Mathematical Models of Project Management
For Interested Parties

By Vladimir I Voropajev and Yan D Gelrud

Abstract

Recently, in regulatory documents and in professional literature more and more attention has been drawn to project management particularities seen through the eyes of various stakeholders. Nonetheless, most sources, unfortunately, confine themselves to examining this, in our opinion, topical issue on content-descriptive level and this approach does not constructively clarify the problem, therefore there is still much to be solved and to be worked on within the subject matter. This makes it difficult to approach the problem from a practical side. The authors have attempted to structure the main features of different stakeholders and to build mathematical models of project management taking the aforementioned features into account. Such models have been built for investor, customer, project team, principal executors, suppliers and regulatory bodies. We hope that such approaches and problem definitions will be of interest to master and postgraduate students, and doctoral candidates will strive to continue research in this direction. The paper is meant to be problem-setting, open to discussion and is the work that must be continued.

This article describes a set of interrelated mathematical models intended for complex project management at all stages of its implementation with participation of various interested parties (project sponsor, investor, general contractor, etc.). Using these models allows for an increase in the effectiveness of stakeholders’ activity, provides systems-thinking approach, integrity and adequacy of the decisions made.

Introduction

According to the international research and professional organizations (e.g., see [30]), only 40% of carried-out projects in the world are completed in time and within budget. That means, about 60% of projects do not end successfully. Roughly the same pattern is observed with the accomplishment of complex and mega projects. Unfortunately, projects in Russia experience the same problems. Thus, in practice, project management makes use of no more than half of its powerful intellectual capabilities. What is the reason? There is a set of factors that reduces the effectiveness of project management. However, we would like to highlight the most important of them and find ways to reduce their impact. Let us try to do so.

Project management is carried out at least at three levels:

1. The higher echelons of government and business management - the level of strategic decision-making - the main stakeholders’ level.

2. The executors’ level - project managers, project management team.
3. Operational level - members of project management team, specialists from the offices.

Let us combine our view of the second and the third levels and let us examine the two levels of management. About 50% of project activity success depends on the first level. It is the place where all the resources are concentrated and the most important decisions are made. The executors’ level plays an important role, too. It does not allocate resources but it acts up to the will of its employers, i.e. key executives.

At the same time, almost all of the entire global methodology and all the modern standards [1,2,3,13,14,15,16,21], focus mainly on the project manager’s and project management team’s role and competence. The few exceptions are, perhaps, Japanese [16] and Australian [29, 30] approaches which pay considerable attention to the higher levels. Thus, in our opinion, one of the main causes of project management failure lies in the fact that the upper levels of management are weakly involved in this work while modern project management methodology and technology do not adequately take their interest into account. We need to change the usual project management paradigm: rather than using a “top-down” approach to management we should develop a “bottom-up” approach.

When implementing rather complex large-scale projects and multi-project activity various interested parties may take part in management with each party possibly having its own project management team lead by their own project manager having the appropriate authority and representing the interests of the particular interested party in the project.

As shown in the system model and the system methodology [2,6,7], the choice of project management methods and tools is largely determined by the choice of an interested party to be managed in particular case. Different interested parties in the project vary in expectations, roles, degrees of responsibility and adequate actions. This is because, despite the fact that in the project they are partners working towards a common goal, they may have different objectives in the project, different criteria for the success and estimations of the achievement of their goals, values and different strategies for achieving goals. These differences significantly affect the formulation of their project management tasks, methods, tools and management decision-making technology for different stakeholders focused on their specific needs.

Key definitions

**Interested parties (Stakeholders)**—individual persons and legal entities either directly involved in the project or individual phases of its life cycle (project participants) or those whose interests may be affected by the processes of project implementation and project results. The term was adopted by ISO (International Organization for Standardization) and adapted for the ICB.

The main interested parties of the project include:

- **Investor**— legal entities or individuals, investing their own, borrowed or other funds for the investment projects.
Customer - legal entity or individual whose interest the project is run in, as a rule of thumb, the future owner of the project product.

Project manager and project management team (maybe the company managing the project implementation).

General contractor – project participant, responsible for organizing the full range of contract work on the project included in the contract.

Supplier - a company that manages the process of ensuring the supply and the purchases under contracts.

Regulatory agencies - international, state, and local authorities exercising supervisory functions and granting permissions for various tasks in the project.

As an example, consider project management from the investor's point of view. Investor usually sees the project as cash flows. The participation of the investor starts with a discussion of the business plan of the project and ends with reaching the planned profit, therefore covering a large part of or the whole life cycle of the investment project (product). The interest of the investor is focused primarily on the dynamics and trends in costs and revenues in the project. The risk of the investor in the project is usually associated with the risk of default on loan or increase in actual profit. Decision-making in the project by the investor is primarily based on cost criteria (costs, revenues, profits) and the specific limitations and requirements (funding, time, interest rates, guarantees, etc.). In addition, it is often necessary to balance costs and interfaces in the design and operations of the investor’s organization.

Project manager should monitor changes in the expectations and interests of the interested parties during the course of the project, analyze their causes and possible consequences, as well as promptly and adequately respond to them.

It should be noted that almost all the modern standards in which such competencies are considered or are referred to [1,2,3,13,14,15,16,21], focus mainly on the role of project manager and reflect the bottom-up approach to project management. In this paper, in contrast to existing standards, there are models which show a greater or lesser degree of competence the other key interested parties of project management activities with their particular attitude to successfully achieve the goals expected by these parties.

In this regard, the most important competence of the project manager must be an ability to identify the interests of all the interested parties and the ability to deliver results which meet or exceed their expectations. Project manager should monitor changes in the expectations and interests of stakeholders during the implementation of project activities, analyze their causes and possible consequences, as well as promptly and adequately respond to them, if necessary.

The composition and content of project management competences for the interested parties are divided into the two groups - basic and special:

- **Basic competencies** define common for all interested parties requirements for the composition, content and level of abilities, knowledge, skills and personal qualities.
• **Special competencies** determine the specific to the project stakeholder requirements for the composition, content and level of faculties, knowledge, skills and personal qualities, taking into account its (side) role of interests and functions.

Table 1 shows examples of the specific characteristics and parameters of project management for the benefit of our selected range of interested parties for some registered in the table cases of their specific features and parameters. Thus, the table does not strive to be exhaustive, but merely provides data necessary for the examples with relevant models formalizing certain project management problems.
### Table 1

<table>
<thead>
<tr>
<th>Key interested parties</th>
<th>Specific characteristics of project management by different interested parties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Expectations</strong></td>
<td>Biggest possible return on investments</td>
</tr>
<tr>
<td><strong>Project vision</strong></td>
<td>Cash flow process, dynamics in the cost and revenue centers</td>
</tr>
<tr>
<td><strong>Purpose in the project</strong></td>
<td>Profit by investing the project</td>
</tr>
<tr>
<td><strong>Criteria</strong></td>
<td>Profit maximization</td>
</tr>
<tr>
<td><strong>Limitations</strong></td>
<td>The volume of funds, Deadlines, Interest rates</td>
</tr>
<tr>
<td><strong>Strategy</strong></td>
<td>Planning, Control, Forecast, Adjustment of cash flows in the project</td>
</tr>
<tr>
<td><strong>Main risks</strong></td>
<td>Default on loans, Revenue shortfall</td>
</tr>
<tr>
<td><strong>Main PM instruments</strong></td>
<td>Milestone plan, Business plan, Budget, Financing plan, Consolidated reports</td>
</tr>
<tr>
<td><strong>Customer</strong></td>
<td></td>
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<tr>
<td><strong>Finished product generating profits</strong></td>
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<tr>
<td><strong>Product creation process</strong></td>
<td></td>
</tr>
<tr>
<td><strong>A competitive product generating certain profits</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Product delivered on time with lowest costs</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Product configuration and quality</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Technical requirements</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Deadlines, Budget</strong></td>
<td></td>
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<tr>
<td><strong>Enforcing customer functions while obtaining its benefits in the project</strong></td>
<td></td>
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<tr>
<td><strong>Poor quality of the product</strong></td>
<td></td>
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<tr>
<td><strong>Project running behind the schedule</strong></td>
<td></td>
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<tr>
<td><strong>Cost creep</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Corporate standard and best PM practices</strong></td>
<td></td>
</tr>
<tr>
<td><strong>General contractor</strong></td>
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<tr>
<td><strong>Successful sale of the services</strong></td>
<td></td>
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<tr>
<td><strong>The process performing the tasks according to the contract</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Fulfillment of the obligations within the project with maximum benefit for the executor</strong></td>
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<tr>
<td><strong>The minimization of production losses, in compliance with terms and conditions of the contract</strong></td>
<td></td>
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<tr>
<td><strong>Contractual conditions and technical requirements for the tasks accomplishment and personnel safety</strong></td>
<td></td>
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<tr>
<td><strong>Detailed planning and efficient management of the work execution in compliance with contractual requirements and executor’s interests</strong></td>
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<tr>
<td><strong>High cost price of work performed</strong></td>
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<tr>
<td><strong>Low qualification of workers</strong></td>
<td></td>
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<tr>
<td><strong>Poor work quality</strong></td>
<td></td>
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<tr>
<td><strong>Schedule creep</strong></td>
<td></td>
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<tr>
<td><strong>High injury rate</strong></td>
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<tr>
<td><strong>Detailed plan Operational accounting, reporting and execution regulation</strong></td>
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<tr>
<td><strong>Tax optimization</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Specific characteristics of project management by different interested parties

<table>
<thead>
<tr>
<th>Key interested parties</th>
<th>Expectations</th>
<th>Project vision</th>
<th>Purpose in the project</th>
<th>Criteria</th>
<th>Limitations</th>
<th>Strategy</th>
<th>Main risks</th>
<th>Main PM instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Supplier</td>
<td>Earn on the procurement</td>
<td>A process to ensure procurement in accordance with the contracts</td>
<td>Ensuring the necessary supplies in the right place at the right time at a good price for the supplier.</td>
<td>The minimization of risks and losses</td>
<td>The specifications, deadlines, prices and place of delivery.</td>
<td>Optimizing the process of managing procurement and supplies in compliance with the interests of the client and the supplier</td>
<td>Late shipment, High cost price and possible fines</td>
<td>Procurement plan, Contracts for procurement and supplies, Monitoring and control</td>
</tr>
<tr>
<td>Regulators</td>
<td>Solve problems within their power and collect taxes for the budget</td>
<td>The process of granting permissions performing fiscal functions, enforcing project compliance with regional requirements and conditions</td>
<td>Resolve the issues of the project and the conditions for its implementation with the greatest possible benefit for the area and the country.</td>
<td>Maximizing taxes collected</td>
<td>Requirements of laws and regulatory documents</td>
<td>Active involvement in the project to assist within the power granted and according to the interests of the state</td>
<td>Failure to comply with social and ecological requirements, Shortage of taxes collected, Violation of tax discipline</td>
<td>Social and economic development plan for the area affected by the project, Budget, Regulatory documents, Tax Plan, Sanctions</td>
</tr>
</tbody>
</table>

In the future, a wider range of possible positions, roles and responsibilities of each interested party will be taken into consideration and corresponding problem model problems with respective solution methods will be formed.
Further down the text, the paper proposes a system of interrelated examples of mathematical models of project management for interested parties taking into account their specific characteristics and parameters as shown in Table 1 with a sample mathematical model formulated for each of the stakeholders. Figure 1 shows the scheme of interrelations between suggested mathematical models of project management.

![Mathematical models diagram](image)

Figure 1. The scheme of interrelations between mathematical models of project management

These models should be viewed as methodological examples and, in some way, as templates, which will then be used to form other models to create complex integrated project management system that takes into account the multivariate nature of the tasks and their formulations.

1. **Mathematical model of the project manager’s and project management team’s activity**

The activity of this group is fundamental in keeping up project management activity for other interested parties. The results of project manager’s and PM team’s work are signed-off and can be used at all stages of project life cycle by other interested parties as well. First, a network diagram of the project is constructed, which, depending on the specifics of the project, can be deterministic, probabilistic, alternative, stochastic, or mixed. Based on the topology of the network model of the project its time and resource
indicators are calculated, which are coordinated with each interested party with regard to their specific characteristics and parameters.

To formulate and implement project management optimization problems a universal mathematical model is used. General description of the universal project management mathematical model can be found in [5, 6]. The algorithms suggested in those papers by the authors of this article take into account the level of risk and can analyze and build a consistent model of the process of project implementation, which in turn promotes forming optimal schedules.

Construction of optimal project schedules, as well as optimal project plan for composite projects, allows determining the necessary resource requirements (including financial ones), project team, machinery, and equipment resource allocation diagrams. Thus, the investment alternatives matrix is \( \{I_i^k\} \), where \( I_i^k \) - required volume of the investments in the k-th version of the project in period t (month, quarter or year - depending on the scale of the project). Projection is made and profit matrix \( \{V_i^k\} \) is formed, where \( V_i^k \) - projected profit from the sale of the k-th version of the project in period t. \( t \in [0, T] \), where T - the duration of the full project life cycle from the beginning of its implementation to the maximum projected profit from operations after project implementation (this information serves as a starting point for the investor).

The process of managing project implementation is brought about by developing a detailed work plan (serves as a starting point for the general contractor), a business plan and a milestone plan for the investor, a complex high-level plan - for the customer, a procurement plan - for the supplier, a taxation plan - for the regulatory bodies.

Periodic data updates make it possible to refine these needs, plans, and schedules (to reduce the level of uncertainty) and creates the necessary prerequisites for the harmonization of technological rehash of projects meeting tight deadlines and intensification of project implementation procedures in the time-resources-cost space.

2. Mathematical model of the investor’s activity

Given: \( I_i^k \) - required volume of investments in the k-th version of the project in period t;

\( V_i^k \) - the projected profit from the sale of the k-th version of the project in period t;

\( B_i^{\text{max}}(r) \) - the maximum possible amount of loans in period t at a rate of r;

\( B_i^\tau \) - payment plan in period t loan (main debt + interest), taken in the period \( \tau \) in the amount of \( B_i \);

\( Q_i \) - own investor’s funds which may be invested in the project in period t;

\( r_{\text{min}} \) - the lowest possible lending rate;
i - discounting rate.

Net present value (NPV) of the k-th version of the project for in the amount of funding with its own forces in the volume \( x^k_t \) will be calculated by the formula:

\[
NPV^k = \sum_{t=1}^{n} \frac{V^k_t - x^k_t - \sum_{j=1}^{t-1} B^c_j}{(1 + i)^t}.
\]  

(2.1)

Then the PM model should be stated as follows:

Find \( \{ x^k_t \} \) - volumes of self-financing of the project,

\( B_t(r) \) - the lending volume in period t at a rate of r,

and the most effective option \( k_e \), in which:

\[
NPV^{k_e} = \max_k NPV^k,
\]  

(2.2)

\[
I^k_t = x^k_t + B_t(r),
\]  

(2.3)

- providing the necessary investments,

\[
x^k_t \leq Q_t
\]  

(2.4)

- limitation on the own funds,

\[
B_t(r) \leq B^{\text{max}}(r)
\]  

(2.5)

- limitation on the possible volumes of crediting,

\[
r \geq r_{\text{min}}.
\]

This model implements many of the competencies that are included into specific characteristics of the investor’s project management (see Table1). Indeed, the Expectations (return on investment with the highest possible profit), Goal of participating in the project (making a profit by investing in the project), Criteria (profit maximization) are fulfilled by the function (2.2); Project Vision (the process of cash flows, the dynamics in the cost and revenue centers), Limitations (the amount of funds, deadlines, interest rates), the Elements of the Strategy (planning and projections) are taken into account in (2.3) - (2.5).
Elements of the Strategy - control and regulation, are implemented by data input on the actual volume of investments (including lending volumes), corrections made in projections and recalculation of the task using the suggested model (if necessary).

The risks of default on loans, and profit deficiency may be included in the additional limitation:

$$V^k_i \geq V^\text{min}_i,$$

(2.6)

where $V^\text{min}_i$ - the minimum acceptable amount of profit, which guarantees repayment of loans and receiving the minimum desired rate of return.

The suggested model uses all the fundamental PM tools corresponding to the interested party: milestone plan, business plan, budget, financing plan. During the operation of the model consolidated statements formed. Thus, use of this model provides a realization of all the basic functions of project management and there for improves the investor’s efficiency.

### 3. Mathematical model of the customer’s activity

Given: Complex high-level plan in the form of a network model, in which the works can be separate, work packages and some stages of the initial project implementation; the full detailed models being developed and used by the project manager, his team and the general contractor.

Let $T^p_i, T^n_i$ be early and late finishes of the completion of event $i$ in the aggregated network diagram,

$$\alpha_{ij}, \beta_{ij}$$ - minimum and maximum duration estimates of works in the high-level plan;

$$r_{ij}$$ - cost of performing the works in the high-level plan;

$l_t$ - budget constraints during the $t$-th interval (year, quarter, month),

$\text{EEC}_{ij}$ - expert estimates of the maximum rate of change of the work configuration.

By the change of the configuration of the project we mean missed deadlines, work omissions and work replacements. For each of the works the degree of configuration changes is assessed on a 10-point scale:

$$\alpha_{ij}(t)$$ - missed deadlines for $t$ days,

$$\beta_{ij}$$ - work exclusion from the implementation,
γ_{ij}—work replacement or modification of its characteristics,

where the values of α, γ, β, close to 0 indicate insignificant changes, close to the 5 -moderately important, and close to 10 - inadmissible changes. The rest of the values are used for intermediate states.

Let us define project quality deviation as an integrated indicator of IIQ, which is calculated using a function (defined by an expert), FIQ by indicators of quality deviations of individual works of the high-level plan IQ_{ij} given also by the expert.

Then the model of the problem will look as follows:

Find such deadlines of possible completion of the events of the higher-level schedule T_{i}, and the duration of the work packages t_{ij}, that satisfy the following condition:

\[
T_{i}^{0} \leq T_{i} \leq T_{i}^{p}, \tag{3.1}
\]

\[
\alpha_{ij} \leq t_{ij} \leq \beta_{ij} + \gamma_{ij}, \tag{3.2}
\]

where δ_{ij}—missed deadlines of the work(i, j),

\[
\sum_{(i,j) \in \Omega} r_{ij} \cdot \lambda_{ij} \leq I_{i}, \tag{3.3}
\]

limit on the financing volume in period t, where Ω_{i}—a set of works accomplished within the interval t, \( \lambda_{ij} \) - the part of work (i, j), accomplished in period t,

\[
\alpha_{ij}(\delta_{ij}) + \beta_{ij} + \gamma_{ij} \leq \text{EEC}_{ij}, \tag{3.4}
\]

\[
\text{FIQ}(\text{IQ}_{ij}) \rightarrow \min, \tag{3.5}
\]

where the argument of the FIQ is the vector of quality deviation of all the works in project plan.

As a result of using this model a high-level project plan, secured by funding and of the optimal quality, is formed.

The feature of the model is the expert definition of quality indicators (the degree of configuration changes on each aggregative operation and evaluation of its limit values), as well as an expert forming of the objective function, which is used to calculate the integrated index of project quality. It seems unreasonable to build a universal system of the above mentioned scores due to the uniqueness of many projects, various importance of their individual works. Therefore, assessment of the quality of the works performed by experts (Customer’s representatives) is believed to be a logical and methodologically valid approach.
4. Mathematical model of the general contractor’s activity

Given: A detailed plan of works, including

\( T_{id}^P, T_{id}^D \) - early and late dates of the beginning and finishing of individual works;

\( a_{id, jd}, b_{id, jd} \) - minimum and maximum duration of the works in detailed schedule;

\( \Omega_{ij} \) – set of works from the detailed schedule included in the aggregative operation \((i, j)\);

\( T_j \) – milestones of the aggregative work’s implementation according to the customer’s plan;

\( PR_{id, jd}^R(t) \) - the need for resources such as power per individual work \((0 \leq t \leq t_{id, jd})\);

\( PR_{jd}^R(t) \) - need for accumulated resources for the individual work;

\( AV^R(t) \) - the expected dynamics of power-like resources’ availability;

\( LOS^R \) - losses from non-used resource units such as power per time unit;

\( CR \) - costs connected with hiring an additional resource unit, such as power per time unit;

Then the model will look as follows:

Find such terms of the events of the detailed schedule \( T_{id} \) as well as completion and duration of individual works \( t_{id, jd} \), that satisfy the following conditions:

Dates of completion of all the events of detailed schedule of works and their duration should lie within the specified limits

\[ T_{id}^P \leq T_{id} \leq T_{id}^D, \] \hspace{1cm} (4.1)

\[ a_{id, jd} \leq t_{id, jd} \leq b_{id, jd}, \] \hspace{1cm} (4.2)

The detailed schedule of all the work included in the complex (an aggregative work), must end before the due date set by the decision-makers

\[ \max_{\forall (id, jd) \in \Omega} T_{fd} \leq T_f. \] \hspace{1cm} (4.3)

To satisfy of the need for the accumulated resources in each period
\[
\sum_{\forall (i, d, j): T \in \text{st} \in \text{st} - \text{td} + \text{tid} \text{jd}} \sum_{\forall (i, d, j): T \in \text{st} \in \text{st} - \text{td} + \text{tid} \text{jd}} \left( \text{mod}^+ (\text{mod}^- (P \text{m}^R_{i, d, j} (t) - \text{AVR}(t)) \times \text{CR} + \text{mod}^- (P \text{m}^R_{i, d, j} (t)) \right) \]
\]

where \( \delta R \) — permissible deviations in availability of the resource.

The objective function - to minimize the losses caused by underutilized resources such as power and the costs connected with involving additional power-like resource units, so:

\[
\sum_{\forall (i, d, j): T \in \text{st} \in \text{st} - \text{td} + \text{tid} \text{jd}} \sum_{\forall (i, d, j): T \in \text{st} \in \text{st} - \text{td} + \text{tid} \text{jd}} \left( \text{mod}^+ (\text{mod}^- (P \text{m}^R_{i, d, j} (t) - \text{AVR}(t)) \times \text{CR} + \text{mod}^- (P \text{m}^R_{i, d, j} (t)) \right) \]
\]

where \( \text{mod}_+ (x) = \begin{cases} x, & \text{if } x > 0; \\ 0, & \text{otherwise}; \end{cases} \)

\[
\text{mod}_- (x) = \begin{cases} -x, & \text{if } x < 0; \\ 0, & \text{otherwise}. \end{cases}
\]

Using this model in the core business of the general contractor provides operational control of works’ implementation that meets the contract requirements and minimizes production losses.

5. Mathematical model of the supplier’ activity of general supplier

Let us consider a multiproduct transportation problem of determining the optimal procurement plan.

Given:

\( P_{TR} \) — planned volume of supply of the entire range of material resources \( R \) in period \( T \);

\( L_{TR} \) - Limits of financing in period \( T \) by resource groups (the group may consist of a single resource);

Possibility of purchasing the product from \( p \) subcontractor:

\( W_{pT} \) — possible procurement volumes with delivery in the period \( T \),
$Z^R$ - purchasing prices,

$D^R$ - shipping cost for there source unit R,

$PZ^R(t)$ - probability of delay for t days,

$SS^R(t)$ - penalties for failure to supply for t days.

It is necessary to optimize the management supply and procurement process in compliance with the procurement plan and costs minimization and penalties.

Thus, it is necessary to find $X^R$ - volume and delivery terms of all the material resources, $X^R_{fp}$ - volume and procurement terms from subcontractors $p$ with a delivery in the period $T$, satisfying the following conditions:

$$X^R = \sum_{fp} X^R_{fp};$$

$$X^R_{fp} \leq W^R_{fp};$$

$$\sum_{fp} \sum_{vR} [X^R_{fp} (Z^R + D^R)] \leq L^R_{fp};$$

Provision of planned volume of supply:

$$\sum_{T=1}^{S} \sum_{R} X^R_{fT} \geq \sum_{T=1}^{S} PP^R_{T},$$

where $\delta R$ - the most acceptable term of disruption of the resource R supply.

The objective function is the total expenses for purchase and shipment of resources

$$\sum_{T=1}^{T_{max}} \sum_{fp} \sum_{R} [X^R_{fp} (Z^R + D^R) + \sum_{t=1}^{\delta} PZ^R(t) \times SS^R(t)] \rightarrow min.$$ 

The resulting solutions $X^R_{fp}$ are required to conclude the contracts for procurement in compliance with the interests of the client and supplier.
6. Mathematical model of the regulatory bodies’ activity

Given:

N_t—taxation plan. Financial stages($V_{t}^{k}$ - profit from sales) of the versions of project implementation as developed by the project manager, his team and general contractor.

The project team together with the customer and a representative of regulatory bodies prepare a list of positive and negative aspects of project implementation (from its development to the subsequent operation), and make their expert judgment for each variant of the project.

The positive aspects ($a_{d}^{+}$) are:

- creation of workplaces (by vocations)
- production of competitive products more attractive to the population of the area in quality and price,
- increasing of budget inflows from the production of new products,
- participation in solving certain social problems (housing, infrastructure, etc.)
- solution of some of the area’s transportation problems.

The negative aspects ($a_{d}^{-}$) are:

- failure to comply with environmental requirements,
- decline of sanitary and epidemiological environmental characteristics,
- landscape pollution (including the loss of historical and architectural monuments of the area).

The financial results of the implementation phases of the project versions significantly affect the assessment of these aspects.

Mathematical model of the regulatory authorities will look as follows:

It is necessary to find such way in the implementation of project $k_{ef}$, that satisfy the following condition:

$$n_{t}V_{t}^{k_{ep}} \geq N_{t}, \quad (6.1)$$

$$\sum_{q=1}^{q} a_{q}^{+}(V_{t}^{k_{ep}}) \geq \sum_{q=1}^{q} a_{q}^{-}(V_{t}^{k}) - \sum_{q=1}^{q} a_{q}^{-}(V_{t}^{k}), \quad (6.2)$$

The optimization of gains and losses for the area in terms of taxation and environmental requirements is ongoing, i.e. such option of the project is chosen, which, with ensuring the taxation plan(at an annual rate of $n_{t}$), provides a maximum evaluation of its positive and negative aspects.
Brief description of the mathematical models

Suggested models implement mathematical programming problems with linear and nonlinear constraints and objective functions. Currently, there is a wide range of software tools for solving such problems, it is enough to specify the SOLVER package part of MS Excel spreadsheet solution. The exception is model 1, which needs to be developed with appropriate software for the implementation of all the possibilities (the description of arising problems and algorithms of their solution are presented in [5]).

Conclusion

The article discusses new scientific and practical directions in organizational management in general and in the project management as a whole in particular. This is much broader than managing a complex project. The fact is that it all boils down to which degree of interest each party - the participant of the project - has, what are its values, interests, roles, positions and responsibilities in this activity (how money, power and other values are allocated). As a rule, they can be multifaceted and diverse and can often interfere with one another.

This article, above all, is meant to formulate the problem and to open the new approaches and directions; the article also contains particular cases of problem statements on some of the directions clear to us. Suggested examples of problem statements for the various parties can serve as groundwork for the development of future models of objectively multivariate project management system.

Meanwhile, the above set of mathematical models fairly reflects the "bottom-up" approach to project management and implements many competences of the various key interested parties involved in the project (see Table 1); this set can now serve as a methodological basis for the development of applied software suite (automated system) to solve the above problems of project management at all stages of its implementation.

Further advancement of project management and increase of its effectiveness requires a more complete engagement of the top government officials at various levels as well as business owners and managers. For all of this to be accomplished, methodology and technologies of a new paradigm of project management activities have to be developed using a "top-down" approach.
Main literature:

13. Further Reading:
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