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THE MODIFIED RANK-RESOURCE METHOD OF EVALUATING NEW PRODUCT PROJECTS IN THE PORTFOLIO MANAGEMENT PROCESS IN PRE-MARKET PHASES

Introduction

The known portfolio methods of assessing strategic situation of a company or products are described in many scientific papers and monographs, among others, in national publications: G. Gierszewska and M. Romanowska [2017], J.M. Rybicki [2000], A. Stabryła [2015], Z. Pierścionek [1998] and others, as well as foreign e.g. R.G. Cooper, S.J. Edget, E.J. Kleinschmidt [1999, 2000, 2001], N. Lahtinen, E. Mustonen and J. Harkonen [2021], Mitzi M. Montoya-Weiss and Roger J. Calantone [1994]. Various proposed portfolio methods in strategic management are used to create decision-making grounds that determine sustainable and long-term development of company in a changing environment, with the increase or reduction of resources. Achieving these goals requires a holistic view of the economic organization. It is therefore important to distinguish relatively autonomous strategic units, to select and focus on strategic success factors, and to apply methodological approaches taking into account management processes focused on the environment and interior of organization [Gierszewska, Romanowska, 2017; Rybicki, 2000]. The proposed portfolio methods combine these methodological approaches.

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Portfolio management involves resource allocation to balance the business risk reduction and sales or profit maximization, with important decisions around the evaluation, prioritization and selection of new products and innovation projects within business strategy [Certo, Peter, 1988; Smith, Arnold, Bizzell, 1985]. This conceptual and methodic paper has its backgrounds in financial portfolio management, relates closely to new product development research and marketing product management, or new product strategy. The organizational ability to manage new product projects portfolios connects portfolio management to key strategic organizational capabilities, including dynamic capabilities and strategic flexibility. Thus portfolio management should be viewed as a source of competitive advantage that supports organizational renewal [Chagas, Eggers, 2019; Kharat, Bhukya, 2022; Dąbrowski, 2022]. New product strategy links to new product development (NPD) through new product portfolio management (NPPM). This dynamic decision process addresses strategy implementation questions of identifying which new product ideas to pursue and their relative priorities. Despite the importance of NPPM in implementing new product strategy, firms exhibit substantial performance-affecting differences. Potential source for such differences is the impact of managers' dispositional factors as a possible explanation of new product success or failure on the market [Cooper, 2017; McNally, Durmusoglu, Calantone, Harmancioglu, 2009]. Increasing new product variety and expanding commercial offering create a challenge for companies in terms of keeping their new product portfolio profitable and managing it through entire products lifecycle (pre-market and market PLC). Effective new product portfolio management (NPPM) practices, supported by product structure considerations, may be crucial for new product profitability over lifecycle. Therefore it is important to examine current practices and improvement possibilities in NPPM, including goals or targets and key performance indicators (KPI), by considering the new product projects, which will be introduced to product lines of a company [Lahtinen, Mustonen, Harkonen, 2021].

The aim of paper is to present methods for valuing new product projects in the new product development process, as well as to propose a new method for optimizing the value of the new product project portfolio. The analysis utilizes previous literature and proposes modified rank-resource method of new product project evaluation. The article also demonstrates difficulties which are stemming from inadequate definition of imperfect NPPM targets and KPIs over the pre-market phases. The basic problem that is posed concerns how to effectively allocate available resources to achieve goals set for the new product. Therefore, the project team managing the new product development process (NPDP) should optimize the use of available resources for research and development of new products. This effect can be achieved by properly defining the new product strategy, selecting product concepts and designs characterized by a high probability of technical and marketing success, and by achieving a balance of the project portfolio in the long term.

1. Problems, goals and factors of portfolio analysis of new product projects

The level of success in new products development is significantly dependent on the level of competence of an enterprise [Rutkowski, 2013]:

- firstly: in the proper application of an integrated, parallel new product development process (NPDP), its capabilities and maturity, taking into account the "voice of the recipient", based on a multidisciplinary team and other best practices (proper project execution – proper implementation of NPDP);
- secondly: in the proper selection of projects or design concepts for a new product (executing the right project).

In particular, the issue of portfolio management is related to the latter competence area. Cooper, Edgett and Kleinschmidt [1999] formally define portfolio management in area of new product development as a dynamic decision-making process, according to which project team constantly updates and revises current set of new product designs. In this process, new projects are evaluated, selected, and their importance and priority determined. Strategic decisions are also made regarding the allocation and reallocation of resources between active projects and whether to accelerate their implementation, change assigned priority or abandon (reject) the project. The portfolio management process is characterized by uncertainty and changeability of information, dynamics of opportunities, variety of goals and strategic conditions, interdependence between projects, variety of places and decision-making entities. Portfolio management in NPDP covers the decision-making processes taking place in company, including a comprehensive review of all projects, formulating a new product development strategy and strategic allocation decisions [Cooper, Edgett, Kleinschmidt, 1999].

Thus, the following general goals of portfolio management in the new product development process and specific techniques and tools for achieving them can be defined [Cooper, Edgett, Kleinschmidt, 2000, 2001]:

- maximizing value of project portfolio at a given level of resource inputs, using financial models, risk and probability models, point and weight valuation methods,
- balancing project portfolio (reaching a balanced project portfolio, achieving desired balance of projects due to adopted balance parameters, e.g. long-term and short-term, high- and low-risk projects, project types related to the adopted new product strategy, taking into account various target markets, technologies as well as product categories), graphic charts are used for this purpose, e.g. bubble diagrams or multidimensional portfolio maps,
- achieving a strategically matched portfolio of projects (projects in portfolio must be correlated with company's development strategy and the required resources), using the methods of bottom-up and strategic "cash baskets" (top down),

- generating an appropriate number of program-projects in relation to limited availability of resources which is achieved through analysis of resource capacity, proper modeling of funnel (tube) in NPDP.

Portfolio management of a new product creates unique decision challenges for a modern enterprise, and the reasons for these unique problems are as follows [De Meyer, Loch, Pich, 2002; De Reyck et al., 2005; Kettunen, Gruksha-Cockayne, Degraeve, De Reyck, 2015]:

- portfolio management concerns future events, phenomena and opportunities, which results in information uncertainty, lack of sufficient information base for project selection,
- the decision-making environment is highly dynamic, the status and perspective and scope of projects in the portfolio change as new information becomes available,
- projects included in the portfolio are in various stages of implementation and compete with each other for required resources, hence the comparison of projects is made when there are different sets of information,
- the resources allocated between projects are limited, so funding of a given project may require limiting resources for others.

NPD best practice studies indicate important reasons for the increase in the importance of portfolio management, which include: maximizing the RF (return factor), maximizing R&D productivity, achieving financial goals, maintaining a competitive position by increasing sales and market share, proper and effective allocation of limited resources, creating links between the selection of projects and the strategy of a new product and a general enterprise (the portfolio of new product concepts should reflect and support the strategy), focusing project/design team on the best concepts of a new product, achieving a balanced portfolio of high and low risk projects in the long term consistent with the company's goals, better vertical and horizontal communication of priorities within the organization, which increases the objectivity of project selection [Stabryła, 2015; Cabała, 2018].

Potentially a conflict can be between the above-mentioned macro goals of portfolio management. For example, maximizing value of the portfolio leads to the maximum net present value (max NPV), or internal rate of return (max IRR) of given projects, although such a situation may indicate an unbalanced portfolio of projects (the portfolio may contain mostly low-risk projects to be implemented in a short time, focused on serving one market segment). Therefore, when choosing the methods of portfolio analysis the hierarchy of goals for managing new product development should be taken into account.

Among the methods used to achieve the maximum value of the portfolio of new product projects, financial models based on discounting methods have a significantly limited application, as they are based mainly on financial goals, do not take into account strategic conditions and the probability of success and risk, and assume

accurate financial estimates. Although some companies try to assess the attractiveness of projects on the basis of NPV or DCF discounted cash flow, such calculations must be considered of little value because the uncertainty inherent in R&D is so important that rigors required by NPV, IRR, ROI methods make these calculations useless or even pointless. These commonly known economic methods are rather used for the evaluation and selection of investment projects (purchase of a new technological line, machine, etc.). They are characterized by correctness and clarity of definition, and procedures for their practical application can be found in sources cited above. The attractiveness of a project is determined by both qualitative and quantitative factors, while its value is determined by quantitative factors [Rybicki, 2000].

For efficient portfolio management it is also important to adapt method of portfolio management to type of organization, to ensure that organization learns in this process and defines roles of employees in process of formulating and implementing the strategy. Employees involved in projects are extremely important for the effectiveness of management processes. These observations are reflected in literature on the subject, in particular within research discussing new products development and implementation of internal development projects enterprises. The literature emphasizes the role of project manager as a change leader, relationship moderator (gatekeeper), facilitator, trainer and mentor. The involvement of senior management and its key role in the process of supporting launched initiatives is also discussed [Loch, 2000; Brzozowski, 2014]. An important challenge from the point of view of project management is to encourage employees to create new ideas in project path emerging in organization, as they are an important element of strategy renewal. Another issue that is particularly important in today's competitive conditions is the issue of portfolio management in context of organizing research and development activities, as well as innovative activities of the project team or entire enterprise [Mikkola, 2001; Killen, Hunt, Kleinschmidt, 2008; Cooper, 2014].

In traditional sense, a new product project portfolio is a properly selected set of projects and their collections that compete for limited resources of the parent organization. Appropriate selection of projects for a new product portfolio allows to properly balance the risk associated with its implementation [Hofman, Spalek, Grela, 2017]. Attention is also paid to strategic dimension, manifested in compliance of the portfolio's new product strategy and goals with the strategic assumptions of the organization [Meskendahl, 2010]. In this case, defining the new product project portfolio's goals consists of decomposing the adopted strategic plans to the level of portfolio's objectives. It is also necessary to define the ways in which the performance of portfolio will be monitored, and to analyze availability of resources necessary for portfolio to create desired results. Thus, a properly structured projects portfolio allows for implementation of all or part of organization's new product development strategy [Crawford, Di Benedetto, 2011].

2. Methods of evaluating new product projects portfolio

In a situation when assessed projects require different amounts of resources (in terms of value and/or duration of capital expenditure), the individual NPV value cannot be used for their assessment and selection, as this value does not accurately express differences in level of profitability (renumerative) of different project variants and resources required for their implementation. Therefore, net present value rate (NPVR) should be used to compare different projects [Rutkowski, 2016]. The basis for the evaluation and selection of the project is the maximization of the NPVR indicator, which is expressed by the formula:

$$NPVR = \frac{NPV}{PVI},$$

where:
NPV – net present value generated by a successful project (amount of benefits – discounted value of expenses and cash inflows),
PVI – present value of required capital outlays necessary to generate net income (discounted overall outlays – costs of the project).

Expenditures here are actual or potential expenses related to the implementation of a new product development process. Expenditures may differ from development costs in terms of time, subject scope and valuation basis. To achieve the maximum value of the portfolio of new product projects, extended indicators can also be used, taking into account risk factors and subjective assessments of the technical and commercial value of the project, which reduce the expected benefits. For this purpose, below is proposed by F. Olsen model of economic value of the project and the H.I. Ansoff's design quality factor [Olsen, 1955; Ansoff, 1964]:

$$\text{Olsen model } V_p = \frac{r \times d \times m \times s \times p \times n}{PVI} = \text{economic value of project;}$$

$$\text{Ansoff model } Q_p = \frac{r \times d \times m \times (T + B) \times E}{PVI} = \text{design quality factor;}$$

where:
r, *d*, *m* – are respectively the success probabilities of the pre-design phases (research), concept design and development, commercialization (marketing),
s – estimated annual sales volume, *p* – profit per product unit, *n* – market life cycle of the product in years,
T, *B* – subjective assessment of the technical and marketing value of the project,
E – present value of expected revenue after successful product launch, i.e. *NPV*.

Thus, the estimated numerical values in these models are adjusted by the probabilities of conceptual, technical and marketing success of a new product. Another method of evaluating projects presented by G.L. Urban and J.R. Hauser allows to determine so-called attractiveness index for various projects in the portfolio, as quotient of probability of the expected return on investment related to a new product (research, development, commercialization) and its development costs D_k [Urban, Hauser, 1993]. This relationship is presented in the following formula modified by the author:

$$I = \frac{T \times C \times P}{\log D_k} = \frac{P_{si}}{\log D_k} \text{ attractiveness index of new product projects}$$

This indicator takes into account the P_{si} innovation success probability coefficient, which is the product of partial probabilities, i.e. the success of technical development (T), commercial development, provided that technical success is achieved (C) and economic benefits (P) resulting from commercial (marketing) success. High partial probabilities increase the feasibility and value of a new product concept at a given level of estimated expenditure on its development. The portfolio should include those project concepts that have achieved the highest values of the attractiveness index, higher than the arbitrarily adopted threshold index. Threshold indicators should also be defined for other methods used to maximize the value of the project portfolio. It can be assumed that the threshold indicator will be the average value of the calculated indicators for individual projects.

R.G. Cooper, S.J. Edgett and E.J. Kleinschmidt propose the method of expected commercial value (ECV) for evaluation and selection of projects, as well as maximizing value of portfolio, taking into account budgetary conditions and introducing the concept of risk and probability. The ECV calculation is related to decision tree analysis (NPDP phases are in decision tree format) and takes into account the present value of expected NPV, the probability of commercial (marketing) and technical success, together with overall development and commercialization costs of the project [Cooper, Edgett, Kleinschmidt, 2000, 2001]:

$$ECV = [(NPV \times P_{sm} - C_k) \times P_{st} - D_k]$$

where:
P_{st} – probability of technical success,
P_{sm} – probability of marketing success,
D_k – development costs (expenditures that must be incurred to complete the project),
C_k – commercialization costs – future market launch costs.

To compare different designs of new products the ECVR indicator should be used, which is expressed by the formula:

$$ECVR = \frac{ECV}{D_k} \text{ expected commercial value rate}$$

The sum of expenses that must be incurred to complete the projects approved in accordance to the rank may not exceed the limit of previously planned total budget for development of new products, i.e. $\sum_{x=1}^{n} D_k \leq$ the development budget. Expenditures previously spent on a given project, until it is completed and introduced to the market, are lost and therefore should not be included in the calculation and ranking of the commercial value of the project, as well as in making decisions: "Accept-Activate", "Suspend", "Reject". Some similarity to the ECV method is characterized by the productivity index (PI) of D. Matheson and M.M. Menke. This indicator allows to maximize financial value of project portfolio, given resource constraints. The formula of the new product design productivity index (*PI*) is as follows [Matheson, Menke, 1994]:

$$PI = \frac{ECV_E \times P_{st}}{D_k}$$

In this formula, the expected commercial value of ECV_E is a different value than the one presented in the indicator of the expected commercial value of ECV. ECV_E is an estimate of the expected net discounted value (NPV). This probabilistic-statistical method used to assess the value of projects and their risk is related to the calculus of probability, the determination of expected values and statistical methods. Application of this method is much more difficult than the application of the methods presented earlier. The basic tools of these methods are: normal distribution, indicators of the probability of occurrence of specific variables as well as variance and standard deviation, the Monte Carlo method and others.

A single project will be profitable if the expected value of ECV_E is greater than zero ($ECV_E>0$). The scale of the associated risk is evidenced by the level of the standard deviation of the S_{NPV} and the coefficient of variation. It can be assumed that the standard deviation and the coefficient of variation are the determinants of the quasi-margin of safety of project activation. It is important that the involvement of resources in a given project is aimed at minimizing these factors. When two projects are compared, two cases may occur: a higher expected NPV is accompanied by a lower standard deviation ($ECV_{E(x1)} > ECV_{E(x2)}$ and $S_{NPV,x1} > S_{NPV,x2}$). A project with a lower coefficient of volatility is then selected, as this project guarantees a higher compensation for the risk incurred. The coefficient of variation can also be used to estimate the risk premium. The higher the ratio, the greater the risk of implementing a given project.

3. Modified rank-resource method of new product project evaluation

The above indicators generally seem to be simple and easy to apply, and expression of benefits as the only financial criterion allows you to maximize the value of new product project portfolio focused on new products development process maturity, in conditions of limited resources. The main weakness of these quantitative methods is their dependence on accurate quantitative financial data and estimates of probabilities of assessed project's success. In addition, these methods do not take into account the balance of project portfolio, considered on basis of risk level (except for the productivity index), market segments served, or level of technology advancement.

At this point, another rank-resource method of valuing projects – programs in the NPDP funnel (portfolio of projects at individual stages of the development process) can be proposed, containing both qualitative and quantitative criteria. In this method, proposed by the author, specific factors, both quantitative and qualitative, make it possible to determine the level of value and attractiveness of projects and, at the same time, to analyze the strengths and weaknesses of a given project. On the other hand, only quantitative criteria concern specific resource constraints (limitations) set by the project team: time needed to complete the project t, personnel K, technical resources of TR, expected commercial value of the ECV project, and above all related to this indicator, future development and commercialization costs and appropriate probabilities of new product project's success.

The analysis and evaluation of the criteria affecting value and attractiveness of the project requires their prior identification, adoption of a rating scale of 0–10[1] and progressing according to the procedure used in the scoring method. Taking into account determinants of development and success of a new product examined so far, generally aggregates of project value and attractiveness factors can be presented as follows:

- strategic fit – SA (compliance of concept with product strategy and company's strategy, degree of affinity with company's existing marketing offer, level of complementarity (deepening the product line) or substitutability (extending the product line), level of financial and material resources, degree of their use);
- advantage of a new product – NPA (product innovation, new physical and aesthetic features, new product properties, new technical features and usability characteristics, structural properties, including quality, potential price, product brand, type of material and raw material, additional benefits, potential unit costs

[1] Assuming that distances on scale are the same, we assume that we are dealing with an interval scale according to the Stevens classification of scales [Stevens, 1946].

variables, potential product profitability, standards and legal requirements for product parameters);
- attractiveness of target market – TMA (market growth rate, market potential measured by turnover, potential of new and existing customers, location of customers and their bargaining power, potential of new and existing suppliers, location of suppliers and their bargaining power, intensity of competition and its strength, strength of seasonality and demand substitutability, marketing service costs);
- functional compliance with the company's key competencies – CCA (knowledge resources, qualifications and experience, type of organization, level of internal competencies in functional areas of the company's operations, level of forecasting and programming of the company's strategic activities, teamwork skills, ability to assimilate new ideas, methods, processes and products);
- level of ability and technological maturity – TCM (novelty and modernity of technical solutions, scope of specialist knowledge and technical skills, domain of basic research, level of construction and design work, use of laboratory tests and measurement techniques, Beta utility, type of original technologies);
- level of potential benefits at a given level of risk – RRL (profitability of production/sales, risk level of research, development and marketing (technical, market);
- level of the relationship network maturity – RNM (an intelligent network of relationships is a multidimensional cultural, business, technological and environmental space for functioning of the project team or new product development department responsible for managing new product development process and its introduction to the market);
- level of the new product development process maturity – NPDPM (defines key practices that describe and differentiate successive levels of process maturity. The process phase includes groups of practices/activities, the joint implementation which leads to the achievement of specific goals. Each process area consists of a specific number of goals, the achievement of which guarantees full implementation/execution of a specific phase of NPDP and making a decision of the type of activate-pause/hold-reject);
- level of resource allocation – RA (the new product project should be evaluated for resource availability and allocation. The project team should have the necessary skills, experience, and resources to complete the project successfully);
- level of alignment with regulatory requirements – ARR (the new product project should be evaluated for its alignment with regulatory requirements and compliance with legal, ethical, and social standards).

The use of this model allows to create a strategically matched portfolio of new product projects that reflect the project team's priorities in terms of resource disposal. And above all, it allows to make the right decisions, and thus avoid type I errors of rejecting good projects and type II of accepting bad ones. The result of good decisions

will be an optimal portfolio of projects in terms of value. The model of finding new product project portfolio optimal in terms of value, using the rank-resource method, is presented in the Table 1.

Table 1. Modified rank-resource method for evaluating new product projects/designs

Project name	X_1	...	X_n
Strategic adjustment SAdj	$Sadj_{x1} \in [0–10]$	...	$Sadj_{Xn} \in [0–10]$
New product advantage NPAdv	$NPAdv_{x1} \in [0–10]$	...	$NPAdv_{Xn} \in [0–10]$
Target market attractiveness TMAtr	$TMAtr_{x1} \in [0–10]$	...	$TMAtr_{Xn} \in [0–10]$
Compliance with the company's core competencies CCA	$CCA_{x1} \in [0–10]$	...	$CCA_{Xn} \in [0–10]$
Ability and technological maturity TCM	$TCM_{x1} \in [0–10]$	...	$TCM_{Xn} \in [0–10]$
Potential benefits at a given level of risk RRL	$RRL_{x1} \in [0–10]$	...	$RRL_{Xn} \in [0–10]$
Level of the relationship network maturity – RNM	$RNM_{x1} \in [0–10]$	...	$RNM_{Xn} \in [0–10]$
Level of the new product development process maturity – NPDPM	$NPDPM_{x1} \in [0–10]$	...	$NPDPM_{Xn} \in [0–10]$
Level of resource allocation – RA	$RA_{x1} \in [0–10]$	...	$RA_{Xn} \in [0–10]$
Level of alignment with regulatory requirements – ARR	$ARR_{x1} \in [0–10]$	...	$ARR_{Xn} \in [0–10]$
Assessment of project attractiveness (ranking database) PAtr	$PAtr_{x1} = \sum$ factor ratings /100	...	$PAtr_{Xn} = \sum$ factor ratings /100
Time limit for project completion t	t_{x1}	...	T_{Xn}
Full-time staff FTE	FTE_{x1}	...	FTE_{Xn}
Cumulative number of Full Time Staff	FTE_{x1}	...	$FTE_{x1} + FTE_{Xn}$
Expected commercial value rate of the project ECVR	$ECVR_{x1}$	...	$ECVR_{Xn}$
Priority and Status (strategic decision type) Accept-Activate A-A, Pause – Hold P-H, Reject R	A-A, P-H, R	...	A-A, P-H, R

Specify:
attractiveness threshold, e.g. at 0.75,
employment threshold, e.g. at level 45,
the ECVR threshold that activated project must meet, e.g. 1.10.
Then, the projects that meet the above criteria should be ranked according to the attractiveness rating from max to min. Select those projects that do not exceed the resource limit.

Source: own study.

The above evaluating method takes into account important decision variables, qualitative and quantitative, solves the problems of project implementation time, its attractiveness and sources of additional resources, ways of their allocation at a given level of probable success of a given product concept which is part of the project portfolio. Relatively high complexity of this method cannot be its weakness, while its application contributes to increasing the effectiveness of decisions made by the project team. In addition to creating the appropriate value of project portfolio, another important goal is to maintain balance of portfolio management in NPDP, i.e. achieving the desired balance of projects, due to the adopted dimensions of

portfolio analysis (balance parameters). It can be assumed that the basic determinants of project portfolio balance may be:

- project maturity level, expressing the projects' ability to achieve the goals set for them in the new product development process and the project team's ability to implement them and market them, at a certain level of process maturity,
- the position of attractiveness and competitiveness of projects, indicating their ability to achieve market success,
- the potential level of cash flows (including other resources), development costs and cumulative potential benefits,
- the level of risk depends on the scale of originality and complexity of the project (development and technological risk) and the level of adaptation to the needs of recipients (marketing risk),
- the amount of time needed to complete the projects.

Conclusion

Faster product development, shorter life cycles covering all activities from procurement and production, through distribution and final consumption seem to set the criteria for future success. The path to achieving competitive advantage seems to be increasingly based on the element of time as an additional source of potential competitive advantage. Here we can cite the example of two global companies producing processors, i.e. Intel and AMD. A decade ago, these companies introduced the next generation of processors once every one or two years, currently they introduce two new generations of processors in one year [Intel 14th gen. October 17, 2023, Intel 13th gen. October 20, 2022].

Over the last decade, the tendency to increase revenues from new products sale in companies has strengthened (new products have an increasing share in total sales, i.e. sale of a new product on the market must generate a certain level of profit for the company in an increasingly short time (hence the tendency to shorten market product life cycle). Therefore, it can be concluded that the company's future development opportunities are indeed conditioned by maintaining an optimal portfolio in the long term, rather than a mature one, as indicated in the literature (there is a weak correlation between profitability and market share). It can therefore be assumed that balancing the product portfolio comes down to its optimization. Therefore, important issues to be resolved in future studies are:

- what quantitative and/or qualitative dimensions should the project team adopt for the portfolio analysis in order to search for the balance of the project portfolio?
- is the portfolio of mature projects optimal and balanced at the same time?
- how to safely use artificial intelligence (AI) in new product development process?

In practice, the project team may use various dimensions – balance parameters, on the basis of which the project portfolio will be plotted and the analysis will be conducted. Balance parameters are single or multi-property composite indexes based on quantitative and qualitative indicators, presenting the value of the product development project program for the project team (company). The use of both qualitative and quantitative balance parameters reduces the risk of making the wrong decisions, in particular in the early stages of the new product development process. In addition, the level of use of project portfolio analysis methods may have a specific impact on level of success of a new product on the market.

Thus, there are many balance parameters, dimensions or variables that can be used when looking for balance in the project portfolio. As a result, we get theoretically countless different maps showing portfolio balance. In this situation, key issue in balancing the project portfolio is the choice of time, determining required amount of time for the implementation of a given project. The time of new product development determines the continuity of stream of new products introduced to the market. In addition to time dimension, the type of project, or in other words the type of new product being developed, and directions of allocation of available resources related to this problem are also important.

Artificial intelligence (AI) for developing new products has applications in various business sectors. In the automotive industry, companies are considering using smart algorithms to produce cars faster, making cars eco-friendly and safer, while taking into account production costs and size. Artificial intelligence enables digital testing and prototyping of new products before the project team spends time and resources physically creating the final form of product. AI can predict whether a given new product design will be unsafe, unsuitable, defective or will not meet demand expectations. If project team managers acquired enough high-quality data and applied artificial intelligence, these companies could see the future of their new products without producing or creating those products. Then, looking back, AI gives them a chance to adjust new product development process appropriately at the concept, design or prototyping stage. New product development already relies heavily on the use of AI, and companies that understand this can add more value in less time at less cost. The project teams or entire company that do not adopt this technology will soon be left behind by the competition. The latter will have to face higher costs and lower operational effectiveness.

Methodological and research limitations identified in this work result from specific circumstances, such as time and financial constraints or information availability. They may also be related to the adopted quantitative and qualitative variables and the complexity of the proposed method. The use of the proposed method by the design team responsible for the new product development is associated with the positivist paradigm and belief, that reality can be objectively measured

and observed. On the other hand, there are many realities shaped by the contexts of the company's turbulent environment and managers' subjective interpretation of their meaning and impact.

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THE MODIFIED RANK-RESOURCE METHOD OF EVALUATING NEW PRODUCT PROJECTS IN THE PORTFOLIO MANAGEMENT PROCESS IN PRE-MARKET PHASES

Abstract

The success level in new products development is significantly dependent on the degree of competence of the company, firstly in the implementation of a new product development process (NPDP), and secondly in the proper evaluation and selection of new product design concepts (executing the right project). In particular, the second area of competence is related to the issues of portfolio management in the area of new product development. This is conceptual and methodic paper and has its backgrounds in strategic management

concepts and applications, financial portfolio management, and relates closely to new product development research. The aim of the article is to present methods for valuing new product projects in the new product development process, as well as to propose a new method for optimizing the value of the new product project portfolio. Methodological and research limitations identified in this work result from time or information availability. They may also be related to the adopted quantitative and qualitative variables and the complexity of the proposed method.

The basic problem formulated here concerns how to effectively allocate available resources to achieve the goals set for the new product. The article presents a rank-resource method of new product project evaluation, to achieve optimal portfolio of new product projects management NPPM, in terms of value in the pre-market life cycle phases.

Keywords: new product management, portfolio methods, portfolio management, new products, new product development process

JEL classification codes: M31, M21, M11

ZMODYFIKOWANA METODA RANGOWO-ZASOBOWA OCENY NOWYCH PROJEKTÓW PRODUKTOWYCH W PROCESIE ZARZĄDZANIA PORTFELEM W FAZACH PRZEDRYNKOWYCH

Streszczenie

Poziom powodzenia rozwoju nowych produktów jest istotnie uzależniony od stopnia kompetencji przedsiębiorstwa po pierwsze w realizacji procesu rozwoju nowego produktu (PRNP), a po drugie we właściwej selekcji i wyborze koncepcji projektów nowego produktu (wykonywanie właściwego projektu). W szczególności z tym drugim obszarem kompetencyjnym związana jest problematyka zarządzania portfelowego w obszarze rozwoju nowego produktu. Artykuł ma charakter koncepcyjny i metodyczny, oparty na koncepcjach i zastosowaniach zarządzania strategicznego, zarządzaniu portfelem finansowym oraz jest ściśle powiązany z badaniami nad rozwojem nowych produktów. Celem artykułu jest przedstawienie metod wyceny projektów nowych produktów w procesie rozwoju nowych produktów, a także zaproponowanie nowej metody optymalizacji wartości portfela projektów nowych produktów. Zidentyfikowane w tej pracy ograniczenia metodologiczne i badawcze wynikają z czasu lub dostępności informacji. Mogą być one również związane z przyjętymi zmiennymi ilościowymi i jakościowymi oraz złożonością proponowanej metody. Problem podstawowy, który tutaj jest formułowany, dotyczy tego, jak efektywnie alokować dostępne

zasoby, aby osiągnąć cele stawiane nowemu produktowi. W artykule zaprezentowano model dochodzenia za pomocą metody rangowo-zasobowej wartościowania projektów do optymalnego pod względem wartości portfela projektów nowych produktów w prerynkowych fazach cyklu życia.

Słowa kluczowe: zarządzanie nowymi produktami, metody portfelowe, zarządzanie portfelowe, nowe produkty, proces rozwoju nowego produktu

Kody klasyfikacji JEL: M31, M21, M11