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DECISION MAKING IN THE COURSE OF MINIMUM VIABLE PRODUCT OPTIMAL STRUCTURE CHOICE

Abstract. *Value-driven management and the idea of a minimum viable product (MVP), developed in the concept of lean manufacturing, are the examples of modern efficient management approaches used in project management. The solutions that integrate both approaches to management are proposed in the paper. The problem of decision making in the course of MVP optimal structure choice is reviewed. The functional models of creation and transferring value in projects as the bases for creating new and developing existing notions – value breakdown structure, value flow, exclusive and mergeable features are proposed. The formal models describing these notions and related informational data structures are proposed. The optimization model for MVP structure choice created on the basis of mathematical model describing the value creation flow is offered. The various scenarios of decision-making allowing flexible selection of mathematical model for choosing MVP optimal structure are presented. The concepts and models proposed allow: to develop the current approaches to value creation and delivering planning, organize the process of project output design in terms of value creation and provide project managers a flexible tool for decision support in the course of MVP optimal structure choice.*

Keywords: minimum viable product; project management; value; value-driven project management; project output value

Introduction

Configuration definition of *minimum viable product* (MVP idea was offered by E. Rice in [1]) is one of the most significant tasks of the value-driven project output creation. Transition capturing from an expected value to a perceived one, that allows us to get satisfaction assessment of stakeholders' expectation [2], is principally important in the MVP concept. From the viewpoint of any business, a potential opportunity to reduce the period of investments return is essential and thus to bring breakeven result point nearer is especially attractive in the MVP idea [2]. Therefore our study is aimed at decision making process development in the course of MVP structure definition.

Research problem statement

The most important tasks in the course of MVP structure definition are: 1) identification the ways of value delivery through the project output properties; 2) balanced selection of those project output attributes that need to be implemented in the first place and thus form an MVP.

Aim and objectives of research

The article is aimed at development the value-driven decision making processes in the course of MVP structure choice through the enhancement of conceptual instrument and the choice model development with the account of features of decision making task.

Recent research and publications analysis

Significant number of works is dedicated to the issues of value definition problems. Key standards in the field of value management are benchmarking standards in project management, i.e. PMBoK and P2M [3; 4]. The analysis of contemporary point of view upon the issues of value management in projects has been made in [5], the examples of key values and recommendations concerning their structuring are presented. The work of prof. S.D. Bushuyev school aimed at arrangement and systematizing issues of value management are of significant interest [6 – 8]. Systematic models of value management processes, project output configuring and value transfer to stakeholders are shown in [9].

Ontological connection of MVP idea with basic notions in the field of project management and a model of MVP structure, its connection with minimum marketable feature are found in [2]. Moreover, the notions of expected and perceived values, both curve and life cycle of value, etc., the model of value assessment and the approach to value visualization for project decisions making support, are demonstrated in the indicated work.

An original example of procedural approach to MVP building is presented in [10]. Project output features are suggested to be structured coming out of the analysis of its operation process, further on define the most significant features and by combining them form the MVP.

However we have not encountered any systematic recommendations concerning value measurement, approach formalization for its detection (disclosure) and structuring, and its construction logics bears exclusively descriptive character. Specific issues dealing with the proposed approach and recommendations aiming at the arrangement of interaction processes in the course of MVP design in the software development projects are considered in [11]. In the works [12 – 14] the criticism of the MVP idea application and alternative viewpoints at the problems connected with value structuring during project output creation are given.

In the above indicated researches dealing with the management of processes of MVP development and creation, obvious shortcoming of systematic solution of issues concerning MVP creation is observed. Techniques of descriptive character, having recommendation form, are proposed.

The main part

General system approach to process simulation of value management in projects is represented in [9]. This approach allows us to describe the process structure and contents of value management at any level of breakdown. In compliance with [9] the following five basic processes are defined in value management: value identification (A1), building project output configuration (A2), output configuration control (A3), value delivery planning (A4) and value delivery management (A5). Functions A3 and A5 are carried on the regular basis in the process of project execution. Functions A2 and A4, directly connected with the subject of the present research, are of utmost interest in the context of the present study.

According to the logic of value management presented in [9], MVP structure definition is one of the sub-processes of A4 value delivery planning that comprises (Fig. 1):

– MVP structure definition (A41);

– forming minimum marketing features set (A42);

– value delivery plan development (A43).

It is evident that the result of MVP definition process A41 is its structure. At the same time, as was indicated above, there exist different points of view towards value structuring and the very logics of MVP structure reshaping. Obviously, the model of value-driven decision making is to take into consideration these features and offer the opportunity of choosing an approach and possibilities of decision making for the relevant project participants – from the owner and customer's representative (product owner in IT-projects [15]) to the project manager and business analyst.

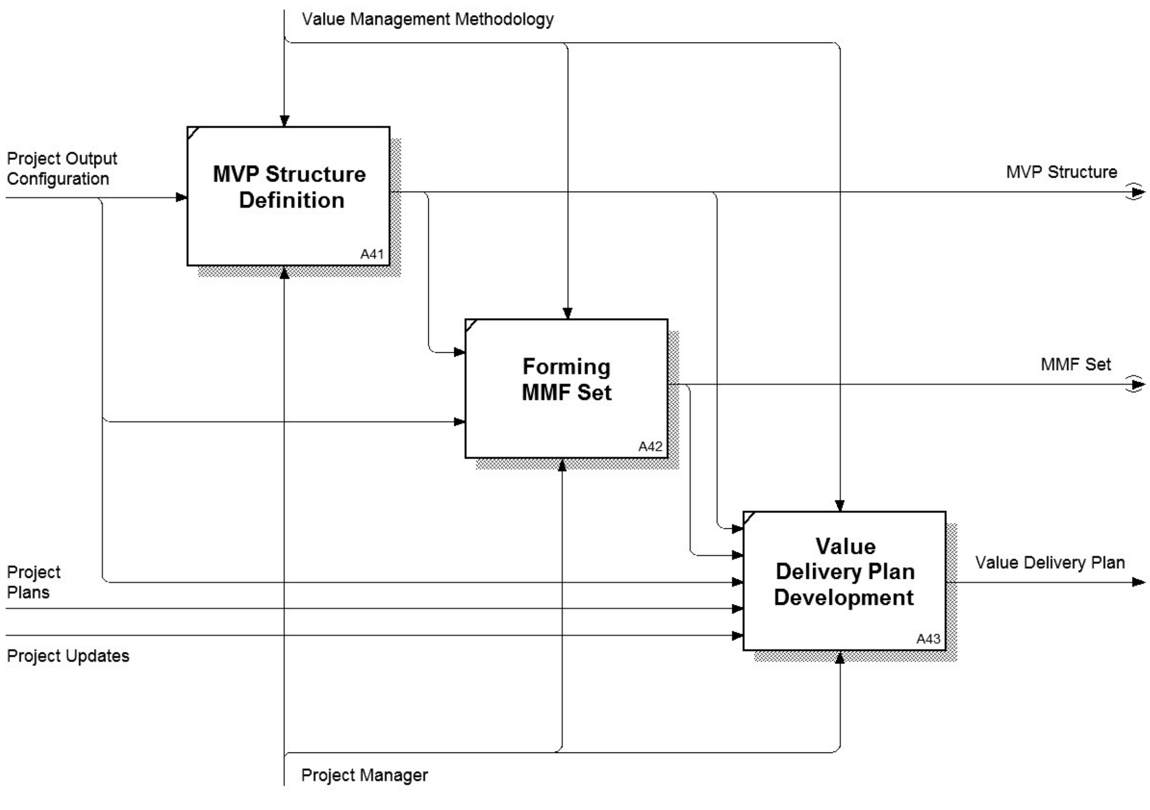

Figure 1 – Functional model of value delivery planning process

In accordance with the idea offered in [2], the value formed by the project output, is defined by its features and their vision on the part of stakeholders. Thus, we can say that the value formed in the project is presented and transferred in fact with the help of project output features.

Therefore, we can come to the most significant conclusion, that the structure allowing us to formalize the information of the project output features, connected with provision of value creation and delivery processes, is required for effective value management in a project.

In compliance with this conclusion, project output configuration is the source information for MVP building. The latter anticipates the solution of the following tasks (Fig. 2):

– product breakdown structure development (A21);

– project output configuration forming (A22);

value coverage analysis and provision (A23).

Thus, in the process of formation of the project output configuration C forming, project manager, perhaps together with the business analyst, unites the project output structure P developed earlier with the value matrix V, that formalizes value expectation of the stakeholders.

At the same time, these or those features, ensuring its formation are assigned to each value:

$$C \subset V \times P \,, \qquad (1)$$

where V implies values set for stakeholders, P means project output features set.

$$V = \{v_{ij}\}, P = \{p_k\} \qquad (2)$$

$$C = \{(v_{ij}, p_k) \mid \forall v_{ij} \in V \; \exists p_k \in P, \; p_k = C(v_{ij}) \,\&\, |\{p_k\}| \geq 1\},$$

where $i = 1..l$, $j = 1..m$, $k = 1..n$, l is the total number of disclosed values, m stands for the number of stakeholders, n is the total number of project output features defined.

This congruency is not a reflection, since each value can be created by a number of output features and, at the same time, each feature can form a number of values (C being neither injective nor surjective). In the theory of databases such congruency is simulated by a specialized types of relations – "many-to-many" and an intermediate abstract entity is introduced for its formalization [16].

Let' use the notion of value breakdown structure (VBS) for further analysis. The same notion was proposed in the work of S. Devaux [17]. However, in the works of S. Devaux the value breakdown structure is actually understood as the structure identical to product breakdown structure (PBS) or work breakdown structure (WBS) formed in compliance with ROI or NPV obtained [18], which are not somewhat relevant to the contemporary viewpoint at the value, formed in the project, that represents a complicated multi-level and multidimensional structure [5; 7].

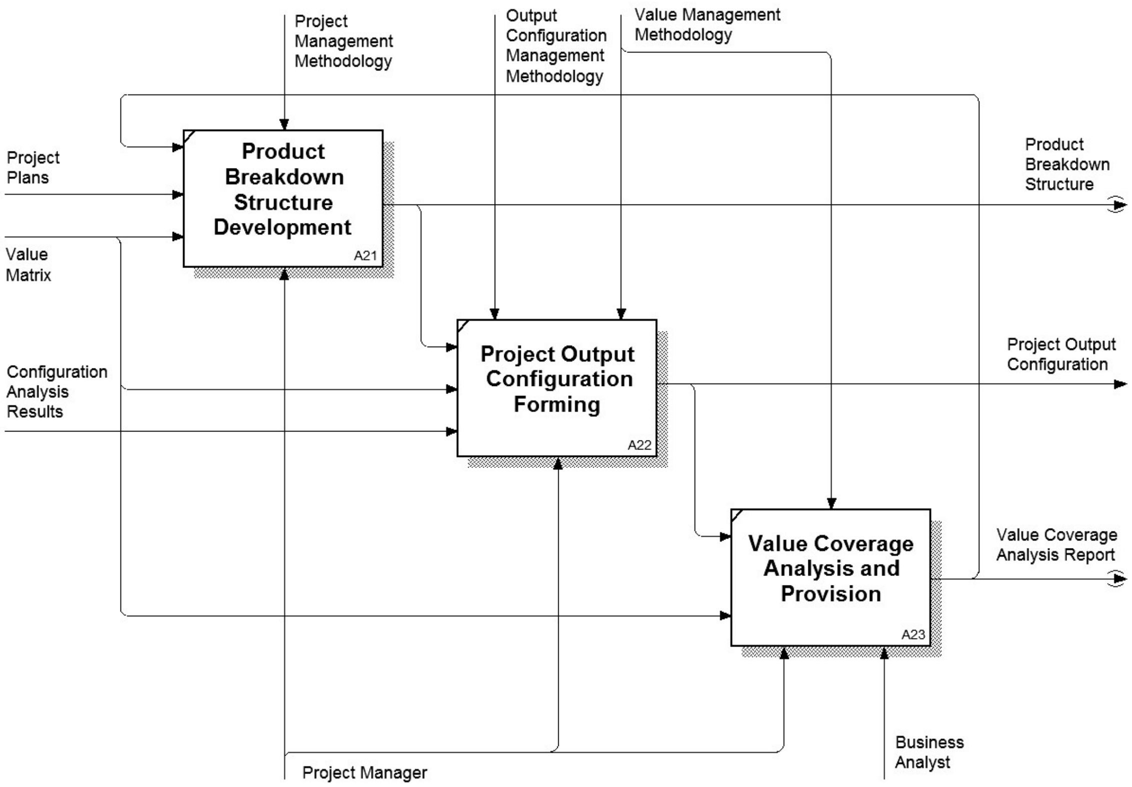

Figure 2 – Functional model of the process of building project output configuration

Let's introduce the following definition: value breakdown structure is an hierarchy of profits obtained by the stakeholders, represented as a graph. In our context it is the ability of the product to form value that is understood as the value in breakdown structure. At the same time, the breakdown is to be performed precisely in the light of delivered value.

The difference between the feature singled out from the viewpoint of value creation and that of the project output attribute is of gain contingency in the VBS concept.

A good example of it, in our case, is the drill value illustration. The ability of this tool to make holes of various diameters is a value forming feature. It is this feature that is the main driver of investing resources into it. Apart from that, the mechanism of value implementation itself, i.e. the way of obtaining holes is not of gain contingency for the customer (it is not regulated in which way the product will provide this ability – by rotating drills, milling cutters or any other means). Thus, the required value – "Ability of hole making" – is fixed in the VBS, but the way of value implementation through the product feature is a prerogative of a project team including a business analyst.

Such an approach, on one hand, allows us to concentrate on these values, already at the initial stage of value analysis, expected by the interested parties, separating oneself from technicalities of its implementation. On the other hand, it reserves certain freedom of actions for the project manager and the team to choose the ways of this value provision in the product attributes. It is the choice of value implementation through the project product features that constitutes the semi-structured task, the effective solution of which, depends on the professional level of technical expert, availability of his experience, capability of both, his context-dependent and creative thinking, and problem solving including non-standard ones. The important collateral conclusion lies in the fact that, evidently, the capability of finding value implementation ways through the product attributes determines the professional level of a project manager and appropriate technical experts. This task solution is to be based on the account of basic constraints in budget, time and quality, however, the maximization of the created value is to be taken into consideration. At the same time, of additional interest is the analysis and identification of possibilities aimed at creation of such product features that allow us to provide the delivery of several value types and, thus, reduce the resource expenses for value creation – "to kill two birds with one stone".

Since the matching of project output features and values provided, owing to them, is a complicated semi-structured task and it is entirely dependent on the level of training and profound knowledge of relevant experts of problem domain, its solution is to a great extent the art, where its efficacy can be increased due to application of widely-spread techniques of stimulating creative thinking [19]. At present, it is obvious that the only way of computerizing this task is an application of models and artificial intelligence means, namely expert systems and knowledge bases [20].

Value breakdown structure is to ensure the following problem solution:

– describe the structure and value content of the project output through its features with the level of detail, necessary and sufficient for solving the problems of value-oriented project management, aimed at value development in the given project output.;

– introduce project product value as hierarchical structure (the value is to be broken down into components till it will be understood unambiguously how to provide it with the relevant project output features);

– introduce output features in such a way that it describes the value created by them;

– provide the ability to formalize the value, expected by the interested parties in the amount, necessary and sufficient for their satisfaction with the obtained profit;

– provide the ability not only to describe, but also to assess the result of the project or its deliverables, that is considered as a result of project management and works execution aimed at creating the given value for stakeholders satisfaction.

In Fig. 3 the example of breakdown structure of IT-project product features is shown (project product is a computer-aided subsystem of production workshop operation planning). Fundamental value structuring has been carried out on the basis of H. Kerzner and F. Saladis work [5]. In compliance with it three basic value groups were selected: business-values, strategic and operational values.

In conformity with the above-indicated features, the VBS output is generally described by the digraph $G(V,E)$, where V is a set of vertices, and E is a set of arcs with basic features attributable to it:

- there is a single node u, called the root $u \in V$;
- a root in-degree equals 0 and a root in-degree of all remaining roots equals 1;
- each node can be reached for the root;
- cycles – $z(G)=0$ are unavailable in the structure.

VBS graph end vertices named *leaves* v_i^{term}, define particular values, presented by the project output and expected by stakeholders (value drivers). For each VBS leaf there is a branch leading to this node from the root – (u, v_i^{term}). Let's agree to call this branch by the value creation path and the path obtained by the customer is to be called the stream of created value – $c(u, v_i^{term})$.

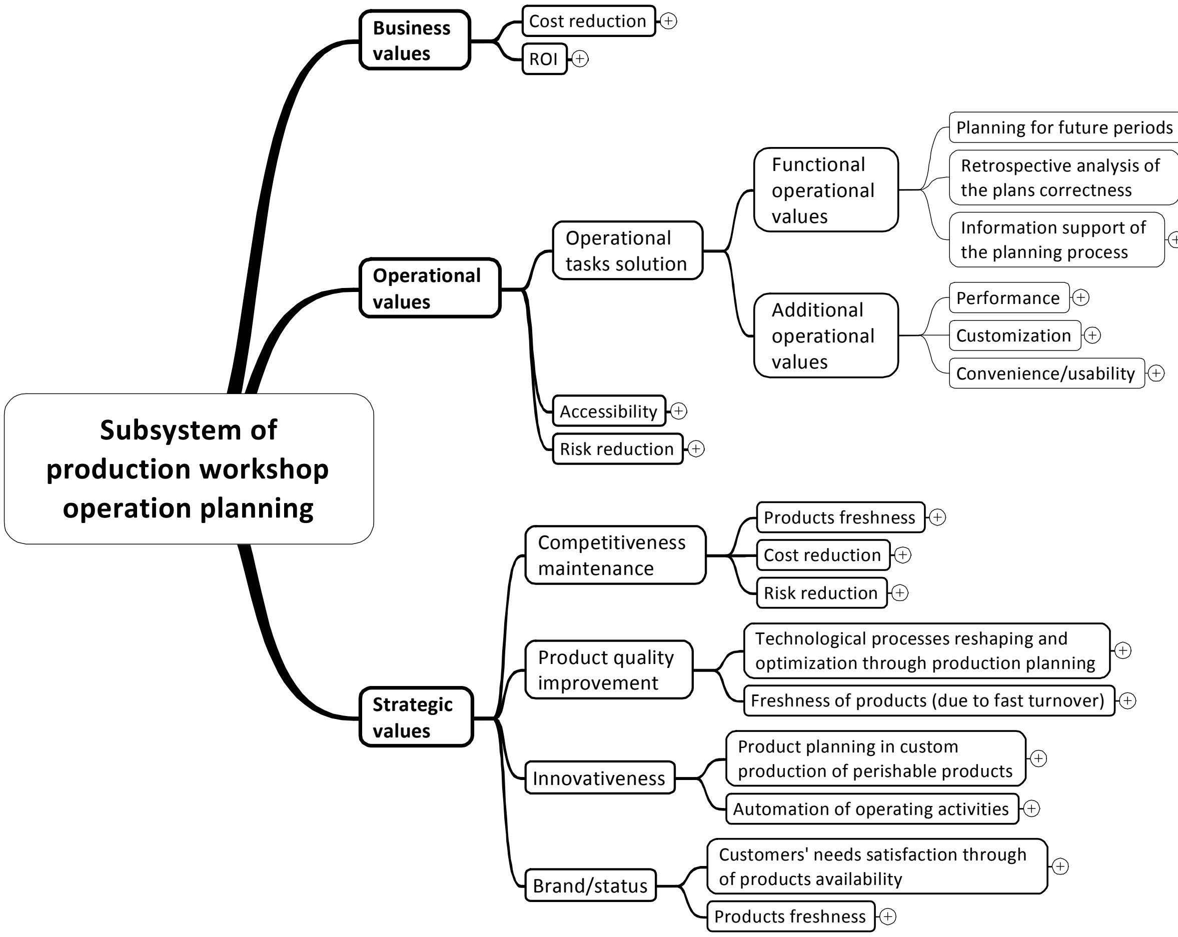

Figure 3 – Value breakdown structure of subsystem of production workshop operation planning

The existence of main arcs connecting VBS graph root with adjacent vertices $\{v_i^1\} \subset V$ in such a way that condition $d^+\langle u, v_i^1 \rangle = 1$ is met for them is an important peculiarity. These arcs are conformed to value categories allocated by stakeholders. Generally, the base arcs are related to the following: business-values, strategic (long term) and operational ones (tactical) (see Fig. 3) [5].

Another distinctive property of the VBS graph is its combinatorial multiple character, caused by the project output features and their abilities in value implementation (1; 2). For instance, such a value of planning system software as "Productivity", created during IT-project implementation, can be provided with several features: 1) "Response rate upon action" (response rate of the system upon the alterations of initial planning terms); 2) "Rate of work" (rate of the planning process itself; 3) "Hardware performance"; 4) "Ergonomic interface", etc. The features indicated above presuppose the possibility of joint implementation, i.e. could be implemented in the final product simultaneously. As distinct from that, such value as "Work planning for future time periods" is provided with the product ability to determine production plans and is implemented in two operation modes that are principally different – "Forecast plan determination" and "Revised plan determination". In doing so these features are alternatively exclusive, i.e. the subsystem can work either in one mode, or in another one.

If P_i is the set of project output features ensuring creation of *i*-th value, then $P_i \subset P$. Let us assume to call the project output features, that can create the value only in case of their separate implementation, as *exclusive* $P_i^e = \{p_{ik}^e\}$, as opposed to *mergeable features* $P_i^m = \{p_{ik}^m\}$, which can form the value in combination with each other. Then $P_i^e \subset P_i$, $P_i^m \subset P_i$, $P_i^e \cup P_i^m = P_i$, $P_i^e \cap P_i^m = \varnothing$ i.e. sets P_i^e and P_i^m form separation of features set of P_i providing *i*-th value. Value breakdown structure expansion can be used to present exclusive and mergeable features. In this case, child nodes, as the properties providing realization of the given value, are added at each VBS terminal vertex – v_i^{term} VBS, i.e. value drivers. Then the exclusive features will form the section of the given VBS tree branch. VBS fragment, defining features that realize operational values of the subsystem of production workshop operation planning are presented in Fig. 4.

Total value C, created by the project output, identified and formalized in VBS structure, is determined as the sum of all the created value streams, and provided by the given output:

$$C = \sum_{i=1}^{w} c\left(u, v_i\right),$$

where w – implies the number of all created value streams.

Minimum viable product G_{mvp} is essentially a VBS subgraph:

$$G_{mvp} \subset G$$

The value, created by MVP, is defined as the overall value of all the value streams, formed by it:

$$C_{mvp} = \sum_{i=1}^{w} c_{mvp}\left(u, v_{mvp}\right) \qquad (3)$$

where w is a number of all the value created, provided by MVP; c_{mvp} is a value stream created by the branch $\left(u, v_{mvp}\right)$, v_{mvp} is a value, which is a dominant one at the initial stage and, therefore, defined and included into MVP structure.

Decision making in the course of MVP optimal structure choice, in compliance with logic, comes down to the optimization problem the objective function of which is a linear functional Z:

$$Z = \sum_{i=1}^{w} \sum_{j=1}^{s} \alpha_i^{(k)} \cdot \beta_{ij}^{(k)} \cdot x_{ij}^{(k)} \qquad (4)$$

Set of constraints Ω:

$$\Omega = \begin{cases} \sum_{i=1}^{n} x_{ij}^{(k)} \le n, & i, j \in \{l_{11}, l_{12}, ..., l_{1m_1}\}, \\ \sum_{i=1}^{n} x_{ij}^{(k)} \le 1, & i, j \in \{l_{21}, l_{22}, ..., l_{2m_2}\}, \\ \sum_{i=1}^{n} x_{ij}^{(k)} = n, & i, j \in \{l_{31}, l_{32}, ..., l_{3m_1}\}, \\ x_{ij}^{(k)} \le x_{lj}^{(k)}, & i, j \in \{l_{41}, l_{42}, ..., l_{4m_4}\} \end{cases} \qquad (5)$$

$$x_{ij}^{(k)} = \begin{cases} 1, \text{if } p_j \to v_i \\ 0, \text{if } p_j \overline{\to} v_i \end{cases},$$

here symbol $\to$ means "forms", i.e. j-th feature creates i-th value; $\alpha_i^{(k)}$ — is a share of i-th value in the total value, created by MVP, k is a code of base parent-value of i-th value; $\beta_{ij}^{(k)}$ is a weight coefficient, describing i-value, created by j-th project output feature; dyads (i, j) are set, based on the problem conditions and features analysis and assessments made by experts.

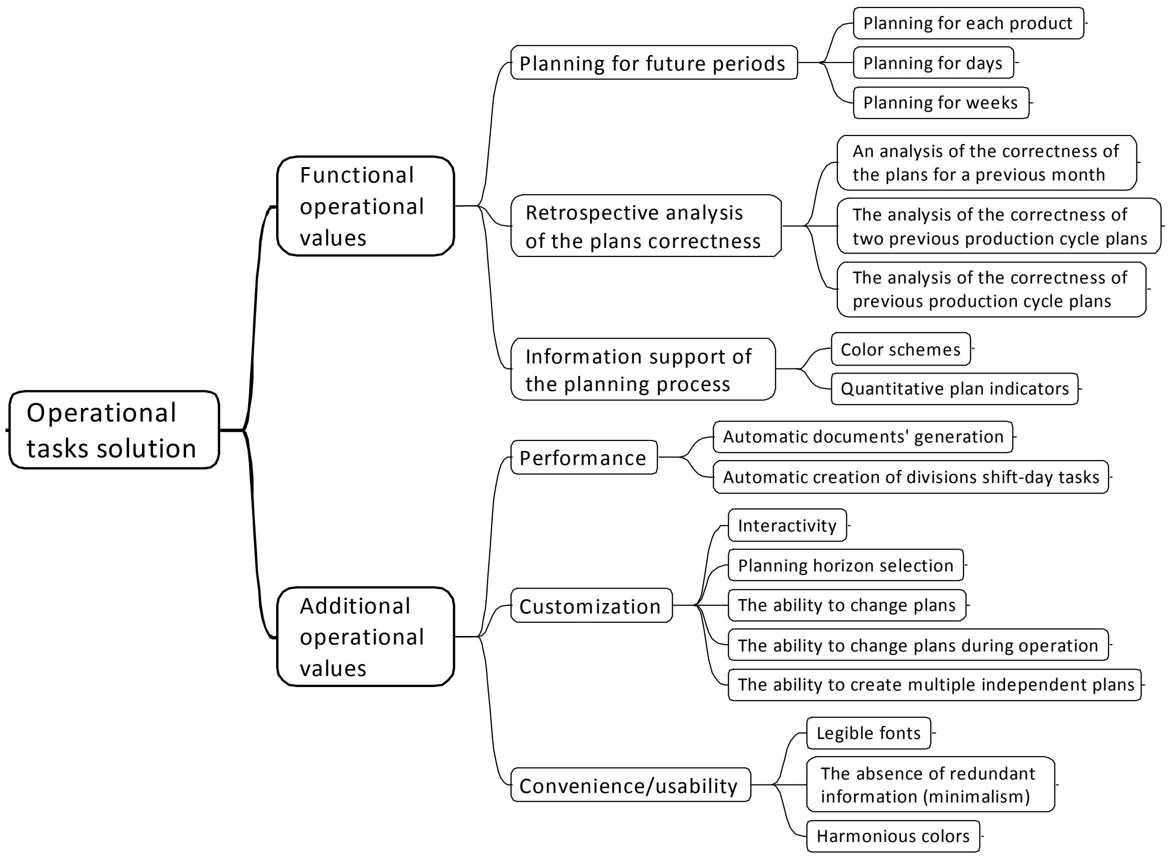

Figure 4 – VBS fragment, defining features that realize operational values of the subsystem of production workshop operation planning

The system Ω regulates the constraints upon the ingress of exclusive and mergeable features when forming values, as well as the terms of repeated use of features when forming several values. $\alpha_i^{(k)}$ and $\beta_{ij}^{(k)}$ are assessed by means of experts. Separation of coefficients into $\alpha_i^{(k)}$ and $\beta_{ij}^{(k)}$ bears a conditional character and, as well as index (*k*), is used for the experts' working convenience, when determining the values of the given coefficients. The stated problem is a kind of the problem of assigning integer linear programming and Hungarian technique or the technique of potentials can be used for its solution.

In compliance with the value structuring concept, set forth above, the following solution versions of MVP structure determination are possible in view of project output attributes.

1) Finding the structure, which is appropriate for the project output, creating maximum value for interested parties. This problem is relevant to the concept, referred to in [12, 13]. In conformity with this concept, MVP cannot create maximum value so much appreciated by a consumer. In contrast to the MVP idea, the quoted author suggests that the products should be created with exceptional value (derived from *Exceptional Viable Product*). The solution of this problem is reduced to functional *Z* maximization:

$$Z = \sum_{i=1}^{w}\sum_{j=1}^{s}\alpha_i^{(k)} \cdot \beta_{ij}^{(k)} \cdot x_{ij}^{(k)} \to \max$$

2) Identification of MVP structure, which is appropriate for the project output having minimum value. This is an opposing point of view and its key provisions are represented in [14]. The main argument of the above approach is the assumption, that larger number of attributes, even though creating value, cause high expenditures of time and financial resources, the need to obtain the feed-back, but also the response to it and the proper work with the early adopters. And, in result, the less attributes in the MVP, the better, as it allows us to receive the feed-back from the users as early as possible. The solution of the problem is reduced to functional Z minimization:

$$Z = \sum_{i=1}^{w}\sum_{j=1}^{s}\alpha_i^{(k)} \cdot \beta_{ij}^{(k)} \cdot x_{ij}^{(k)} \to \min$$

3) Finding the structure, appropriate to the product, representing minimum amount of value, is, however, sufficient for the delivery to the customer. This approach is intermediate between the first two and is based on the strengths of each of them. That means it is necessary to provide stakeholders with the values which they expect. Herewith, the expenses should be minimized and the moment of decision making by the customer, concerning further development and investments into the project, should be accelerated. The idea dealing with the fact, that a project manager has to minimize delivered value, has been laid into the basis of its implementation. However, the output possessing the value not lower than the $Z^{\sim}$ level, set by the stakeholders beforehand, should be presented to the interested parties. From the viewpoint of mathematics, the constraint on the magnitude of a minimized level of delivered value is added to the problem:

$$Z = \sum_{i=1}^{w}\sum_{j=1}^{s}\alpha_i^{(k)} \cdot \beta_{ij}^{(k)} \cdot x_{ij}^{(k)} \to \min, Z \geq Z^{\sim}$$

This approach is realized in the procedure of dialog with the customer or its representative. It is during this process that the threshold value of the acceptable level for the delivered value is determined (the so called human-machine procedure of the third group of decision making in accordance with academician O.I. Larichev's [21]). The concept of objects proximity measure and the appropriate formulas can be used with taking into account constraints on the threshold magnitude in solving the problem.

4) Identification of MVP structure multiple versions, representing the amount of value, is not less than a certain one, set by the interested parties. This approach is a further development of the third version for the problem solution and it assumes that at the stage of MVP structure approval by the customer or its representative, – product owner, – additional information rendering key impact upon the decision making, including that which shouldn't be disclosed due to some reasons, can be known to them. In order to bypass such a constraint, it is suggested that the strengths of the previous approach to the solution of MVP structure determination problem should be preserved and used as well as supplemented by the opportunity of choosing the best version of a structure from the set, preselected on the basis of analysis of their value creation streams. In this case, decision making problem is divided into the following phases: 1) reshaping multiple MVP structures, corresponding to the project output presenting the value not less than the assumed threshold $Z \geq Z^{\sim}$; 2) stratification of the multiple structures obtained in conformity with the stream value descent of the value created by them; 3) the choice of the structure version, which is the most relevant to the problem vision of the interested parties, performed by the person, who makes a decision.

It is evident that the most flexible and effective is the fourth approach for problem solution of MVP structure choice. However, as it occurs with any powerful means for problem solution, this approach presupposes not only availability of highly qualified experts, but also the violent work of the manager and its team with the customer, which complicates problem solution from organizational point of view.

Conclusions

Proposed ideas, approaches and models that formalize the work of the project manager and his team with the value created in the project, allow us:

– develop essentially the existing approach to problems solution of creating values in the project and planning its delivery to the customer;

– structure and systematize the process of projecting the product from the point of view of value creation efficiency;

– provide the manager and his team with flexible instrument of support and decision making during the choice of MVP optimum structure.

The conclusions dealing with peculiarities of value management in IT-projects comprise significant practical solutions obtained in the process of testing and work with the models of MVP optimum structure choice. In particular, efficient and resulting implementation of business-values in IT-projects is only possible through the multivariate approach and parallel changes in the organization, its structure, business-processes, etc. As far as the implementation of strategic values is concerned, we have to say that it is based upon the by-products of operational values creation, i.e. reasonable realization and delivery of the majority of operational values to the customer will allow us to provide him with strategic values. Further research is to be directed to the analysis and systematization of values in IT- projects with strategic values, taking into account of both, projects proper, and the companies and markets where they are implemented.

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ПРИЙНЯТТЯ РІШЕНЬ ПРИ ВИБОРІ ОПТИМАЛЬНОЇ СТРУКТУРИ МІНІМАЛЬНОГО ЖИТТЄЗДАТНОГО ПРОДУКТУ

Анотація. *Розглянуто проблему ціннісно-орієнтованого вибору оптимальної структури мінімального життєздатного продукту. Розроблено функціональні моделі процесів створення та передачі цінності в проектах. Запропоновано і розвинуто нові поняття, для яких розроблено відповідні формальні моделі. Розроблено математичну модель, що описує потік створюваної цінності, на основі якої запропоновано сценарії прийняття рішень, що дозволяють використовувати різні математичні моделі вибору оптимальної структури мінімального життєздатного продукту проекту.*

Ключові слова: мінімальний життєздатний продукт; управління проектами; цінність; ціннісно-орієнтоване управління проектами; цінність продукту проекту

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ПРИНЯТИЕ РЕШЕНИЙ ПРИ ВЫБОРЕ ОПТИМАЛЬНОЙ СТРУКТУРЫ МИНИМАЛЬНОГО ЖИЗНЕСПОСОБНОГО ПРОДУКТА

Аннотация. *Рассмотрена проблема ценностно-ориентированного выбора оптимальной структуры минимального жизнеспособного продукта. Разработаны функциональные модели процессов создания и передачи ценности в проектах. Предложены и получили развитие новые понятия, для которых разработаны соответствующие формальные модели. Разработана математическая модель, описывающая поток создаваемой ценности, на основе которой предложены сценарии принятия решений, позволяющие использовать различные математические модели выбора оптимальной структуры минимального жизнеспособного продукта проекта.*

Ключевые слова: минимальный жизнеспособный продукт; управление проектами; ценность; ценностно-ориентированное управление проектами; ценность продукта проекта

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