

A Concept of Constructing a Common Information Space for High Tech Programs Using Information Analytical Systems

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Abstract. The paper deals with the issues in program management used for engineering innovative products. The existing project management tools were analyzed. The aim is to develop a decision support system that takes into account the features of program management used for high-tech products: research intensity, a high level of technical risks, unpredictable results due to the impact of various external factors, availability of several implementing agencies. The need for involving experts and using intelligent techniques for information processing is demonstrated. A conceptual model of common information space to support communication between members of the collaboration on high-tech programs has been developed. The structure and objectives of the information analysis system "Geokhod" were formulated with the purpose to implement the conceptual model of common information space in the program "Development and production of new class mining equipment – "Geokhod".

1. Introduction

Russia's economic transition to an innovation-driven model of economic growth has created all the prerequisites for the development of high technology industries in the economy. According to the experience of more economically developed countries, the development of innovative sectors of the economy is the driving force for social and economic progress and creates competition in economy. Innovative activity of high-tech industrial companies enables a steady growth of the economic system through the widespread introduction of leading science-based technologies and the development of high technology products with high intellectual labor costs.

The innovative activity of high-tech companies is focused on the development of a product innovation that has fundamentally new or improved performance characteristics. As a rule, the development of high-tech products is based on the latest achievements in science and technology. The process of designing and developing high-tech products is accompanied by a series of scientific researches and development projects (R&D).

The process of developing high-tech products comprises a set of projects which are part of high technology program.

A high technology program is made as a set of interrelated projects forming a complex of business processes serving to ensure the effective solution of scientific and technical tasks within the specified period of time and in compliance with limited resources.

High-tech program management is a system of tools, techniques, methodologies, resources and procedures used for the coordinated management of interrelated projects intended to achieve



collaborative strategic goals formulated in the program that requires the use of modern software to ensure its proper and effective implementation [2], [3].

Management of high-tech programs is complicated by a number of problems.

First, the innovation-related activity is associated with a risk to a greater extent than any other activities [4]. This can be explained by the fact that high-tech programs are implemented in the field of complex technical systems, and a high-technology manufacture is associated with certain difficulties, such as technical complexity to develop and manufacture products, lots of document turnover, limited resources, constant monitoring from the side of sector ministries, difficulty to set a deadline for implementing innovative projects because of the influence of external factors. Such projects are not governed by any well structured design procedures because they are determined as knowledge-intensive and characterized by high technical risks and unpredictable results in view of the influence of various external factors [5], [6]. While planning and implementing high-tech programs, there is a need to solve a lot of ill-defined problems that require expert and intelligent information processing methods [7], [8], [9].

Secondly, program management is also complicated by participation of several members involved in project activities, including those performing work remotely, and this makes the process of effective management difficult and leads to communication barriers. The lack of effective communication between participants in the program may contribute to a dramatic delay in the time taken to implement the program, declining quality and additional costs. In this regard, creation of a common information space among all project participants is the priority for successful implementation of a high-tech program.

Consequently, there is an urgent need to design an information analysis system capable of solving ill-defined problems relative to management of complex programs, improving the effective communication between program participants and the qualitative implementation of the whole program.

2. Survey of the existing project management systems

Project Portfolio Management (PPM) systems are most commonly used for solving problems. Currently, according to analytical studies, the market of project portfolio management systems is sufficiently stable and mature. On the market there are a huge number of PPM packages, ranging from simple tools that can aid you in project managing within a small company to powerful systems used to effectively manage several related projects, planning, controlling and implementing projects, programs and portfolios.

Analyses made by Gartner, one of the world's leading information technology research and advisory company, providing information technology related insights, allow us to explore the latest trends on the software market in the field of project management. According to the researches of many years delivered by this research company, for 10 years the major players in the market of project management information systems are the following PPM packages:

- CA Clarity PPM is the advanced PPM software solution that includes a set of software applications providing a base for comprehensive management of corporate IT resources through the building of a unified information analysis system for strategic planning and IT services management.
- HP Project and Portfolio Management is the flexible integrated software for project and portfolio management solutions, enabling effective control of resources and finances within a company, to ensure the timely implementation of projects and prioritize the investments in IT.
- Oracle Primavera Portfolio Management is one of the best and most reliable PPM software solutions, providing the process improvement of strategic program, project and portfolios management with its unique functionality, scalability and unlimited configurability. Powerful security features and a clean user interface make this program become the best product among similar PPM solutions for communication between all project team members using a common information sharing space [10].
- Microsoft Enterprise Project Management (EPM) is an effective toolset, providing the Enterprise Project Management technology that is engineered in accordance with international

standards in the field of project management to support all project management functions: project implementation planning and monitoring, resources management and reporting activities.

In the international PPM software market, in addition to the leading project and portfolio management solutions, there are a lot of PPM environments such as Planview, Innatas, Wrike and Basecamp, and others.

Currently, there is no reliable statistics on the percentage of using PPM-based solutions by Russia's companies, and among the leaders providing software products and applications for projects and portfolios management on the Russia's market are the same leading project management system as those on the world market:

It should be noted that the Microsoft Enterprise Project Management solution is the most popular among Russia's customers today as an effective integrated environment for project management, program and portfolio management, management planning, investment portfolio management and innovation management.

According to the analysis compiled by the TAdviser Russian analytical agency on project management systems, Russia's developments such as SpiderProject, Proektnaya Integratsiya (upravlenie proektom), 1C: PM Project Management, including cloud-based services, for instance, Advanta on-line project management system, and others are in operation in addition to leading foreign project portfolio management systems on the PPM market over the past few years.

Any of the PPM – based solutions is a flexible and useful tool, which helps a company manage projects and programs in an easier and more effective way [11], [12].

All above management systems are the state-of-the art solutions for project portfolio management, and are designed for different types of companies depending on their size and objectives. Big companies prefer the powerful PPM software, where a senior level board clearly understands the need of providing support to today's business processes through the use of information systems of management. The Microsoft Enterprise Project Management technology is the most optimal among the existing solutions in terms of their functionality and price level.

The survey of the most popular information systems used for project management has shown that, to ensure comprehensive professional management within the existing PPM – related systems, the basic processes are computerized: workflow management, lifecycle management (LCA), project scheduling and resource planning, budget planning, monitoring of project work implementation with creating Gantt charts, histograms and graphs to show activities required, linear and on-line modeling and planning of projects and programs, risk management, etc.

However, despite such a variety of project management tools, software products are insufficient to automatically support the process of solving ill-defined problems relating to high-tech program management, which appear in an environment of high technical risk levels and uncertainties [13]. In engineering business processes, when the PPM software systems are used, many factors and conditions are not taken into consideration. Such factors and conditions are caused by uncertain external environments, in the long run resulting in an incorrect display of real world environment, where processes of project and program management are implemented. In this connection, it is necessary to use modeling tools for forecasting and analytical control of high-tech program management in addition to the PPM – based systems.

3. Rationale for the use of information and analytical support for high-tech program management

The process of implementing the program on developing a multi-purpose shield-type tunneling machine “Geokhod” has proved that constructing a common information space is critical. The project works are performed within the framework of RF government program “The development of science and technology” [14], [15]. This large-scale program is of a complex hierarchical structure with involving a significant number of program participants and is planned to be implemented in a 5-8 year period.

In order to set up a common information space, it is proposed to develop an information analytical system to manage the program (IAS PKMiSP "Geokhod").

For designing main modules of the information analytical system, the following tasks are identified to perform:

- systematic analysis of such business processes as planning, coordination, monitoring and program implementation support;
- engineering of knowledge models in the field of mining equipment - geokhods and the design and implementation of technology for using geokhods in underground workings;
- development of a distributed database for use in IAS PKMiSP "Geokhod";
- engineering of information processing technology to support the project, which provides collaboration of project members in the common information environment;
- development of a conceptual model of decision support technology for planning, coordination, monitoring and program implementation support;
- development of methodologies and mathematical models for planning the project implementation program;
- development of methodologies and mathematical models for program coordination;
- development of methodologies and mathematical models for use in program monitoring.

A structure of the designed information analytical system PKMiSP "Geokhod" should have several sub-systems to ensure the use of information technology tools and informational support for high tech product program management at industrial companies (see Figure 1). On this figure there is a hierarchical data model showing the multilevel structure in program management. Each level presents a software package that provides program management from the lowest level of product database management to the highest level of strategic management; all systems must be integrated with each other.

IAS PKMiSP "Geokhod" provides the tools for use in decision support management system through all stages of high-tech program: planning, coordination, monitoring and program support.

The basic modules of IAS PKMiSP "Geokhod" are as follows:

1. PLM software is an information system used to manage all aspects of the product development lifecycle. The main component of the PLM system is a PDM system that manages all information about the product. It provides the operational level of program management.
2. Program management information system PMIS is an integrated complete solution with a set of technical, software and methodological tools to support the planning process and improve the effective project and portfolio management. It enables the tactical and partially strategic levels of project management.
3. Information system to support strategic high-tech program management ISSHPM is a set of software / hardware tools and technical solutions to support the decision making process in a complex information space in program management.

The system has several modules:

- The module "Strategic Analysis" is designed for analyzing external and internal environments of high-tech programs. When analyzing the external environment, tools are used to analyze external factors that affect the successful implementation of the program in order to anticipate potential threats, develop plans in the event of unforeseen circumstances. Analysis of the project internal space is carried out so that to identify the strengths and weaknesses in high-tech product management. The resulting analysis in the output module presents environmental factors, distributed in order of their importance in high-tech program strategy management.
- The module "Strategic Choice" is designed to evaluate development strategy options for high-tech programs. Particular projects, resources, suppliers and other are among alternatives. Such ill-defined tasks are solved as the selection of the most optimal resource suppliers and investors as well as resources required to perform the work on projects in

programs, the predictive modeling of timing and cost parameters relating the program on the basis of relevant information available with regard to successful projects, the selection of the most feasible alternative of program models, and others.

- The module "Implementation Control" is designed to collectively evaluate the strategy implementation through the program according to criteria developed during the analyzing process. The inspection results are then used for a new cycle of strategic management.
- The module "Expert Evaluation" is used for performing procedures intended to select experts, evaluate and assess the extent of their consistency in the field of high-tech product management.

ISSHPM provides the strategic level of program management.

The ISSHPM module refers to Decision Support System, and this clearly determines its use as a toolset to support decision-making in planning and program management, decision making techniques in a context of uncertainty, methods of expert assessments [16].

Management Levels

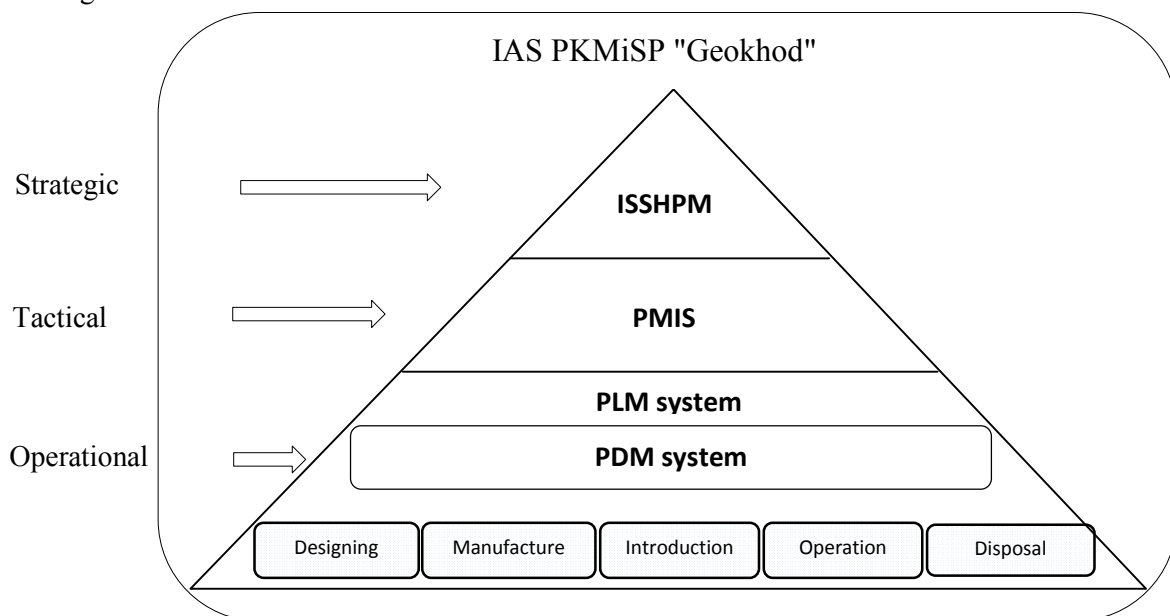


Figure 1. Information Technology for high-tech product program management

IAS PKMiSP "Geokhod" is a toolset designed to support the decision making process in program management, provide all participants in the project with relevant information, construct a common space for sharing information between program members and improve performance of program works through the use of tools for planning, coordination, monitoring and program implementation support in the information analytical system.

4. A conceptual model of a common information space for collaboration between program participants

While implementing large – scale innovative product programs, a great number of stakeholders are usually involved in from both organizations and enterprises, directly engaged in the design and development of high-tech products, and external organizations interested in the project implementation: investors, customers, suppliers, contractors, consultants, and representatives of public organizations.

Across the program organization structure, the following key positions are classified in a hierarchy of authority and responsibilities:

1. A Program General Manager is a person responsible for controlling that project strategies in the program are in line with global business strategies of the program.

2. A Project Portfolio Management Group is a key element in the hierarchy of program management; is responsible for balancing the conflicting opportunities and making the decision on setting priorities, choosing programs and allocating resources to projects within the program, conditioned upon the need of different points of view.

3. A Project Manager is a person responsible for the planning, direction and control of the project during all phases of its project life cycle.

When a large number of participants are involved in the program, the issue of establishing an effective collaboration among them is critical by creating a common integrated information environment.

The common information space must meet the following requirements:

1. Retention of technical and project documentation data in electronic form in order to make an easier access to those data for any participant in the project in accordance with the approved level of access.

2. Formation of a unified database of high-tech products, the filling of which is available at each stage of the program by any participant in project activities.

3. Providing access to the information system via a corporate portal to each project member in accordance with the seniority of staff, experience and competence at any phase of program life cycle. The corporate access, granted to all participants, to the information analytical system is achieved using Portal Technology. Using the portal technology allows the collaboration among participants working remotely or in various organizations, in order to overcome a lack of workplace integrity.

4. Software and hardware integration should be governed by international and relevant industrial standards.

The application of project communication software will greatly simplify the processes of collection, storage and exchange of information among the participants in the program; reduce the time for program managers to obtain the necessary information on the current status of projects and decision-making.

Project Information Space for use in high-tech products manufacture is a specifically structured and interconnected set of computation, information and communication resources and technologies, which operate on the basis of unified principles and techniques to ensure information communication security among all participants, to meet the information demand of project members in accordance with their data assess level.

Figure 2 displays the model of a common information space for communication between the participants in high-tech product programs.

The basic components in the information analytical system are given in the inner circle of the picture to indicate the planning, coordination, monitoring and program implementation support processes (IAS PKMiSP):

1. KB – Knowledge Base in the domain of mining equipment - geokhods.
2. DDB – Distributed Database where all the information about the product, technical and project documentation is stored
3. DDBMS – Distributed Database Management System for IAS PKMiSP
4. DSS – Decision Support System in the program strategy management in a complex IT environment.

The next contour indicates the corporate portal, which serves as a tool for members of the collaboration to communicate with each other. The third contour displays the basic functions of information analytical system:

1. Discussion and approval of documentation in a collaborative manner by the program participants. Setting up a unified system for informing on the works in progress relative to the projects.
2. Automate workflow process at all phases of the program lifecycle.

3. Scheduling, resources and budget planning.
4. Report generation on the results of the project activities at each phase of the program lifecycle.
5. Granting the program participants access to common databases using the secured corporate Extranet
6. Providing a framework for strategic planning of business processes of the program

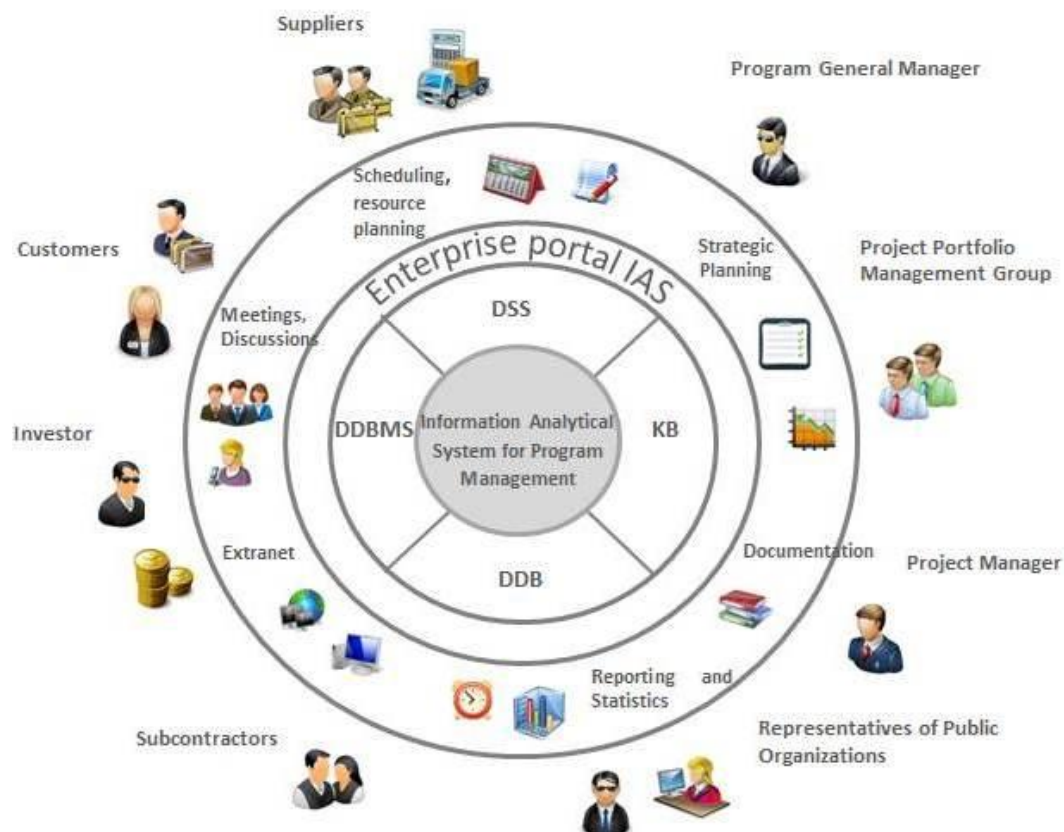


Figure 2. The conceptual model of a common information space for communication between participants in high-tech program

The outer contour displays all information system users.

Conclusion

The proposed concept of the common information space will ensure the improvement of quality of business processes management of high-tech programs and enhance the efficiency of interaction between the participants in the program.

The main advantage of the information analytical system "Geokhod" is using the module to support decision making in program management, which allows you to

- provide senior staff members with effective program management tools for planning, coordinating, monitoring and implementing the program, with giving a visual representation of business processes taking place in the program, as well as provide information required for making decisions on strategic management;
- improve the efficiency of management and decision-making on the program, and enhance program participants' responsibility.

By using information technology, all program participants are granted corporate access to common databases at any phase of the program lifecycle in accordance with the approved levels of access.

Thus, conceptualizing the common information space, based on the engineering of information analytical system used to manage a high-tech program, will ensure data integrity and increase a data access rate for remote participants in the project, enabling decision making to be effective in a context of uncertainty under the external environment.

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