used technologies on the capital investment projects applying for the state support, installed for the productions grounded on new and high technologies; on capital investment projects with engaging of foreign credits under warranties of the Government of the Republic of Belarus, and also on other capital investment projects in cases and subject to conditions, defined by the Government of the Republic of Belarus.

Thus, the state regulation of the investment activity is realised to stimulate investors' activity, to attract foreign investment to the Republic and to defend investors' rights on the territory of the Republic of Belarus.

3. A choice of criteria of the estimation of a capital investment project

For that reason, it is necessary to have a system of metrics that allows estimating the attractiveness of a given investment project. What is the most important is the preinvestment stage assuming the analysis of direct and indirect metrics. The author offers the following system of metrics for performance evaluation of investments.

1) Straight metrics

a. Preliminary: (i) the sum of expenses; (ii) the period of the inactivity of productive capacities; (iii) investment attractiveness.

b. Settlement: (i) the pure resulted income; (ii) an internal rate of return; (iii) profitability; (iv) yield; (v) payback period.

2) Indirect metrics

a. Reputation of investment value: (i) activity period; (ii) quantity of units of a portfolio.

b. The expert judgment of investment value: (i) liquidity of investment activity; (ii) an estimation of investment value; (iii) an estimation of the trend of a branch.

A solution to the challenges of stabilisation and purposeful output of a country from a crisis state is inseparably linked with a change of an investment policy and essential reconstruction of all investment sphere, including capital construction system. Defining directions of a new investment policy are:

– refusal of the centralisation of planning of a great bulk of investments except for investment of objects of state significance;
– change of the sources of finance with primary substitution of state budgetary appropriations by the resources of collective and private, domestic and foreign investors;

– preferable investment of cost effective and fast-paid back projects, including the projects of the firms of small and average power, and also the projects of reconstruction and modernisation of going concerns;
– creation of a free market of investment resources;
– transition to new organisational forms, economic methods, and modern technology of handling capital investment projects.

The modern investment policy is based on the project finance, having the minimum periods of realisation and capable to make the maximum profit. Investment projects are divided into two groups of branches: on the one hand, rather small investments that are capable to create competitive goods on the world market, on the other, those which production will find sales on home market and will bring thus significant incomes. It is possible to carry branches of the power complex to the first, the petrochemical industry and metallurgy, modern transport and telecommunication communication systems. To the second, housing construction, production and processing of agricultural production, development of a network of public catering, etc. The state task in these conditions consists in purposeful orientation of an investment policy to solution of problems of structural conversions and in effectivisation of the investment policy.

It is possible to invest in both complete scientific, technical production cycle (science-engineering-manufacture) and its units (stages) which are research activities, construction work, the extension or reconstruction of active production, the organisation of new production or issue of new production, etc. Objects of investments include:

– project scales;
– trends of projects (commercial, social, linked to the state interests, etc.);
– character and the reinvestment cycle contents (all stages of life cycle or only separate stages);
– character and a degree of involvement of the state (public investments, the block of shares, dividend credits, warranties, other forms of involvement);
– degree and features of a recoupment of committed facilities.

The following forms of investments are used:

– money resources and their equivalents (target contributions, circulating assets, shares and shares to authorised capital stocks of firms, securities, for example, shares or bonds, credits, loans, liens, etc.);
– buildings, structures, machines and the equipment, measuring and test resources, equipment and the instrument, any other property used in production or having liquidity;
– the proprietary interests evaluated, as a rule, by money's worth (know-how, licences for industrial property cession of rights – patents for inventions, certificates on useful models and industrial designs, trade marks and company names, certificates on production and "the know-how", the rights of land tenure, etc.).

The sources of investments are:

– own financial assets (profit, accumulations, depreciation charges, the sums insured paid in the form of reimbursement for a damage, etc.), and also other sorts of assets (main funds, the lots, an industrial property, etc.) and borrowed funds (a resource from stock trading), the charitable and other resources selected higher holding and joint-stock companies (commercially-financial groups on a free basis);
– loan proceeds (credits of banks and other institutional investors, investment foundations and companies, insurance companies, pension funds, bonded loans, and other resources);
– appropriations from state, regional and local budgets, funds of support the businesses represented on a free or privileged basis;
– foreign investments represented in the form of financial or other involvement in an authorised capital stock of joint ventures, etc.

The ideology of programmed control accepted in the Republic of Belarus defines a necessity of development and usage of methods adequate to it. Now the most developed unit of methodical support is a process of creation of target comprehensive programmes. At the same time, the problems arising at the stage of project development remain open. It is linked with hard-to-prognosis economic development, social and political instability.

The organisational controlling mechanism is in general assured by the state and regional programmes also. Concerning the question of programme management and projects, it is possible to tell that methods used for this purpose now demand serious perfection with allowance for features of a transition period. From this point of view of the most universal and in the conditions of market economy, the methodology and management engineering by projects is tested.

At the transition period initial stage, there are the limitations essentially constraining distribution of given methodology as for handle by large-scale projects and comprehensive programmes. They concern the common slump in production and unstable functioning of economy; insufficient political stability (as an additional risk factor); sharp abbreviation of the state investment and recession of investment activity; stable high inflation; the insufficient development of credit and financial and bank systems constraining a turn-over of investments and capitals; absence of a reliable system of support of warranties and privileges for investors, including, foreign. However, despite all these limitations, in the Republic of Belarus conditions of wide usage of the given methodology are formed.

Management methods projects can and should become a resource of effective implementation of reforms as at the state and regional level, and should be a common (main) control link.

Besides ideology of programmed control of projects, it is possible to expand the management methods by:

- liquidation of the according to plan-distributive system based on compulsory and strong-willed administration, the beginning of creation of legal system of regulation;
- gradual transition to market relations and legitimisation of the various patterns of ownership;
- realisation of privatisation of a state ownership;
- certain movement in a direction towards demonopolisation of manufacturers and any contractors; in particular, in investment sphere, contract activity, research activities, designing etc.;
- cancellation of the state monopoly in the field of foreign trade;
- market grouping of capital investment projects, the real estate (construction in progress), securities, contract and other jobs;
- process of decentralisation of handle and gradual transmission of certain functions on places;
- process of education of new organisational forms of government of market character;
- creation of investment trust companies, engineering and consulting firms offering the services in the field of economic, administrative, informational support of implementation of projects;
- appearance in investment sphere of the first design (objective), the oriented structures created on the basis of government facilities and again organised corporations;
- certain changes in psychology of managers;
- development of computer software, networks, and e-mail;
- active participation in the implementation of capital investment projects of foreign contractors and investors which already widely use today management methods projects;
- creation of new market structures working with projects (investment foundations, commercial finance companies, banks of commerce, etc.), which build the job on a design basis.

Objectively complexity of managing the projects increases because of an increasing number of participants, complication of their operations, lowering level of professionalism of management personnel. The modern investment policy is based on the project finance, realised in the minimum periods and capable to make the maximum profit. In such conditions these methods become the checked up instrument of the implementation of construction projects of necessary quality in target dates within the limits of the accepted budget.

Thus, the features of handle in the Republic of Belarus are defined by a transition period to market relations. The transition period requires usage of methods and mechanisms, characteristic for the market system grounded on a private property and rather free prices, and for the system of planned regulation.

Transition to design management methods first of all is linked to gradual liquidation of the organisational system grounded on plan-distributive management

methods and transition to market relations. For the state, the main form of programmed control is target comprehensive programmes, which appear in the form of the state purpose-oriented programmes.

In the Republic of Belarus the conditions of wide usage of methodology of programmed control are formed. It is an important premise for the application of management methods projects. The given methods are a handle effective remedy in varying conditions at significant instability and uncertainty when legislation questions in the conditions of an uncontrollable rise in prices are insufficiently studied. Management methods projects are the checked up instrument of the implementation of capital investment projects of necessary quality in target dates within the limits of the accepted budget.

4. Evaluation of the chosen criteria

Taking into account the above-stated, the complex technique of an estimation of innovations is developed for the subjects of innovative system that are carrying out expertise and financing of capital investment projects. It is necessary to mark that the offered approach does not change existing domestic practice, and only supplements and improves it. The algorithm of performance evaluation of investments is the following:

1) Definition of the list selection and construction of a network of estimated criteria. It is impossible to select universal system of criteria; therefore, each organisation of investment system, which organizing expertise, competitive selection of projects for investment, should work out their own system of criteria which are not contradicting normative acts.

2) Elimination of the capital investment projects which are not corresponding to selection criteria.

3) Creation of an expert group (creation of an universal expert group or a specialised expert group in which experts will give estimations only by criteria of the area of specialisation is possible).

4) Experts put down marks to criteria of a network in the form of indistinct triangular or trapezoid numbers (indistinct numbers, on the one hand, are free from probability axiomatics and from problems with a substantiation of a choice of probability scales and, on the other hand, include all scenarios of succession of events).

5) Defuzzyfication of the estimations of experts.

6) Definition of a coordination of the estimations of experts.

7) Definition by experts of ranks of criteria of all levels.

8) Definition of a coordination of experts by estimations of ranks of criteria.

9) Reception of final quantitative estimations under all projects and definition of the winner.

The offered complex technique of an estimation of capital investment projects has the following advantages:

1) eliminating, at a preliminary stage, obviously unpromising capital investment projects which do not correspond to selection criteria;

2) matching various capital investment projects on a uniform scale of the criteria covering all the key aspects of efficiency and the significance from the point of view of a person providing a solution;

3) the offered technique allows evaluating capital investment projects by many criteria including qualitative, to consider the various significance of criteria, the contribution of each criterion to general efficiency and antagonistic criteria;

4) at implementation of a given technique, not probably manifestation of "effect of compensation" when unacceptable estimations by one criteria can be compensated an appreciation by other criteria; "the effect of compensation" can lead to the responsibility to finance an innovation with unacceptable characteristics for the winner of the competition selected "under the formula";

5) the offered approach allows building the branched out outlines and defining "weak" places of each capital investment project;

6) the offered approach of an estimation of capital investment projects allows considering the uncertainty generated by the necessity of the implementation of a capital investment project in the future;

7) there are indistinct-plural approaches used as a mathematical apparatus: on the one hand, there are free from probability axiomatics and from problems with a substantiation of a choice of probability scales, and on the other hand, there are all possible scenarios of succession of events. Such an approach allows generating a continuous spectrum of scenarios of implementation on each of predicted parameters of financial model;

8) a lobbying exception as solution will be accepted on the basis of the calculated integral metric of efficiency of a capital investment project;

9) effectivisation of the work of experts; coercion of process of expertise to standard procedures will considerably reduce time for the consideration of a capital investment project and decision-making on it;

It is possible to point out some disadvantages of the offered approach:

1) it is obvious that the introduction of additional stages in the procedure of an estimation of capital investment projects increases the cost of the procedure and complicates it, but it is obvious as well that the introduction of given procedures reduces risk of a wrong choice of a capital investment project for financing, increases scientific validity of accepted solutions;

2) at the heart of an offered technique of an estimation of capital investment projects lie expert judgements; according to the given approach, there are all disadvantages inherent in expert methods: complexity of negotiation of opinions of experts; subjectivity of opinions of experts; limitation of their opinions.

The aggregated estimation business of the schedule of a capital investment project:

Block "Firm": reputation of a firm; competence of an applicant; efficiency of the organisational-administrative structure of a firm; technological level of production; production potentialities; firm's financial position.

Block "Market": channels of the distribution of production; perspectives of the development of a branch; influence of the project on the development of allied industries; perspectivity of seller's markets; stability of demand for production; competitiveness level on the considered market; level of costs on advertising.

Block "Production-marketing": quality of the design of appearance and packing**;** competitiveness of production; reliability of production in comparison with clones; correspondence of production to national and international standards; level of transfer prices of production in comparison with known clones; quality and reliability of results of the project of market research spent by authors; efficiency of the strategy of the allocation of production; efficiency of the strategy of sales promoting; efficiency of the industrial cooperation provided by a project.

Block "Finance": investment costs; the investment in financing of an organisation or persons directly representing a project; possibility of applying for financing of foreign investors; credit drawing facility in a national bank.

Block "Efficiency and risk": social effect of the implementation of a project; budgetary efficiency of a project; the value of the net present value (NPV); sensitivity NPV on an innovation strike price; sensitivity NPV in terms of volume innovation implementations; the value of an internal rate of return (IRR); simple ay-Back Period (PP); metrics of liquidity and solvency of a firm in the course of project implementation; probability of loss risk of committed facilities in connection with a problem of implementation of production; risk of a stoppage of production in connection with insufficient financing; risk of impossibility of effective job of a firm owing to any criminal operations; environmental risks.

For a complex estimation of business plans of capital investment projects, the following blocks are offered, accordingly:

Block "Firm": corporate criteria that are linked to the purposes, its strategies, policies, and values: compatibility of a project with a current company strategy and its long-term schedules, etc.

Block "Market": market criteria: correspondence of a project to accurately certain market demands; the common market capacity, etc.

Block "Production-marketing": group of criteria evaluating the competitiveness of production in comparison with known clones and quality offered by authors of the project of marketing strategies.

Block "Finance": financial criteria: research and development cost; productive investment; nestings in marketing, etc.

Block "Efficiency and risk": criteria on efficiency and risk: new engineering procedures; sufficient number and qualification of industrial staff, etc.

5. The conclusion

In the article the technique and criteria for the selection of capital investment projects at the creation of the portfolio of capital investment projects are described. This instrument allows giving the conclusions, most approximate to a reality, on profitableness, recoupment, and viability of a given capital investment project.

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TWORZENIE PORTFELA PROJEKTÓW INWESTYCYJNYCH PRZY UŻYCIU WIELOKRYTERIALNYCH ROZMYTYCH METOD PODEJMOWANIA DECYZJI

Streszczenie: Artykuł dotyczy metod tworzenia portfela projektów inwestycyjnych przy użyciu wielokryterialnych rozmytych metod podejmowania decyzji. Na przykład ANP (*Analytic Network Process*) zapewnia możliwość wprowadzania wyników oraz miar, aby na ich podstawie uzyskać współczynniki wpływu poszczególnych czynników lub grup czynników na decyzję. Jako że proces bazuje na współczynnikach liczbowych może być użyty na przykład do przydzielania zasobów na podstawie liczbowych priorytetów zadań.

Słowa kluczowe: podejmowanie decyzji, projekty inwestycyjne, ocena inwestycji.