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Model and toolkit of innovation activity in the engineering business

A. Shichkov
Vologda State University
Vologda, Russia
shichkov-an@yandex.ru

N. Kremlyova
Vologda State University
Vologda, Russia

T. Akhmetov
Institute of Economics and Information technologies
Kazan State Power Engineering University
Kazan, Russia

***Abstract*—The relevance of the research is determined by the need to develop the mathematical toolkit for designing investment, innovative and complex projects in which technological, productive, and incremental and breakthrough innovations are implemented in manufacturing technological systems of production enterprises. Innovation activity of production enterprise should be realized in the "think-make-think" mode; therefore in conditions of digital economy each implemented innovation should be placed in a digital information analytic system of the enterprise management accounting. The aim of this research is to develop the toolkit regulating the sequence and validity of making management decisions. As the model of a manufacturing cycle we take the closed operation cycle converting manufacturing capital of the manufacturing-technological system in an enterprise into monetary capital in the form of manufactured and sold products having market added value. As a result of the study we developed the graphical analytic toolkit in the form of the plot of monetary flows vectors. This study allowed us to create a digital platform of an innovation activity in engineering business. Further research will be devoted to the development of entropy method of analysis and design of innovative projects in engineering enterprises.**

Keywords— innovation activity; engineering business; mathematical toolkit; projects; model.

I. INTRODUCTION

Production and technological systems (MTS) of engineering business enterprises [1], built for producing goods in industrial state economy, focused on the continuous growth of production volume while the range of products remained limited. These MTSs in the new conditions of innovation market economy should increase the sales value by continuous growth of the added market value of products. This goal can be achieved by implementing productive and technological innovations [2]. Constant innovation activity of enterprises [3] is the structural part of enterprise controlling [4] including production organization [5] and management accounting [6]. Each implemented innovation should be immediately digitized and placed in the digital information analytic system of enterprise management accounting [7]. Only in this case the innovation activity will be efficient. We offered the model of an enterprise digital platform [8, 9] to be used as the "Innovation passport" being the tool regulating the innovation activity in management accounting. The informative logic of innovation passport allows justifying the decision, which income-producing ideas implement as technological or productive innovations [10].

II. THE AIMS AND OBJECTIVES OF THE RESEARCH

The purpose of this study is to create a digital platform and structure of the innovation passport of an enterprise, as well as an algorithm for analyzing the parameters of MTS to justify the decision to introduce the product and (or) technological innovations that ensure the growth of the share of the products added market value.

The main task of the study is to adapt a model and a digital platform toolkit of production enterprises in order to implement innovation activity [11].

III. RESEARCH METHODS

The model of the production cycle is a closed operation cycle of converting manufacturing capital of MTSs into monetary capital in the form of manufactured and sold products having market added value [12].

IV. RESEARCH OF THE INVESTMENT PROJECT IN THE CLOSED OPERATION CYCLE CONVERTING MANUFACTURING CAPITAL INTO MONETARY CAPITAL

Fig. 1 shows a plot of monetary flow vectors [12]. The equilibrium closed operation cycle converting manufacturing capital Q_{mc} (1-3) into monetary capital Vsv (1-2) is presented as an equilateral vector triangle (1-2-3). According to the model of management accounting [13], manufacturing capital Q_{mc} (1-3) is the sum of equal orthogonal vectors of technological costs C_{tc} (1-4) and the vector of main funds U_{mf} (4-3), which includes fixed assets and balance intangible assets of all technological stages 10-11, 12-13, 14-15.

Similarly, the monetary capital vector V_{sv} (1-2) is equal to the sum of orthogonal vectors of technological costs (expenses value of product) V_{ev} (1-4) and the vector of net income (added value of product) V_{av} (4-2). The vector of manufacturing capital Q_{mc} (1-3) is the sum of the collinear vectors of manufacturing capital of technological conversion (for example: ball production (10-11), separator production (12-13), ring production (14-15), grinding and assembly production and business waste. Similarly, the vector of monetary capital V_{sv} (1-2), the vector of technological costs C_{tc} (1-4), the vector of net income (added value) V_{av} (4-2) and the vector of main funds U_{mf} (4-3) are the sum of the collinear vectors of the corresponding technological stages products.

The sales value of products and the manufacturing capital increase while implementing productive and/or technological innovations.

V. Research of Investment Project in Coordinate System Performance T, Rub./Hour and Entropy S, Hour/Year

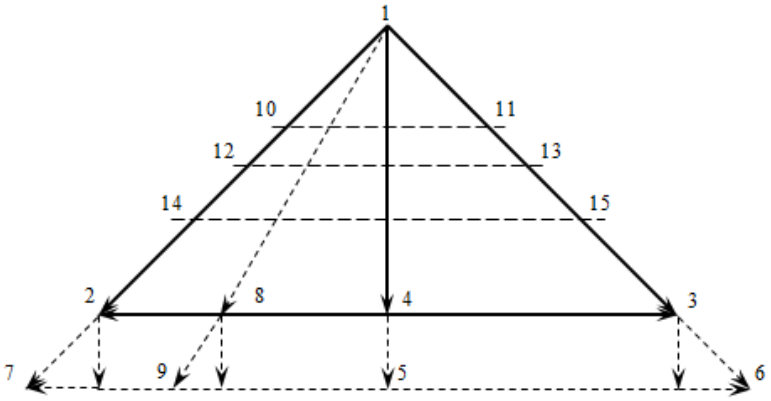

Fig. 1. Plot of monetary flow vectors in closed operation cycle converting manufacturing capital MTS into monetary capital in the form of manufactured and sold product at implementing investment projects

At equilibrium conversion operation cycle the increment of manufacturing capital and the increment of monetary capital are equal. Manufacturing capital increment is equal to fixed assets in investment projects, while in innovation projects it is equal to intangible assets, and in mixed projects the increment share of tangible and intangible assets is included in manufacturing capital.

At non-equilibrium conversion operation cycle the increment of monetary capital is less than the increment of manufacturing capital.

Manufacturing capital increment in investment projects is equal to technological costs and taxable and depreciable fixed assets. Consequently, the added value will be used to compensate fixed assets tax and operation costs. As a rule, investment projects are not efficient.

Manufacturing capital increment in innovation projects uses intangible assets that are not taxable but amortizable.

As a rule, projects implemented in enterprises should be investment and innovative. In this case intangible assets amortization may by equal to the sum of tax and depreciation of fixed assets.

Fig. 2 presents the graphical plot of designing [14] the added market value V_{av} by reducing the share of business waste in operation cycle converting manufacturing capital into monetary capital in the form of manufactured and sold products (technological innovation).

The plot is formed in the coordinate system where operational processes are performed, measuring the reprocessing of technological costs and the entropy of main funds [15], calculated by the annual resource time worked, equal to the annual resource useful life of main funds. Sales value of products V_{sv} rub/year depends on annual resource of working time R_0, hour/year. As a result we obtain the performance T, rub./hour. Main funds value U_{mf} depends on annual resource of useful life R_G, hour/year, and the performance T, rub/hour of the main funds is obtained in this case. Business effectiveness should ensure the equality of R_0 and R_G. These constants are numerical values of main funds and sales value of products.

Entropy parameter [16] is very important for estimating the modernization, renovation, simple and extended reproduction of fixed assets. Actual investment is reasonable if the entropy reduces.

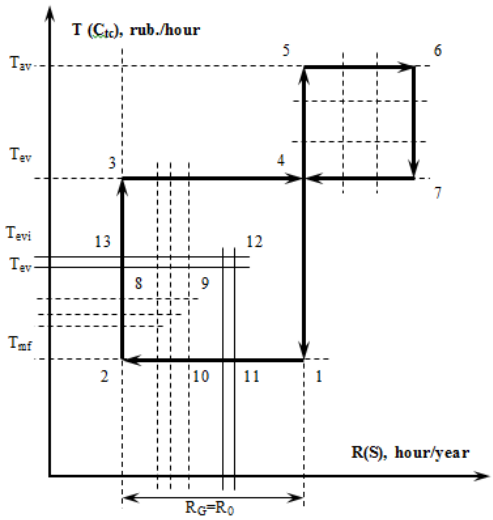

Fig. 2. The plot equilibrium operation and innovation cycles converting manufacturing and innovation capitals into monetary capital in the form of the sum the expenses and added value of products

Equilibrium operation conversion cycle (1-2-3-4) including operation conversion cycles of all technological stages consists of following processes: the formation of main funds (1-2), the formation of technological costs (2-3), the manufacturing process (3-4), the formation of expenses value of products, and the formation of added market value of products (4-1). One of the operation conversion cycle in technological stage (2-8-9-10) implements technological innovations. The space of the equilibrium operation conversion cycle of technological stage uses business waste share which increases in cycle 11-12-13.

Innovation equilibrium cycle converting income-producing ideas (7-4-5-6) consists of intangible assets (7-4), labor payment with the growth (4-5), added consumer properties of products (5-6), net profit with tax and amortization of intangible assets (6-7). In this case labor payment increases in technological costs, main funds rise by the increment of intangible assets, and the added value increases by net profit for business owners.

VI. THE RESULTS OF RESEARCH

Integrated digital information analytic toolkit in the form of graphical analytic vector analysing and designing the innovation processes in manufacturing-technological systems of production enterprises has been created.

The analysis of closed operation conversion cycles showed that innovation projects should consist of the share of innovations (intangible assets), ensuring the economic efficiency of implemented productive and technological innovations.

VII. CONCLUSION

We developed the 'Digital Platform' to manage innovation activity of production enterprises. It is an integrated information analytic system of controlling production business processes. It ensures the growth of the share of added market value of manufactured and sold products and services in business and territory life activity.

Digital transformation of the production cycles in the form of operation cycles converting manufacturing capital into monetary capital allowed us to conclude that digital platform of production enterprises can be applied in strategic planning of digital ecosystems in municipal territories

VIII. FURTHER RESEARCH

Further research will be devoted to the development of entropy methods in designing innovation projects

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