

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE
« IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE»**

PROJECT MANAGEMENT

LECTURES SUMMARY

**For master level students of specialty 073 «Management»
specialization «International Business Management»**

Kyiv 2017

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Recommended by the Academic council

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Kyiv
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Project management

Lectures summary for master level students of specialty 073 «Management»
specialization «International Business Management»

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CHAPTER 1. BASIS OF PROJECT MANAGEMENT

TOPIC 1. PROJECT MANAGEMENT IN ORGANIZATION MANAGEMENT SYSTEM

1.1. Essence of project activity, concept, main characteristics, project classification

1.2. Project management as a specific sector of management

1.3. The processes in project management

1.4. The functions of project management

1.5. Characteristic of project management model

1.6. Environment and project participants

1.7. Project life cycle

1.1. Essence of project activity. concept, main characteristics, classification projects.

Approaches to the "project" concept

- an activity that involves the set of specific actions to achieve certain goals (getting some results) similar in content terms - "economic activity", "work (work package)"
- a system of organizational, legal and financial documents necessary to perform certain actions or those that describe these actions.

Project:

- a temporary venture designed to create a unique product or service ("Body of Knowledge on project management", PMI, USA)
- project - a set of interrelated activities designed to achieve within a specified period and at the established budget assigned tasks with clear objectives (World Bank)
- the project is a set of the targeted, consistently focused in time, one-time, complex and irregularly repeating actions (or works) focused on achievement of the final result with limited resources and at set terms of their beginning and end (Ukrainian sources)

Features:

1. focused on achieving a specific goal;
2. based on the coordinated execution of related actions;
3. limited time on execution, set start and end dates;
4. existence of a certain budget (financial, etc.);
5. to some extent originality, uniqueness.

Generally, these five features, or characteristics, distinguish projects from other actions, plans, programs, initiatives (табл.1.1.).

Table 1.1.

Difference of projects from other spheres of activity

The uniqueness of result	Permanent activity (time frames)	Temporary activity (time frames)
The result is not unique	<ul style="list-style-type: none"> – Customer service (for example, McDonald's) – Regular bus – Technical support 	<ul style="list-style-type: none"> – Delivery of the enterprise balance sheet
Unique result	<ul style="list-style-type: none"> – Publication of the magazine – Automobile factory work 	<ul style="list-style-type: none"> – Construction of the plant – Issue of the magazine – Implementation of the new IT system – Rebranding – Advertising campaign – Investment project

Let's consider the most known international associations and the organizations which are engaged in standardization of project activity. They include:

- *Project Management Institute, PMI* — the non-profit organization uniting more than 290 thousand of members. The greatest achievement of this organization is development of certification of experts in the field of project management on the basis of Guide PMBOK, later has been recognized as the national standard of the USA. Since January, 2013 has come into force the fifth version of the PMBOK 2012 standard.

- *International Project Management Association, IPMA* — the non-profitable professional association uniting more than 50 national associations. Among them there is the Ukrainian association of project management, UKRNET which has joined the international community in 1993 and is national office of *IPMA*, and since 1997 cooperates with *PMI*.

- *Association for Project Management, APM* — an independent UK national organization in the field of project management, which was established in 1972. This association is engaged in development of standards for evaluating the competence of managers for programs and portfolios management (The APM Body of Knowledge).
- *Project Management Association of Japan, PMAJ* — non-governmental organization which is urged to create unique Japanese approach to project management. Within this association the committee on innovative development was created which has developed further the standard of project activity under the name "The Guidance on Projects and Programs Management for Introduction of Innovations at the Enterprises" (P2M).
- *Global Alliance for Project Performance Standards, GAPPS* — the non-profitable organization uniting volunteers for the purpose of development of qualification standards for the project managers. By public discussion this organization has created and has improved a number of standards. The most known is Framework for Performance Based Competency Standards for Program Managers.
- *Interstate council for standardization, metrology and certification (IC) of the Commonwealth of Independent States (CIS)* is CIS intergovernmental body on formation of coordinated policy on standardization, metrology and certification. IC is recognized by the International Organization for Standardization (ISO) the regional organization for standardization as the Eurasian council for standardization, metrology and certification (EASC) which members are national authorities on standardization of the states entering the CIS and there can be national authorities of other countries that joined the Agreement on carrying out the coordinated policy in the field of standardization, metrology, certification. IC develops and accepts the interstate standards.
- *International Standardization Organization, ISO* — the most famous and most authoritative international organization of standards development, which was established in 1947. It developed about 20,000 standards, which formed the basis for tens of thousands of national regulations in many countries. The key event in 2012

for the development of project activities was the creation of ISO 21500: 2012 Guidance on project management. In countries such as the USA, Russia and the European Union this standard is considered perfect by all previous standards used in these countries.

In project management allocate the following main classifications of projects (fig. 1.1).

- projects classes - by composition, structure and its subject area;
- projects types - by the main fields of activity in which the project is implemented;
- projects kinds – be the character of subject area of the project, projects duration

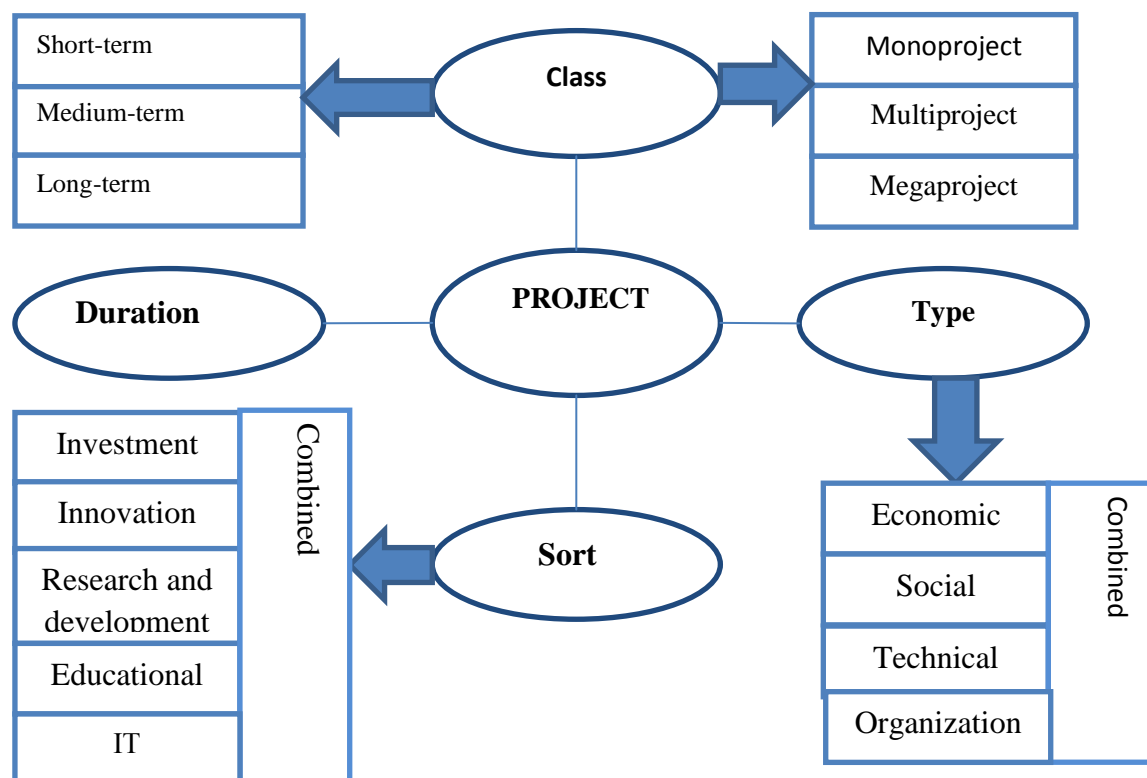


Fig. 1.1. Classification of projects by the main criteria

This variety of project activity requires a certain classification of projects given in table 1.2.

Table 1.2.

Project classification

Classification signs of the project	<i>Project type</i>
1. By the nature of changes	<ul style="list-style-type: none"> • Operational • Strategic
2. By the scale (size)	<ul style="list-style-type: none"> • Small • Medium • Large
3. By duration (realization terms)	<ul style="list-style-type: none"> • Short-term • Medium-term • Long-term
4. By branch belonging	<ul style="list-style-type: none"> • Industrial • Construction • Transport • Educational • In trade • Complex
5. By specifics of the final product	<ul style="list-style-type: none"> • Economic • Organizational • Technical • Social • Mixed
6. By the functional direction	<ul style="list-style-type: none"> • Production • Technological • Financial • Research and development • Marketing • HR • Combined
7. By the nature of the involved parties	<ul style="list-style-type: none"> • International • National • Territorial • Local
8. By the complexity degree	<ul style="list-style-type: none"> • Simple • Difficult • Complex
9. By the structure of attracted organizations	<ul style="list-style-type: none"> • Single-function • Multifunctional
10. By the requirements to quality of the project	<ul style="list-style-type: none"> • Standard • With extraordinary requirements

1.2. Project management as a specific sector of management

The essence of project management is to manage organizational goals that will allow the company to be successful in a competitive environment, rapidly respond to external and internal changes, save time and money. There are three things that are under constant attention of project manager: time, budget and quality of work.

‡ **Project triad** - (time, budget and content of work, quality is also selected in some sources) are main constraints imposed on the project.

‡ **Project management** - the process of team and resources management with specific methods by which the project is completed successfully and achieves its goal.

Application of Project Management is really necessary and depends on such major factors as:

- Project scales, amount of works, their cost;
- Complexity of the project;
- Quantity and interrelations of internal and external project participants;
- Probability of changes both in the project, and in its structure, conditions, environment and in need of quick response to them;
- Presence of competitors;
- Conviction of the top management in need of a special organizational structure and the person which will be responsible for general work on the project.

Project management involves the systematic application of methods and management tools in order to obtain a given project results. Project management system may include the following levels of project management (Fig. 1.2.): Strategic Management (Project Direction), operational management (Project Management), technical management (Project Realization).

As a part of system the following governing bodies of the project can be developed: Project Board, Project Management Team, Project Office, Project Management Office, Technical Team, Project Audit team, Project Assurance Team.

Project Board organizes and provides strategic management. It is recommended to include the sponsor, the customer, the user of project product, the project manager,

the prime contractor and other most important project participants in structure. Project Management Team and Project Office organize and provide operational management. Technical Team organizes and provides technical management. Project Audit team carries out internal and external audit of the project for the benefit of the main participants and project management team.

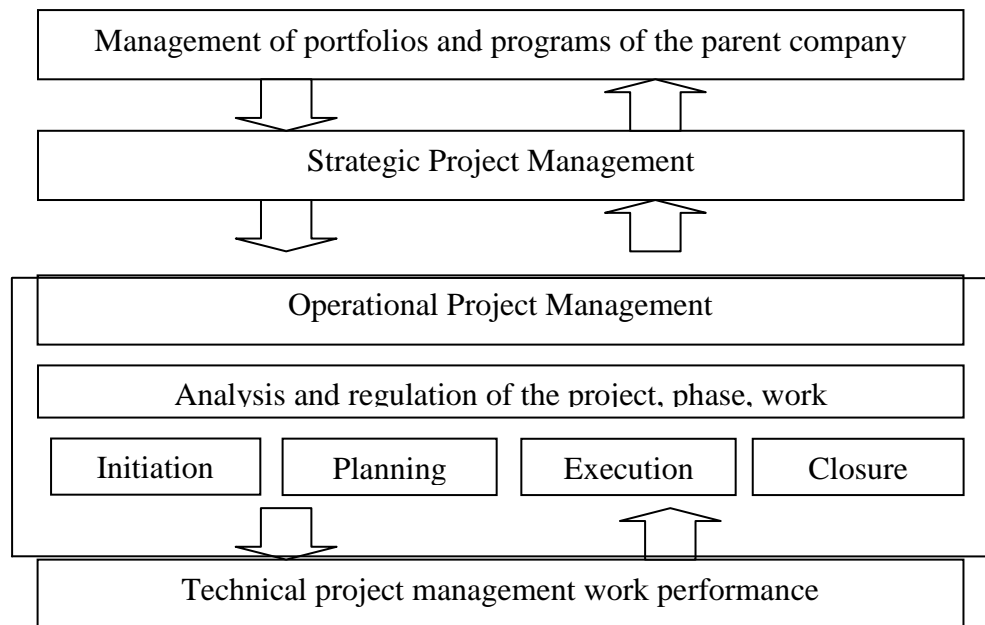


Fig.1.2. The system and levels of project management

Reasons of emergence of project management:

1. Rates of changes in the industry increase therefore project management is one of the ways to succeed in a competition with changes.
2. Market conditions become more demanding, projects are larger and need bigger professionalism in management.
3. Often management activity is related to the project, but project management is different from other management activities, requiring special skills, tools, organizational structure, etc.
4. Integration challenges are increasing both in different companies and in different activities during project implementation.

1.3. The process of project management

Project management tasks - to achieve effective objectives in terms of amounts, time, costs (budget), quality.

Main objectives of the project are achieved by means of certain management processes. There are such approaches supplementing each other:

- Classical;
- By problem resolution cycle;
- By lifecycle of project management.

The classical approach offered by Henry Fayol in 1949 represents five main functions of management - four direct and one integration. Implementation of such functions in process of project management is provided:

- Planning of work amount, necessary for project implementation and achievement of objectives
- The organization of resources within established budget and terms;
- Implementation of the developed action program;
- Monitoring the plan implementation or its adjustment if it is necessary;
- Team management of the people involved in project.

Project management as cycle of problem solution. Very often the project arises as the answer to existing problems of the entity:

The first stage - development of alternative decisions

The second stage - decision making

The third stage – implementation

Often the performance of any of these tasks is closely related with **the stages of project management life cycle.**

Project managers consider a lifecycle question differently; it is influenced by nature and features of any project, its scope. According to one of the most common approaches life cycle is divided into four phases:

- Formulation of the project;
- Planning;

- Implementation;
- Closure.

🏠 **Process** - set of actions bringing result; set of interconnected resources and activities which have certain input and output and create as a result the value (VAT).

The benefit of the process approach consists also in a continuity of management which it provides on joints of separate sub processes taking into account their interaction.

According to the process approach **the project is unique process, which represents set of the interconnected coordinated sub processes.**

Project management as process assumes achievement of goals according to the established requirements taking into account restrictions on terms, cost and indicators of quality.

According to the **process approach** it is advisable to allocate two groups of the processes connected with the project:

- 1) processes of project management;
- 2) processes of project life cycle.

The process can be broken down into five main groups that implement various management functions:

- 1) **Initiating Processes** - the decision to start the project;
- 2) **Planning Processes** - setting goals and criteria for project success and development of operational schemes to achieve them;
- 3) **Executing Processes** - coordinating people and other resources to implement the plan;
- 4) **Analyze is Processes, Controlling Processes** — determination of compliance of the plan and execution of the project to effective objectives and criteria of success and decision making about need of application of the adjusting impacts, determination of the necessary adjusting impacts, their coordination, confirmation and application;
- 5) **Closing Processes** — formalization of project implementation and its leading to the ordered final.

1.4. The functions of project management

American Project Management Institute has developed a certification program that, in addition to code of ethics and professional experience, professional knowledge was identified, known as the **Project Management Body of Knowledge (PMBOK)**. PMBOK includes ten functions:

- *Project Integration Management.* Integration is understood as consolidation, consolidation, joints and various integration actions directed to successful management of expectations of concerned parties and accomplishment of certain requirements.
- *Project Scope Management.* Scope management is understood as the process that allows doing selection, filtering and grouping on the project of those works which will be necessary for the Project manager to complete the project successfully. Scope management of the project is directly connected with determination and control of scope that will be included and doesn't enter the project.
- *Project Time Management.* Project Time Management is understood as a process by means of which timely project completion is ensured.
- *Project Cost Management.* Management of project cost is understood as a process, regarding planning and development of the budget, and also management of expenditures which provides project completion within the approved budget.
- *Project Quality Management.* Under quality management of the project are understood processes and various actions from the performing organization, approaches and quality policy, objectives, tasks and areas of responsibility in the field of quality - the project shall meet the needs it was initiated for.
- *Project Human Resource Management.* Processes of human resources management of the organization include approaches to management and project team management. Project team is understood as a pool of skilled workers who has specific roles and responsibilities for project implementation. In the project progress the professional and quantitative composition of the project team can often be changed. The correct distribution of roles in the project and responsibility between

project team members gives the chance to all team members to be involved at a stage of project planning and decision making.

- *Project Communications Management.* Communications management processes are used to ensure the timely formation, preparation, distribution, archiving, transmission, receipt, use of the information on the project. The most part of time on the project for Project manager is to conduct communications with team members and other project stakeholders (internal, from ordinary employees to senior management or external). The effectiveness of communication is that it serves as a bridge between the various stakeholders involved in a particular project.
- *Project Risk Management.* Risk management processes of the project are understood as risk management planning, identification and risk analysis, development of methods of a risk response, control, monitoring and risk management in the project progress. By means of risk management processes of the project, Project managers try to increase probability of origin and impact (influence) of favorable risks (events) on the project and reduce probability of origin and influence (impact) of adverse risks (events) on the project at the time of project execution.
- *Project Procurement Management.* Processes of project procurement management include purchase or acquisition of these or those necessary entities (products, services, results, documents) which are made by the external (contract) organizations in relation to that in which the project is implemented. The organization in which the project is carried out can act as the buyer or the seller of these entities.
- *Project Stakeholder Management.* Processes of management of expectations of project stakeholders are understood as communication between a project team and stakeholders, and also works directed to satisfaction of their requirements and the solution of the arising problems which may result in changes in the project. Thanks to the correct forming of the relations between all concerned parties on the Project manager project can increase probability of success.

These functions are divided into two groups - the main: project scope management, project cost management, time management of the project, quality management; and additional - other 6 functions.

As we see, the main PMBOK functions are determined by the **objectives**, project manager is responsible for their achievement, and additional are determined by **objects** controlled by the head. However in the name of all these functions there is a general word “management”, which in turn provides performance of such functions as organization, planning, control, motivation. In other words, the project manager should perform basic management functions on specific objectives and objects of his projects.

Functions of project management are also called fields of knowledge on project management.

↑ **Field of knowledge on project management** (Project Management Knowledge Area) - the special field of project management which is defined by its requirements to knowledge and is described in terms of its components: processes, practical, inputs, outputs, tools and methods.

1.5. Description of project management model

It is possible to connect the main functions of project management to tools which are for this purpose applied by means of project management model (Fig. 1.3.).

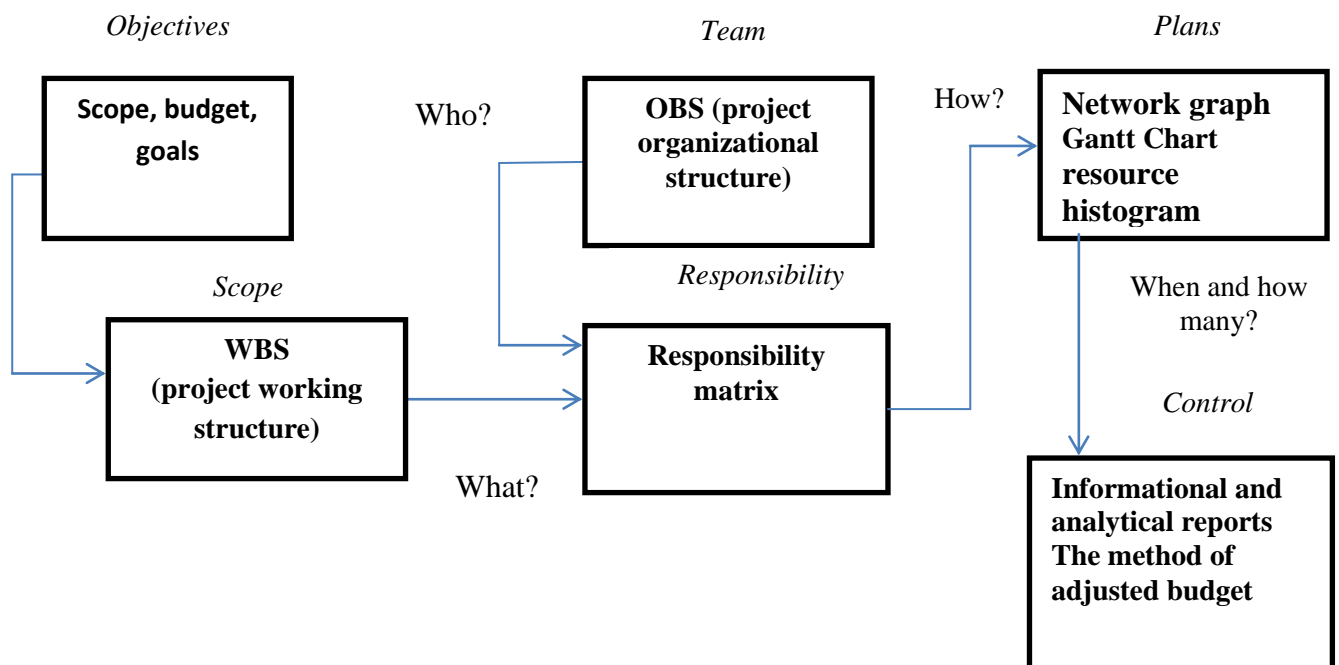


Fig.1.3. Project Management Model

SOVNET specialists offered project management system model, which is the basis for the development of relevant standard.

† **System model of project management** is a tree rolled over many tasks and procedures that can theoretically be performed in the management of various objects. This excess (fullness) of model is fundamentally important property for practical building of organizational structures and business processes of project-oriented companies, standards and management systems.

Project management process is implemented by direct and inverse relation between subjects and objects of management and includes management levels, management processes, management functions (Fig. 1.4.)

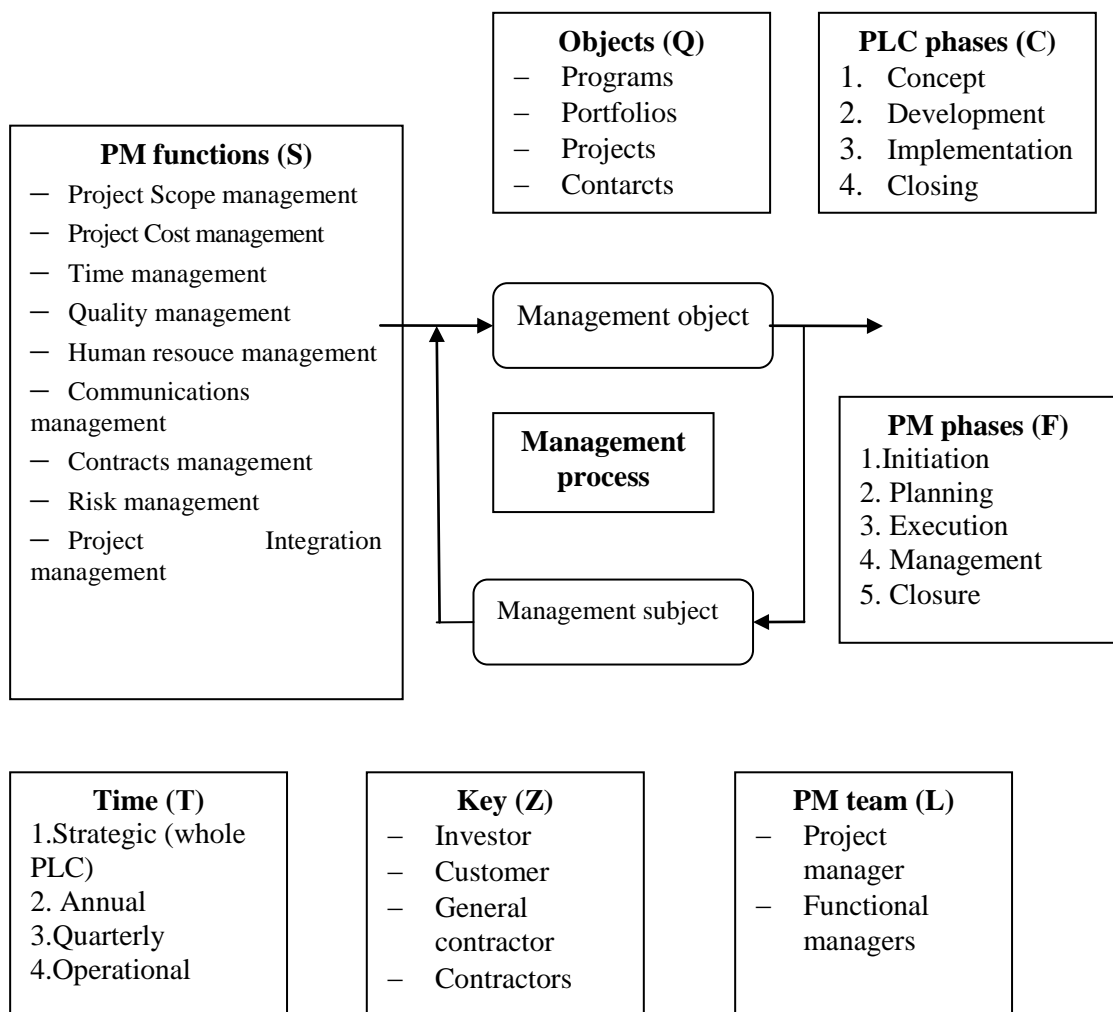


Fig.1.4. Project Management System Model

1.6. Project environment and participants

Project environment is an important element of project management, as it is important to define the environment in which project arises, exists and comes to the end.

🏠 **Project Environment** — a set of internal and external forces that promote or hinder the achievement of project objectives.

Considering that the project is implemented usually in the specific environment, **external factors** in which it is implemented should also be kept in mind. Such factors are *political, economic, social, legal, scientific and technical, natural and ecological*.

Significant impact on the project, especially on process of successful implementation, has internal project environment. Internal project environment determines: leadership style, specific project organization, project participants, project team, methods and means of communication, economic conditions of the project, social conditions of the project.

The factors connected with project organization belong to internal. Project organization is distribution of the rights, responsibility and obligations between project participants.

🏠 **Participants** - persons or organizations involved in the project, as well as those who depend on or interested in the results of the project, its successful completion.

According to the PMBOK project members include:

1. *Project Manager* — the person responsible for the project management.
2. *Project Sponsor* — person in or out of organization that provides financial resources to the project.
3. *Project Customer* — entity (organization) that takes the work and pays for its implementation.
4. *User* — person in or out of organization that will use the project results.
5. *Stakeholders* — project participants.
6. *Performing organization* — an organization whose employees directly involved in the implementation of project activities.

7. *Project team members* — a group that works on the project.
8. *Influencers* — a person or group of persons who are not directly managed or use project results, but because of their position in the organization can impact positively or negatively on the progress of the project.
9. *Project Management Office* — unit that is directly or indirectly responsible for the project.
10. *The project management team* — part of the project team involved in the management.

According to other sources the following main categories of participants are distinguished.

There is "*initiator*" - project participant, who carries the main idea of the project and its implementation initiatives. Any participant can be the initiator.

Synonym of the phrase "participants of the project" is "interested parties" (stakeholders) - this term has been approved by ISO and accepted in IPMA (ICB) basis of competences.

1.7. Project life cycle

The concept of project life cycle is one of the most important for the manager, because determination of current project implementation phase creates tasks and types of activity of the project manager, techniques and tools that he should use.

🏠 **Project life cycle** or project cycle is the interval between the beginning of the project and its completion.

The beginning of the project can be considered as the moment of the origin of idea or the start of its implementation. For example, in designing the investment project the start point is spending money on the project.

The end of the project can be determined differently:

- Entering of a designed project in operation;
- Achievement by the project of the planned results;
- Termination of project requirements financing;

- Liquidation of the project.

The life cycle consists of phases. Each phase of the project life cycle is characterized by the achievement of one or more results. The result is a product of work that can be measured; detailed design or working prototype.

Phase completion is usually connected with the analysis of the main results and the project progress to determine whether to continue further project implementation and to reveal and correct mistakes in the most efficient way. Such analysis is called a phase exit.

Each phase, as a rule, breaks into separate works to provide the best controllability. The majority of such works belong to a main product of a phase and the name of a phase corresponds to the name of the main product.

The majority of phases of project lifecycle have the following similar characteristics:

- The cost and the number of participants at the start are small, but grow in the end and sharply decrease before project completion;
- The probability of a successful completion of the project at the start is small, but grows in process of project implementation;
- The capability of the customer to affect results and project cost is the highest at the start and decreases in the course of project implementation as in the end the cost of modification and error correction considerably increase.

There is no universal approach to separate project into phases. Project managers divide project lifecycle into stages differently. The most traditional approach is the selection of project four general phases: initiation, planning, execution and control, closure. The most common are two - planning phase and implementation phase.

Formally project phases include *stages*. Project stages consist of *steps*. Steps of the project include *work types*.

The World Bank differentiates the following stages:

1. creation of the idea, concept;
2. task definition;
3. development;

4. workplace design;
5. examination;
6. negotiations;
7. decision making on loan granting;
8. project implementations;
9. control of implementation;
10. analysis and evaluation of results;
11. project closure.

TOPIC 2. PROJECT FEASIBILITY AND ASSESSMENT OF ITS EFFICIENCY.

ORGANIZATIONAL STRUCTURES OF PROJECT MANAGEMENT

1. *Project concept development*
2. *Project analysis structure*
3. *Project evaluation*
4. *Project business plan and planning*
5. *The basic principles of creation of the project organizational structure*

2.1. Project concept development

⌚ **Initiation** - process of formal recognition of need of project implementation.

The main reasons for initiating projects are:

- market requirements, for example: authorization of the project on airport reconstruction in large scientific, industrial and cultural center as request for inclusion of the megalopolis in the international network of air routes;
- Business requirements, for example: authorization of the project on construction of residential complex by the developer (builder) for the purpose to enter the market with premier-class housing;

- Demand of consumers, for example: authorization of the project on construction of a powerful processing line to release high-quality bottled water in response to the growing needs of the population;

- Technological development, for example: authorization of the project on collection of solid waste by citizens as a result of the reorientation of government policy in the area of municipal waste treatment;

- Legal requirements, for example: authorization of the project on development of transport and communications of new guidelines to travel in the municipal transport in order to improve the safety of transportation in the city.

Initiation of the project passes through the following main stages:

Initiation of the project passes through the following main stages:

- definition of a problem to be solved;
- designation of the measured expected result of the project;
- the analysis of approachability of project objectives;
- decision-making about start / liquidation of the project;
- definition of priority of the project;
- appointment of the project manager;
- fixing of starting point of the project.

These stages can be implemented simultaneously.

The entities often underestimate an initiation stage, starting directly with planning at best or with implementation at worst. However it is difficult to reevaluate initiation - at this stage there are study and analysis of the project and its objectives. Lack of attention to these steps often leads to dispersion of entity efforts on chaotic initiatives without visible result.

Project justification represents the document that formally confirms justification of the project, and contains the description:

- Business requirements;
- Product, object, service description.

Justification shall be constituted by the manager, external on the project, but at such organizational level of hierarchy that would meet project requirements.

Justification gives to the project manager the chance to distribute resources of the entity on the project works.

In the projects which are carried out under the contract, the contract serves as justification for the project.

⌚ *Project development* represents a special organized research work of analytical, technical and economic nature connected with project development goals setting, development of its concept, the planning and execution of the design estimates.

At the development stage (a preinvestment phase) there are such work types:

- determination of investment opportunities and promotion of the business idea;
- analysis of alternative versions of the project and preliminary choice of the project;
- preparation of the project - development of preliminary feasibility statement (FS);
- functional researches on the project;
- the conclusion on the project and the decision on investment.

If the innovative idea of the project is interesting for the owner of the organization, there is a need to obtain more exact and deep information on future project taking into account its value for the development strategy of the organization; it is necessary to expand and add «Business Ideas on the Project" sections. This work is usually charged to group of specialists from the customer. Result of deep study and refining of this information is the document "Concept of the Project".

⌚ **The concept of the project** is a preliminary plan of implementation of the project business idea, it is provided to the director or the potential investor for the purpose of assessment of this business offering.

Project conceptual phases:

- I. Forming of the project investment plan
- II. Preliminary discussion of the purposes and project tasks
- III. Preliminary analysis of project implementation
- IV. Declaration on intention

2.2. The structure of the project analysis

After the formulation of the business idea of future investment project there is a question whether the entity is capable to realize this idea. For the answer to this question it is necessary to analyze an economy industry condition which the entity belongs to and to find its competitive position within an industry. This analysis is content of the previous stage of development and the analysis of the investment project. In practice of the western project analysis it is accepted to use the following two criteria:

- *industry maturity,*
- *Business competitiveness, market position.*

According to the second criteria it is necessary to establish business competitiveness within an industry to which it belongs. A resulting effect of a preliminary stage of project analysis is establishment of a position of the specific entity by certain criteria, to which cell of lifecycle matrix possesses this entity.

Having determined a position of the specific entity, it is possible to consider one of the possible strategies of his further behavior in the market:

Because of variety of projects, their analysis is put in order according to the general scheme including special sections which estimate commercial, engineering, financial, economic and institutional feasibility of the project.

Table 2.1

Matrix of enterprise life cycles

Market position	Maturity			
	Embryonic	Growing	Mature	Declining
Dominating	Invest quicker than requirements of the market	Hold positions. Hold a share	Hold positions. Develop together with industry	Hold positions
Strong	Invest with a speed dictated by the market	Try to improve situation. Increase a share	Hold positions. Develop together with industry	Hold positions or sum up the results
Favorable	Selectively or completely increase a share. All forces on increase in a market share	Try to improve situation. Selective increase in a share	Expectations or stabilization. Find your niche and try to defend	Sum up the results or be close up gradually
Unbalanced	Selectively gain of positions	Find your niche and defend	Find a niche and hold or gradually	Close up gradually or at

			close up	once
Weak	"Up or out"	Reorganize or close	Reorganize or close gradually	Close up immediately

1. Analysis of commercial feasibility. Marketing researches are of great importance in the analysis of projects as allow obtaining the market information necessary for assessment of viability of the project.

Essentially the essence of the marketing analysis consists in the answer to two simple questions:

- whether the entity will be able to sell the product which is result of project implementation?
- whether the entity will be able to receive from it sufficient amount of profit to justify the investment project?

But they are preceded by consideration of more conceptual questions:

- for what market the project goes (internal or international)?
- does the project provide the balance between the international and domestic market?
- if the project is oriented to the international market, whether its objectives coincide with foreign policy of the state?
- if the project is oriented to domestic market whether its objectives coincide with domestic policy of the state?
- if the project isn't compatible to policy of the state whether it worth further discussion

2. The technical analysis of the innovative project allows to reveal technical and economic alternatives; options of location of an object; scale and project scope; project deadlines in general and according to phases; availability and sufficiency of raw materials, labor power and other necessary resources; market capacity for project products; costs on the project taking into account unforeseen factors; project implementation terms. The listed problems are solved with high accuracy at FS stage and at the stage of creation of technical and working projects. In the course of the technical analysis the estimate and the project budget are specified and also physical and price unforeseen factors which cause additional expenses.

Tasks of the technical analysis of the investment project consist of:

- determination of the most acceptable technologies for project objectives;
- analysis of local conditions, including availability and cost of raw materials, energy, labor power;
- verification of potential opportunities of planning and project implementation.

The technical analysis is usually carried out by group of own entity experts with possible involvement of highly specialized specialists. The standard procedure of the technical analysis begins with the analysis of own used technologies.

3. *Financial analysis.* This section of the project analysis is the most volume and labor-consuming. The general scheme of the financial section of the investment project is in such sequence:

- financial analysis of the entity during 3-5 previous years of work;
- financial analysis of the entity during investment project preparation;
- establishment of amount of investment requirements;
- establishment of sources of investment financing and their cost;
- breakeven analysis of production of main product types;
- the forecast of profits and cash flows in implementation process of the investment project;
- investment project efficiency evaluation.

It is also important to provide in the financial section the main financial reporting of the entity for several previous years and to compare the main indicators by years. If the investment project prepares for involvement of the western strategic investor, the financial reporting should be transformed to the western formats of that country from which it is supposed to attract the investor.

The most responsible part of the financial section of the project is its investment part which includes:

- determination of investment requirements of the entity on the project;
- establishment and search of sources of financing of investment requirements;
- capital rating, the investment project attracted to implementation;

- the forecast of profits and cash flows for the realization account of the project;
- assessment of performance indicators of the project.

4. *Economic analysis.* Unlike a financial analysis, directed to determination of whether the project will be able to increase the number of entity equity owners (shareholders), the economic analysis consists in a project contribution impact assessment to increase national welfare.

It is necessary to emphasize once again that the economic analysis is usually carried out for large investment projects which are developed by request of the government and are designed to solve a problem of national value.

5. *The institutional analysis* estimates a possibility of successful execution of the investment project taking into account an organizational, legal, political and administrative environment. The main task of this section of the project analysis is to estimate set of the internal and external factors in investment project implementation. Assessment of internal factors is carried out on the following three components.

Possibilities of production management.

Workforce.

Organizational structure.

Policy of the state in which the following items are allocated for the detailed analysis:

- conditions of import and export of raw materials and goods;
- an opportunity for foreign investors to make investments and to export goods;
- laws on work;
- basic provisions of financial and bank regulation.

These questions are most important for those projects which provide involvement of the western strategic investor.

6. *Risk analysis.* Sometimes, in the course of risk analysis, the analysis of scenarios is enough which can be carried out according to the following scheme:

- selection of the most uncertain parameters of the investment project;

- efficiency analysis of the project for extreme values of each parameter;
- development of three scenarios of the investment project: basic, the most pessimistic, the most optimistically (optionally).

The strategic investor, as a rule, draws a conclusion on the basis of the most pessimistic scenario.

Finally the project is arranged in the form of the business plan in which the listed above questions find reflection. At the same time, the structure business - the plan doesn't assume repeating of the sections determined earlier.

7. *Social analysis.* The purpose of the social analysis is to constitute the project implementation plan acceptable for its users. The social analysis concentrates on such questions: sociocultural and demographic characteristics of the population in the region of project implementation (quantitative and social structure); the organizations of the population in this region, in particular availability of a workforce; the project acceptability for local culture; the strategy of ensuring accomplishment of indispensable obligations before national groups and the organizations, that use project deliverables or fall under its influence.

In most cases social project deliverables pass cost assessment and are included to total project costs and deliverables within determination of project cost efficiency.

8. *The ecological analysis* reveals potential losses of the project to the environment, and also determines the measures necessary for mitigation or prevention of these losses.

2.3. Evaluation of the projects effectiveness

Depending on the basic principles of the project efficiency evaluation there are methods which can conditionally be divided into three groups:

- 1 - the methods based on discounting of cash flows (table 2.2)
- 2 - the methods without discounting
- 3 - the methods which consider probabilistic characteristics of innovations

The discount rate depends on three factors:

- *The risk* - consists of risk, area and this project. The award for risk is determined by experts or by analogy with similar projects;

- *Lost profits* are an interest rate for alternative deposits (average market profitability) without inflation;
- *Inflation* - is determined by statistical bodies.

Table 2.2.

The methods of an assessment of innovative project efficiency based on discounting of cash flows

Indicator	Calculation procedure	Notes
Net Present Value (NPV)	$NPV = \sum_{t=1}^n \frac{CF_t}{(1+i)^t} - IC$ <p>In which IC - initial investments; CF_t - cash flows of the corresponding year; t - amount of the periods (t = 1, 2... n), in which cash flows are defined; i - discount rate.</p>	If NPV > 0 — the project can be approved; NPV = 0 — the project neither results in incomes nor losses; NPV < 0 — the project is unprofitable and it should be rejected.
Profitability index (PI)	$PI = \frac{\sum_{t=1}^n \frac{CF_t}{(1+i)^t}}{IC}$	The project is rejected if PI < 1; accepted if PI > 1; in the case of PI = 1, the project is neither profitable nor unprofitable.
Internal rate of return (IRR)	$IRR = r, \text{ when } NPV = f(r) = 0.$ $IRR = A + \frac{a(B - A)}{(a - b)}$ <p>In which A — the value of the discount rate at which NPV is positive; B — the value of the discount rate at which NPV is negative; a — value of positive NPV, at a value of discount rate of A; b — value of NPV, at a value of discount rate of B.</p>	Enterprise may take any decisions of investment character, if the level of profitability (IRR) is not lower than the current capital cost (CC). If IRR < CC, such project is rejected, if IRR > CC, is accepted.
Discount payback period (DPP)	$DPP = \min n,$ $\sum_{k=1}^n P_k * \frac{1}{(1+r)^k} \geq IC,$ $DPP = t + \frac{KPV_t}{PV_{t+1}},$ <p>in which t – year of the last negative value of cumulative cost; KPV_t – cumulative cost of t year (last negative value), UAH; PV_{t+1} – the discounted cost of a cash flow in t + 1 year, UAH.</p>	a) project is accepted if there is a payback; б) project is accepted only if the payback period does not exceed the limit set in organization.
Benefit-cost ratio (BCR)	$BCR = \frac{\sum_{t=1}^n \frac{B_t}{(1+i)^t}}{\sum_{t=1}^n \frac{C_t}{(1+i)^t}}$ <p>in which B_t – benefits of the project in t year, C_t - project expenses in t year,</p>	The selection criterion of projects is in choosing all independent projects with BCR coefficients, big or equal

coefficient of specific expenses	$K_n = \frac{\sum_{i=1}^t (C_t \times \frac{1}{(1+i)^t})}{\sum_{i=1}^t (B_t \times \frac{1}{(1+i)^t})}$	Less than 1 - the effective project
Integrated effect (or NPV in other words)	$E_{imezp} = \sum_{t=1}^t (B_t - C_t) * \frac{1}{(1+i)^t}$	

2.4. Business plan and project planning

All future aspects of new project activities and possible problems are analyzed in the business plan. The relevance of business plan depends on projects features.

The business plan *is detailed, accurately structured document in details describing the objectives and tasks to solve, methods of achievement of set objectives and technical and economic indicators of the entity and/or the project as a result of their achievement.*

Planning process of the project is a process which assumes determination of the objectives and parameters of interaction between works and project participants, resource allocation and the choice and adoption of organizational, economic, technological solutions for achievement of effective project objectives.

- *At a stage of project planning all necessary parameters of project implementation are determined:* duration of works, need for labor, material and financial resources, delivery dates of all types of resources, terms and amounts of involvement of project, construction and other organizations.
- *The main task of project planning* - project planning process shall provide feasibility of the project in set terms with a minimal cost of standard costs of resources and with proper quality.
- *The main objective of project planning* - to provide performance of works and achievements of resulting effects of the project.

2.5. Basic principles of creation of the project organizational structure

Success of project implementation in many respects depends on its organizational structure. The concept of an organizational structure covers organizational structures of project management and organizational forms.

Organizational structure of project management is set of the interconnected governing bodies which are at the different levels of system, and *organizational form* - the organization of interaction and relations of participants of investment process.

It is possible to allocate two ways of group forming:

1) **functional** when specialists of one profession, specialties, functions unite in functional divisions;

2) **target** when contractors of different specialties or functions which work together on some task or a stage of the project unite. Such groups tend to be semiindependent, isolated; they are called "mixed organization units".

Thus, people who are involved in project implementation, form groups, functional divisions or organization units.

Allocate the following forms of project structures (tab. 2.3.).

Table 2.3.

The main forms of project structures

The form of the projects organizational structure	Advantages	Disadvantages
<i>The isolated project.</i> The main characteristic is the fact that the independent group of experts constantly works on the specific project. This cumulative management of the labor, financial, material and energy resources is necessary for project implementation in the stipulated time, within the planned estimated cost and with the corresponding quality.	<ul style="list-style-type: none"> • The project manager receives all powers connected with his realization. • All group members report to one head. They shouldn't worry about manifestation of devotion and fidelity to the functional manager. • The procedure of opinions exchange is considerably reduced therefore decisions are made much quicker. <p>Such concepts as command pride, motivation and devotion to business gain very great value.</p>	<ul style="list-style-type: none"> • Duplication of resources. The equipment and personnel aren't used in various projects. • Organizational goals and policy of the entity are ignored as group members often both psychologically and physically move from one division to another. • Because of weak communication of functional divisions the organization can't develop new technologies in time. • As group's members have no "native" functional zone, they worry about their further work after project closure that quite often leads to tightening of

<p><i>Functional project</i></p> <p>It is characterized by the fact that the project is performed in the existing functional divisions.</p>	<ul style="list-style-type: none"> - Project team members can work on several projects at the same time. - Technical experience remains within a specific functional zone even if the project participant leaves group or the organization. - The functional zone remains "native" for project team participants even after project implementation. Functional experts can move ahead up service. - As a result of a group saturation of highly professional specialists from several functional zones increases efficiency of the solution of various technical problems connected with the project. 	<p>terms of its execution.</p> <ul style="list-style-type: none"> - Not enough attention is paid to the aspects of the project, which are not connected directly with a concrete functional zone. - The motivation of team work is often very weak. - Needs of the client have secondary character, and reaction to them is slowed down.
<p><i>Matrix project</i></p> <p>The classical matrix organizational form is characterized by the fact that it unites qualities of structures of both separate and functional projects. People from different functional zones are involved in each such project. The project manager makes the decision on tasks and when they should be carried out, and functional managers decide who will be engaged in this work and which processing methods are necessary to be used.</p>	<ul style="list-style-type: none"> • The interrelation between various functional divisions increases. • The project manager is responsible for its successful implementation. • Duplication of resources is minimized. • The functional zone remains "native" for project team members even after project completion therefore they are less concerned about their further work after its termination, than in case of such organizational structure as the isolated project. • The activities of the project are consistent with the basic policy of the organization, which increases support for the project. 	<ul style="list-style-type: none"> • There are two heads, and often the opinion of the functional manager is listened before opinion of the project manager. In case of such situation, among other things, it is hard to say which of them is more important for promotion of the specific person on service. • The project is doomed to failure if the project manager has no talent to conduct negotiations successfully. • Project managers aim to have an inventory of resources for the projects, causing thereby damage to other programs of the company.

Forms of an organizational structure shall be considered at two levels - external and internal

1. External level assumes availability of a certain structure of communications and the relations between the certain contractors and groups involved in project implementation and their parent divisions, departments, the companies.

2. Internal level reflects the relations between certain contractors and groups which carry out the project. This structure is considered irrespective of the external relations. The internal structure exists in external.

The following main forms of external organizational structures:

- form of a project team;
- matrix organization;
- hybrid organizational structure;
- modular communication structure.

Main forms of internal structure:

- internal functionalization;
- internal matrix structure;
- divisional structure;
- federal organization;
- the centralized / decentralized form of large project organization.

CHAPTER 2. PROJECT PLANNING

TOPIC 3. Project planning as part of project management

3.1. Development of the project management plan

3.2. Project scope management processes

3.3. Essence and functions of project structurization

3.4. Directions of project structurization

3.1. Development of the project management plan

Development of the project management plan is a process of documenting the actions necessary for definition, preparation, integration and coordination of all auxiliary plans.

Development of the project plan - iterative process, almost always repeats several times. Development of project plans covers all stages of its life cycle. It begins with

participation of project manager in the course of concept development, choice of strategic objectives, including contract offers, and proceeds with conclusion of contracts and comes to an end only at end of the project.

There is traditional system of plans:

at a preinvestment stage as a part of project concept, business plan, preliminary feasibility study - *the preliminary plan of project implementation* taking into account the needs for main types of resources and justification of investments;

at a stage of development of project and technological documentation as a part of the project implementation management plan.

📌 **Project Management Plan** - the fundamental document containing coordinated by all participants documentary recorded idea of the project.

📌 **Project Management Plan** is the approved formal document in which it is specified how the project and project monitoring will be carried out. The plan can be generalized or detailed, and also can include one or several auxiliary management plans and other documents on planning (tab. 3.1.).

Table 3.1.

Project Management Plan

Component	Content
scope management plan	the document describing how project scope and hierarchical structure of works will be defined, developed and checked and also how to control the project scope.
schedule plan	the document establishing criteria and operations on development and management of the schedule of the project.
cost management plan	the document that sets a format and defines operations and criteria for planning, structuring and managements of project cost
quality management plan	the document defining the quality standards which correspond to the project, and means of achievement of these standards
staffing management plan	the document describing a way of implementation of requirements to resources
communication management plan	the document which defines information need and communications of project participants: who they are, what degree of their interest and influence on the project, who needs information, which information, when it is necessary and how it will be provided.
risk management plan	the document describing how risk management of the project will be organized and carried out.
procurement management plan	the document describing management of deliveries processes, beginning from development of documentation on deliveries and till the contract closure.
milestone plan	Milestone (control point) - an event or date during implementation of the project. The plan on milestones is the sequence of the milestones determined by the manager.
project change management plan	it is provided if it is necessary to make changes to the management plan the project. Such changes can be connected with modifications, additions and audits of the project. At the same time the status of the plan changes on <i>updated</i> .

!!! *Don't confuse the project plan with basic the plan.* **The project plan** is a document or the list of documents which changes in process of receipt of additional information whereas the **basic plan** serves for control of performance and changes only in case of the adoption of requests for changes.

Project plans is classified by the following features:

- project management level;
- functions of management;
- degree of coverage of project works.

3.2. Processes of project scope management

⌚ **Processes of project scope management** include the processes providing inclusion in the project of those and only those works which are necessary for a successful completion of the project.

In the context of the project the term "scope" can mean:

- properties and functions which characterize a product, service or result
- works which need to be executed for creation of a product, service or result with the specified characteristics and functions.

Project scope management is directly connected with definition and control of what is included and excluded in the project.

The general scheme of processes of project scope management includes the following:

- planning of scope management - process of creation of the scope management plan which documents how the project scope will be defined, confirmed and controlled.

- collecting requirements - process of definition and documenting of requirements of project interested parties in order to achieve project objectives.

- scope determination - process of development of the project and product detailed description.

- creation of the hierarchical structure of works (HSW) - process of division of project results and works on smaller elements which are easier to operate.

- scope confirmation - process of formalized acceptance of complete project results.

- scope control - process of monitoring of the project status and the maintenance of a product, and also changes management of the basic plan on scope.

3.3. Essence and functions of project structurization

Project management can be divided into separate blocks which are independent subjects to planning, account, organization and coordination, which is creation of structure of the project. From theoretical positions of project management the *structure of the project* is considered as the organization of communications and the relations between its elements.

It provides development of:

- Work Breakdown Structure - WBS
- Organization Breakdown Structure - OBS
- Cost Breakdown Structure - CBS.

† **Structurization** is a distribution of the project to hierarchical subsystems and components and establishment of communications and relationships between them, which allows carrying out project management.

Main objectives of project structurization:

- project distribution on the blocks which are subject to management;
- distribution of responsibility on various elements of the project, definition of communications between various works and structure of the organization;
- definition of expenses - time, money, material resources;
- creation of uniform base for expenses planning, estimating and control;
- establishment of interrelations between works on the project and system to conduct accounting;
- definition of works complexes.

3.4. Directions of project structurization

Structurization of the project can be carried out in one, two or three directions. Nowadays many firms apply the "**unidirectional**" system to projects structurization,

management, planning and control (structurization only of amounts of works). Success in project implementation planning and control depends on how quickly and precisely the amounts of works will be determined. This problem is solved with the help of WBS - working structure of the project.

Structure of works distribution includes:

- *Structure* - set of the relations between system elements which are necessary and sufficient for achievement of project goals;
- *Decomposition* - division into components or categories, into simpler components;
- *Work* - the long physical or intellectual effort directed to achievement of result; activity, duty, function, operation which is performed by the employee or collective; a part of labor process which requires expenses of time and resources.

↑ **WBS** is the hierarchical structure constructed for the purpose of logical distribution of all works on project implementation and is presented in the graphic form. It is set of several levels; each is formed as a result of distribution of previous level work to its components.

Principles of WBS levels formation:

- Functional approach;
- Productive approach;
- By stages of project life cycle;
- Geographical approach;
- Structure of functions of innovative project management;
- Structure of the organization.

For example, by products or subprojects (the subproject 1 - the subproject 2 - the subproject 3), by project phases (design - construction - reception), by the place of work performance (the base - external works - internal works), by the centers of expenses (the company 1 - the company 2 - the company 3).

Development of works distribution structure can be carried out by two main methods - deductive and inductive. At deductive structurization of the project the WBS elements are defined on the basis of approach from top to down (top-down approach). At inductive structurization of the project the WBS elements consist of

elements of the previous level on the basis of approach from down to top (bottom-up approach). Often both methods are used alternately for the same project that is WBS can be considered created when both approaches are used.

To create WBS structurization can be made at the following levels: level 1 - the project; level 2 - stages or subprojects, level 3 - systems or blocks, level 4 - work packages.

The element of the lowest level - work package - represents group of works or operations which are exposed to an assessment from the point of view of definition of expenses and resources, of performance duration and appointment of responsible person and has the following characteristics: the volume and the list of works which need to be executed; execution of a work package; budget; necessary resources; start and end date.

System of coding

Key to integration of separate elements of the project is the systematized system of coding which helps to structure the project, to define elements of the expenses accounting, WBS and OBS and to establish their relationships. It is used to separate and to combine everything: works, their planning and control, resources and means, account, assessment, etc.

Coding is a vital component of the project information management system. In the coding multfigured numbers or a combinations of figures and letters are used, each of which has its content, the value.

Each code number corresponds to certain expenses, WBS or OBS level and element, and also indicates relationship in WBS and OBS structures. Each level of structure is presented by a part of a code. One part represents WBS structure, the second - OBS. Connecting them, we receive the expenses inherent in these structures and their separate elements.

WBS dictionary or CTR catalog

Due to the creation of WBS/OBS-structures and coding it is necessary to create them the dictionary which would define elements and the accounting of expenses. It guarantees understanding everyone attracted to the project of value and the

maintenance of each of the WBS or OBS elements. The dictionary can be expanded to scoping of works, costs, resources and restrictions on time. It can be given to look of the Expenses — Time — Resources catalog (Cost - Time - Resources, or CTR).

Table 3.2.

CTR- dictionary

Number	Work code	Work content	Cost, UAH.	Duration, days	Necessary resources
...					
3.	813-42	System analysts training	4000	5	Trainers — 2 persons Audience — 5 days

Three-directed structure of the project is created by addition to bidirectional structure of the third one - Cost Breakdown Structure - CBS.

CBS is formed on the algorithm similar to an algorithm of creation of WBS and OBS. The first level is all this expenses on the project. The second level - basic elements of CBS: materials, knots, component parts; equipment maintenance costs; labor expenses; other expenses. The third level is further distribution. For labor expenses there are: expenses on selection and training; expenses on compensation on delivery and installation of equipment; expenses on compensation according to the software. The fourth level - further distribution, for example, for compensation according to the software: compensation of programmers; compensation of systems analysts; compensation of operators.

TOPIC 4. PROJECT TIME MANAGEMENT

4. 1. *Network and calendar planning*
4. 2. *The procedure of network graphs construction*
4. 3. *Network planning in the conditions of uncertainty*
4. 4. *Calendar planning of projects*

4.1. Network and calendar planning

Initial step in project planning is *structurization* which provides planning of amounts of works. However the stage of structurization doesn't allow answering a question: how much time you need to perform all project works, which are the

calendar periods of execution of separate operations, subprojects, and how the need for different resources is distributed in time during project implementation? There is a need of planning of one more main project goal - *its execution in time*.

To solve this issue network and calendar planning in project management are used.

Network planning arose in the fifties when computer means began to develop. Its methods have well-known international name and abbreviation CPM (Critical path method), or CPA (Critical path analysis), or PERT (Programme evaluation and review technique). In our practice these methods are called "network graphs". Now they are applied vary widely, especially in big and difficult projects, by means of computer facilities and the software.

Network planning consists in creation of logical charts of the sequence of project works implementation - network graphs - and determination of these works duration and the project in general for further control.

Application of network planning helps to answer the following questions:

1. How much time it is required to implement the whole project?
2. In what time separate works have to begin and come to an end?
3. What works are "critical" and have to be carried out precisely according to the schedule not to break terms of project implementation in general?
4. For what term it is possible to postpone execution of "noncritical" works that it hasn't influenced terms of project implementation?

Network planning consists first of all in creation of the network graph and calculation of its parameters.

The network graph is a graphical representation of works of the project which reflects their sequence and interrelation

Main elements:

1. **The work (operation)** can be defined as the action necessary for implementation of the project. In network graphs works generally have the number or a code which is assigned for them by drawing up WBS and it is given in the CTR-dictionary.
2. **Event** - the end results of the previous work (the moment of planned action

completion)

3. **Path**- the continuous sequence of works from beginning to end

4. **Duration** - time from the beginning till the end of work

5. **Logical links**. To construct network graph it is necessary to define relations between works which can be two types:

- consecutive, when one work is performed after the second;
- parallel, when several works can be performed at the same time.

Depending on a way of the image they are distinguished by two types of network graphs:

- lancet (tops-events, "actions on shooters" AOA)
- proceeding (tops-works, "operations in knots" AON)

4.2. Order of network graphs creation

1st step. Definition of the list and sequence of performance of work. Directly the list of works can be received from working structure of the project, however WBS doesn't show in what sequence the specified works have to be performed. Therefore between them the manager has to establish logical connection.

Work code	Work title (content)	Previous work	Work duration, weeks

2nd step. Graphic creation of the network graphic.

Early Start <i>ES</i>	Work duration <i>t</i>	Early Finish <i>EF</i>
Work code and title		
Late Start <i>LS</i>	Float <i>F</i>	Late Finish <i>LF</i>

Fig.4.1. Placement of parameters of the network graphic («key»)

Thus, the network graphic with definition of works and logical communications between them is result of the second step.

3rd step. Determination of work duration.

4th step. Determination of early terms of the beginning and the end of project works by "direct passing".

Path - a sequence of related works from the beginning to the end of the project

Early Start — the earliest possible starting date of work.

Early Finish — the earliest possible date of work completion.

These parameters are calculated by the following formulas:

$$EF_i = ES_i + t_i ;$$

$$ES_{i+1} = EF_i ,$$

In which EF_i — early date of i-work completion;

ES_i — early starting date of i-work;

t_i — i-work duration;

ES_{i+1} — early start of i + 1 work.

Rule: *when carrying out calculations of early terms if a certain work is observed after several previous, early starting date of this work is defined taking into account the latest from early completion dates of the previous works.*

This step gives the chance to determine duration of all project. Duration of the project is defined as the highest value of early completion date of other works.

5th step. Determination of late terms of the beginning and completion of works as "the return passing".

This step involves calculating the parameters in reverse order - from the latest work of the project to the first.

Late Start — late possible starting date of work after which the delay will affect a date of completion of all project implementation.

Late Finish — a late possible date of work completion.

These terms are calculated by the following formulas:

$$LS_i = LF_i - t_i ;$$

$$LF_{i-1} = LS_i .$$

Rule: *if a certain work is followed by two parallel works, the late completion of the work is determined taking into account the earliest of these works late start.*

6th step. Definition of a critical path and float on works.

Works in which early and late terms of the beginning and the end coincide call **critical**. Works in which early and late terms of the beginning and the end don't coincide call **noncritical**.

The critical path is formed by the sequence of critical works. It is the longest of all ways existing in the project which shows the least time needed to perform all works on the project.

Float The general reserve (Time stock (F - Float)) is the maximum time for which it is possible to postpone the beginning of noncritical work and at the same not to change time duration of implementation of all project. It is calculated by formulas:

$$F_i = LS_i - ES_i$$

or

$$F_i = LF_i - EF_i.$$

4.3. Network planning in the conditions of uncertainty

As characteristic feature of projects is their uniqueness, it is very often difficult to determine precisely duration of performance of separate works therefore it is necessary to take into account uncertainty of performance terms of separate project works.

To consider probability of term of work performance, it is necessary to receive three assessment of possible duration for each work. These are:

- **optimistical time (a)** — work performance term if everything is provided ideally; time minimum
- **most likely time (m)** — the expected work performance term under normal conditions;
- **pessimistic time (b)** — work performance term if there are essential obstacles. time maximum.

Following formula of calculation of *Expected Time* is used by three estimates of time:

$$T_{oq} = \frac{T_{\min} + 4T_{\dot{u}M} + T_{\max}}{6}$$

To simplify calculations, it is possible to use formulas by two estimates, respectively for the average expected:

$$t_{oc} = \frac{3t_{min} + 2t_{max}}{5},$$

and quadratic average:

$$\sigma_i = \sqrt{\frac{(t_{max} - t_{min})^2}{5}}$$

The greater the difference between optimistic and pessimistic at times, the bigger σ^2 is, that is degree of uncertainty increases in an assessment of works duration. These calculations are based on the assumption that uncertainty of time for performance of work can be received by β -distribution of probability.

The analysis of the network graph is carried out in the following order:

- the topology of the network graph is checked that is appropriateness of separation of each operation, the sequence of performance of work and correlation in between, a possibility of increase in parallelism of execution of separate operations;
- tension of the network graph is calculated;
- the probability of completion of the final event in time is calculated.

To calculate tension of the network graph first of all coefficients of works tension are calculated according to the formula below:

$$k_{Hi} = \frac{t[L_{max}] - t^1[L_{kp}]}{t[L_{kp}] - t^1[L_{kp}]},$$

where $t[L_{max}]$ – duration of the maximum path running through this work;

$t^1[L_{kp}]$ – part of the maximum $t[L_{max}]$ path, which coincides with a critical path;

$t[L_{kp}]$ – duration of critical path.

Further works are distributed according to coefficients of tension in the zones in the following intervals:

- critical zone: $1 \geq k_{Hi} > 0,95$;
- subcritical zone: $0,95 \geq k_{Hi} > 0,8$;
- reserve zone: $0,8 \geq k_{Hi}$.

After this work is the share of each zone is found – for critical C (%), for subcritical S (%), for Reserve R (%) – by the formulas:

$$C(\%) = \frac{C}{C + S + R},$$

$$S(\%) = \frac{S}{C + S + R},$$

$$R(\%) = \frac{R}{C + S + R},$$

in which C , S , R – the amount of work in a critical, subcritical and reserve zones. Based on these calculations tension coefficient of network graph is calculated by the formula:

$$K_{Ycc}(\%) = C(\%) + 0,5S(\%).$$

Tension coefficient should be between 15-25%. If it is greater, it indicates congestion and complexity of the project and its practical implementation.

If the completion time distribution is normal, and with this distribution, it is possible to calculate the probability of completing the project within a particular timeframe T_{dup} by the formula:

$$P = \Phi(X) = \Phi\left(\frac{T_{dup} - T}{\sigma_{sp}}\right),$$

where $\Phi(X)$ – the value Laplace function for the normal distribution of probabilities;

T_{dup} – scheduled time of the whole project activities performance;

X – the argument of Laplace function:

$$X = \frac{T_{\text{dup}} - T}{\sigma_{sp}}$$

P values are on the table of Laplace function.

The probability of completing the project in a specified period must be within $0,35 < P < 0,65$. If $P < 0,35$, there is a considerable risk of break-down of calculated term project, and it is necessary to rebuild the network graph and relist its options. If $P > 0,65$, it indicates that there is relatively small number of works in critical and subcritical zones, there are significant reserves. In this case it is necessary to check network graph and reduce the duration of works.

4.4. Project calendar planning

Project calendar planning is a process of drawing up and updating of the schedule in which the works performed by various organizations, interconnect among themselves in time and with opportunities of their providing with different types of material resources and manpower.

Types of project calendar planning

There are two accepted ways of representing calendar graphs:

- Table - with the list of works with the indication of duration of their performance;
- Chart (frame charts or Gantt's charts).

Gantt's chart is an evident source of such project information as:

- what works are critical and what - noncritical;
- what float noncritical works have;
- when project works have to begin and come to the end according to the plan;
- what are logical links between works;
- what is the actual performance of work for a certain date.

Positive lines of Gantt's chart:

- 1) is easily to construct and read;
- 2) allows presenting visually work progress on the project;

- 3) allows understanding easier the idea of the float and its use;
- 4) is a prerequisite of calendar planning of needs in resources;
- 5) is a condition of definition of cash flows;
- 6) is best means of planning and control;
- 7) can be used for an agreement and distribution of information;
- 8) is the key document in decision-making process.

TOPIC 5. Project resource planning

5. 1. Resource planning of the project

5. 2. Creation of resource histograms

5. 3. Estimation of cost of operations

5.1. Project resource planning

Project resources are necessary for performance of operations of the project.

Resources can be:

- renewable (power type) - can be reused on various operations of the project (a manpower, the equipment).
- non-renewable (energy type) (materials) which on operations of the project are spent and can't be used any more.

Resource planning defines which resources and in what quantity will be used at works on the project.

As a rule, the **main problem consists in compliance of the available and necessary workforce** as it is easier to provide other types of resources at the necessary level. An ideal situation - when the needs for resources coincide with their existence. Unfortunately, in project management it happens very seldom therefore it is necessary to look for a compromise.

If the need for resources exceeds opportunities, there are three ways of its decision:

- to postpone (to detain) work within the float;

- to correct terms of performance according to limited resources (i.e. if resources are limited, in advance limited, then it is necessary to change the planned schedule);
- to correct intensity of use of resources within the determined time (if it is impossible to change terms, increase, for example, duration of the working day).

The assessment of volume of necessary resources directly depends on the amount of works which should be expressed in labor input. The number of workers is determined by a formula:

$$K_p = \frac{T}{\Phi_{\text{kop}}}, \text{ where } T - \text{labor input; } \Phi_{\text{kop}} - \text{useful fund of time of one worker.}$$

Further it is necessary to compare this number with the planned period of operation. So, if it is necessary to spend 120 man-days for a certain work, then this requirement can be satisfied differently:

12 people × 10 days;

6 people × 12 days;

4 people × 30 days;

3 people × 40 days.

There are three types of dependence of need for resources on duration of works

1. **constant** - during all cycle of work performance, the volume of the planned resources doesn't change.
2. **graduated** - during work loading of resources changes in steps
3. **triangles** - grows from the beginning of work to the maximum value, and then comes to the end of work.

The resource conflict - a situation when the need for any resource exceeds his maximum limit of consumption.

Methods of alignment of the resource conflict:

1. *a normal method of alignment* - scheduling for later term at the expense of a reserve time before emergence of necessary quantity of a resource.
2. *a distribution method for alignment* - distribution of work on several parts, each performance requires a certain quantity of a resource.
3. *a stretching method for alignment* - reduction of intensity of resource use due to increase in period of operation

4. *compression method for alignment* - in case of surplus of a resource, reduction of duration of work performance due to increase in intensity of resource use.

Process of resources appointment - definition for each work of necessary resources and their necessary quantity.

5.2. Creation of resource histograms

After resources are defined and coordinated with the planned schedule, it is necessary to compare them with the available resources of firm.

The histogram of need for resources is similar to a bar charts where on a horizontal axis calendar terms are specified, on vertical - the daily number of resources necessary for all works performance, on each profession separately.

It is very widely applied in planning of projects as it is evident, it is easy to understand and connect it to other aspects of planning. For its construction it is necessary to have:

- the schedule diagram for early terms (we do the assumption that we try to perform all works as soon as possible)

- forecasts of need for resources in a section of works.

There are two cases:

1. The lack of a resources leads to increase in duration of work performance if not to pay attention to it. Ways to overcome this problem:

- after hours of work (at the same time it isn't necessary to involve new workers, but productivity of available decreases)

- increase in shifts (level of use of the equipment grows, however it is necessary to take into account possible quantity accommodation of people in limited space)

- increase in labor productivity (by means of education and a training)

- the principle "made and left": the worker can leave a workplace after end of necessary amount of work (even if he is paid for the working day or shift), thus works will not stretch in time;

- involvement of subcontractors (the temporary labor increases, but it is more expensive. It is also an opportunity to compare own workers productivity with

attracted from the outside. Sometimes it rises, but it is necessary to watch quality and moral atmosphere)

- a training curve (with performance of identical work expenses of time decrease in process of acquisition of skills and growth of labor productivity). For example, if release series of similar measuring devices, then time expenses with each following series are reduced.

2. Surplus of resources is also a problem as the workers should be paid the salary. These expenses can be cut down in the way:

- the direction of free resources on performance of critical works;
- performance of components in advance;
- installations of the equipment in advance;
- personnel trainings on the future
- estimates of last projects to predict tendencies in use of resources, and, respectively, release of excess workers.

Profitability of the company during the long-term period depends on efficiency of use of resources.

Smoothing of resource histograms

Smoothing of resource histograms aims to improve loading of resources (especially when there is a lack of them) by the correction of calendar terms of work performance within the float.

Ways of smoothing:

- change of logical links;
- displacement of noncritical works within the float.

1. Planning in the conditions of limited resources.

If the resource is limited or it can't be increased, it is necessary to increase period of operation until this resource becomes available. Sometimes it increases duration of critical work, and then implementation of the project in general is postponed. It is possible in the following situations:

- a) work is performed in limited space (repair of a cabin of the elevator)

b) capacities are limited (for example, the number of cars for transportation of freight)

c) limited number of the equipment, i.e. computers, machines, cranes, etc.;

d) safety requirements limit number of workers in a certain zone (painting of the house outside in a cradle).

Increase in duration of works can be less if to use measures which were considered on regulation of a lack of resources.

2. Planning in the conditions of limited time.

This method is applied if it is impossible to prolong a date of completion of project implementation.

In this case it is necessary to satisfy the needs for resources (i.e. to update a lack of resources due to additional acquisition). Such situations are possible when:

- the project has strict penalties for non-performance in time;
- the project is a part of other project with the opportunities limited in time (repair of river pier for summer recreation facilities).

As it is impossible to postpone the date of such projects, resources are increased.

5.3. Estimation of cost of operations

† **Estimation of cost** is an assessment of possible cost of the resources necessary for implementation of project works.

There are several standard methods to calculate cost estimation:

1) **Top-down estimate** are used for determination of cost at early development stages of the project when information on the project is rather limited. Therefore estimation of cost of all project in general is actually carried out. Plus - such assessment doesn't require many efforts and time. Minus - and very considerable - the accuracy of such assessment is much lower, than by more detailed bottom-up estimate.

2) **Bottom-up estimate** is contrast of top-down estimate. Is used for development of the coordinated price base of the project or a final cost assessment of the project. The assessment assumes estimation of cost of each task at the level of work group, with the further summation of results at the total levels. Addition of estimates gives the general estimation of cost of all projects. Accuracy and labor input of such

assessment is defined by extent of specification of works of the project. The more projects are divided into operations in detail, the higher both labor input, and accuracy of bottom-up estimate. The team of the project has to find an optimum ratio between labor input and accuracy.

3) *Analogous* is a kind of top-down estimate. Estimation of current project cost is carried out on the basis of the actual cost of similar previous projects. The basic principle is in that the project on the basis of which the assessment is carried out completely corresponds current project. Only provided that the assessment will be rather exact.

4) *Parametrical assessment* is also top-down estimate. Its accuracy concedes to the accuracy of analogous. Process of definition of a parametrical assessment assumes search of parameter of the estimated project, changes in proportion to project cost. On the basis of this parameter the mathematical model is created. Models can be simple (estimation of cost of housing for square meter) or difficult with use of a large number of factors. After introduction to model of values of parameters as the result turns out project cost. The parameters used at an assessment have to be easily measurable that will allow to increase the accuracy of parametrical estimation of cost.

CHAPTER 3. CONTROL AND PROJECT MANAGEMENT SUBSYSTEMS

TOPIC 6. Project Implementation Control

- 6.1. *The essence of project control*
- 6.2. *Monitoring of works on the project*
- 6.3. *Control of cost of work performance.*

6.1. The essence of project control

Control of project activity is a process in which the project manager establishes whether set goals are achieved, establishes the reasons of destabilization of process of work performance and considers adopted administrative decisions correcting performance of tasks, earlier than damage will be caused to implementation of the

project (failure to meet time constraints of performance of work, excess of use of resources and cost, poor quality, etc.).

The purpose of project control process or Project Monitoring and Control is to provide information necessary for understanding of the project course to allow the manager to perform the operations in situations when the project course significantly differs from planned.

Subjects of control are: facts and events, check of implementation of concrete decisions, clarification of reasons for rejection, assessment of the situation, forecasting of consequences. Control assumes constant observation of the course of project implementation.

Project elements that are the **subjects to control**: time, cost, quality, changes arising during project implementation, preparation, receiving, distribution and approval of documents of the project, a situation with financing, operational characteristics of the project, compliance to provisions of the contract, etc.

There are three main types of control:

- preliminary;
- current;
- final.

Preliminary control is carried out till the actual beginning of work performance and is directed to observe certain rules and procedures, as a rule, it concerns resource ensuring works.

The current control is carried out at the project implementation, it includes: control of time, achievement of the intermediate purposes of the project, performance of the set amounts of works, control of the budget, control of resources, quality control. A main objective - regulation of the course of project implementation. Such approach is based on comparison of the achieved results with the cost, temporary, resource characteristics established in the project. Depending on the required accuracy distinguish the following technologies of the current control:

- control at the time of works completion;
- control at the time of 50% of readiness of works;

- control in established in advance certain points of the project;
- regular operational control;
- expert assessment of extent of performance work and readiness of the project.

Final control is carried out at a closure stage of the project with the purpose of an integrated assessment of project implementation. Basic purpose is getting experience for further development and implementation of projects analogs and in order to improve management procedures.

Control includes stages:

- I. Establishment of control standards
- II. The accounting of actually achieved results
- III. Definition of deviations between control standards and the actual results
- IV. Carrying out researches and analysis of deviations
- V. Carrying out necessary works for correction of a situation.

6.2. Monitoring of works on the project

Monitoring - control, observation, accounting, analysis and drawing up reports on the actual project implementation in comparison with the plan. The first step in the course of control consists in data collecting and processing on actual state of works. The managers are obliged to watch continuously the course of the project implementation to define degree of completeness of works and proceeding from current state to do estimates of parameters of performance of future works.

Control methods of the actual performance are divided on:

1. *a method of simple control* which is also called the 0-100 method as it traces only the moments of completion of detailed works (there are only two degrees of completeness of work: 0% and 100%). In other words, it is considered that work is performed only when its end result is achieved;
2. *a method of detailed control* which provides performance of estimates of intermediate conditions of work performance (for example, completeness of detailed work for 50% means that, by estimates of performers and the managements, the objectives of work are achieved half). This method is more

difficult as demands from the manager to estimate completeness percent for the works which are in process of execution (for long works).

Sometimes there are a little modified options of detailed control method:

- a method 50/50 in which there is a possibility of the accounting of some intermediate result for incomplete works. The measure of work completeness is defined at the moment when 50% of the budget is spent for work
- a method on milestones which is applied to long works. Work is divided into parts by milestones, each of which means a certain degree of completeness of work.

6.3. Control of work performance cost.

In project management for tracking the progress of the project the Earned Value Technique is really popular. In domestic literature it is called "method of the mastered volume", "method of the mastered cost", "method of the specified cost", "and method of the executed cost" and it is designated by EV abbreviation.

Earned Value Management (EVM) - system which combines the purposes, the schedule and cost of project work performance.

This equipment for objective measurement of progress in the project has a unique opportunity to combine measurements of achievement of the objectives, graphics and cost in uniform complex system which allows answering a question: "What have we received for that money which we have spent?".

At the correct application Earned Value provides the early warning of problems of project implementation. Besides, this approach improves determination of project scales, prevents its "slipping", gives interested party's information on progress of the project and encourages the project team to achieve progress.

The Earned Value method is based on the following data:

- 1) structured by WBS project plan which defines works which have to be carried out;
- 2) an assessment of the planned volume of the cost (PV)
- 3) Actual Cost (AC);

4) Earned Value (EV) - really executed amount of works, specified in the budget (fig. 2.24).

$$EV = \%COMP * BAC,$$

where BAC - the general planned budget of the project.

Earned Value for implementation of large and difficult projects includes many additional functions, such as indicators and forecasts of performance cost (out of / and within the budget) and the schedule of performance (with lag / and schedule advancing).

The network graph, Gantt's chart, schedule control graph forma basis for comparison of the plan with the actual work flow.

Use of a method of the analysis of the earned volume requires additional structurization of a cost management system on the project and additional efforts of the manager on collecting and the analysis of data.

The main advantage of this method - a possibility of "early detection" (identification at early stages of project implementation) of non-compliance of the actual project indicators with the planned, forecasting on their basis of results of project implementation (terms, expenses, etc.). And acceptances of the timely correcting influences, up to the project closure.

In tab. 6.1. the content of the basic concepts (total amount of indicators - 25) which are operated by the Earned Value (EV) method is explained.

Table 6.1.

Essence of the basic Earned Value concepts

Basic Earned Value concepts	Calculation formula	Content
Fundamental Measures		
BCWS — Budgeted Cost of Work Scheduled (PV)	The amount must be equal to the estimated amount of costs for all work packages $BCWS = BC$ (total budget) x % of the plan.	How much money it is necessary to spend at the moment
ACWP — Actual Cost of Work Performed (AC)		How much money has been really spent for the works at the moment
BCWP — Budgeted Cost of Work Per formed (EV)	$BCWP =$ The planned cost x % of used resource.	How much would cost what we have already done on the project
Forecasting		

EAC — Estimate At Complete	$EAC = AC + ETC$ or $EAC = ACWP + ETC$ <i>Optimistic assessment:</i> $EAC = (BAC - BCWP) / CPI + ACWP$ <i>Pessimistic assessment:</i> $EAC = (BAC - CWP) / CPI * SPI + ACWP$	How much will cost the whole project depending on the cost of previous steps
ETC — Estimate to Complete	$ETC = (BAC - EV) / CPI$ BAC - it is planned (the budgetary cost), it is equal to cumulative value of the BCWS budgetary expenses	How much it is necessary to spend money to bring the project to end, proceeding from the budget of the project or the actual cost of the performed works
Performance Indices		
CPI — Cost Performance Index	$CPI = EV / AC$ or $CPI = BCWP / ACWP$	if indicator: > 1 — good (the cost of the performed works is less planned, within the budget) also testifies about "economy", but it is sometimes bad; < 1 — badly, the budget is spent too much; = 1 — good, the cost of the performed works corresponds to planned
SPI — Schedule Performance Index	$SPI = EV / PV$ or $SPI = BCWP / BCWS$	>1 — good (a schedule advancing)
TCPI — To Complete Performance Index	$TCPI = (BAC - EV) / (BAC - AC)$ or $TCPI = (BAC - EV) / ETC$ or $TCPI = (BAC - BCWP) / (BAC - ACWP)$	Shows efficiency in which resources need to be used for completion of works of the project
Variations		
CV — Cost Variance	$CV = BCWP - ACWP$ $CV = EV - AC$	How much money was spent from the budget for the project performance If indicator > 0 — it is good (expenses within the budget) <0 over expenditure of funds for the current date
SV — Schedule Variance	$SV = BCWP - BCWS$ $SV = EV - PV$	> 0 — it is good (a schedule advancing)
TV — Time Variance	Time Variance (TV) = Status Date— Date (BCWS =BCWP).	How sooner or later works of the project are performed on a significant date
VAC — Variance at Completion	$VAC = BAC - EAC$	A negative result indicates that the project budget is exceeded

Indicator of project completion		
<i>on planned costs by the formula</i>	PCI_B = BCWP / BAC , in which BAC - the general planned costs of the project;	
<i>on actual costs</i>	PCI_A = ACWP / EAC , in which EAC - Total estimated project costs that include the actual cost of a particular time and reconsidered estimated cost of the work which needs to be executed: EAC = ACWP + (BAC-BCWP)/ CPI	

Allocate 5 possible options of actions in case of project deviations from the plan:

1. Finding of the alternative decision. First of all it is necessary to consider the possibilities connected with increase in efficiency of works at the expense of new technology or organizational solutions. The new decision, for example, can consist in change of the sequence of performance of a number of works;
2. Viewing of cost. This approach means increase in amounts of works and purpose of additional resources. The decision can consist in increase in load of the existing resources or involvement of additional people, the equipment, materials. This approach is usually applied in case of need for elimination of temporary delays of the project;
3. Revision of terms. This approach means that the time of work performance will be postponed. The managers of the project can go to such decision in case of rigid restrictions on cost;
4. Revision of content of works. This approach assumes that amount of works on the project can be reduced and respectively only a part of the planned results of the project will be reached. We will note that this is not about revision of qualitative characteristics of the received results of the project;
5. Termination of the project. It is, perhaps, the most difficult decision. However it has to be accepted if the predicted expenses on the project exceed the expected benefits. The decision connected with the termination of the project besides purely economic aspects, is connected with overcoming the problems of psychological character connected with interests of various project participants.

TOPIC 7. Project Risk Management

7.1. Concept of risk and uncertainty. Classification of project risks.

7.2. Planning of management of design risks

7.3. Identification of risks

7.4. Analysis of project risks

7.5. Planning of response to risks

7.6. Monitoring and control of risks

7.1. Concept of risk and uncertainty. Classification of project

risks.

Uncertainty is an incompleteness or inaccuracy of information in conditions of implementation project, including the related expenses and results.

All aspects of life and business are connected with risks. In general the risk reflects deficiency of our knowledge of the forthcoming events. At the same time we call favorable events opportunities, and adverse - threats.

Project risks - set of the risks menacing to implementation of the investment project that can reduce its efficiency (commercial, economic, budgetary, social, ecological, etc.); set of circumstances under which the probability of project goals completion decreases or excluded.

Not only adverse events, but favorable are interested to project manager. Therefore we consider risk from the point of view of receiving losses and profit.

Risks can be "known" - those which are defined, estimated, for which planning is possible, and "unknown" - those which aren't identified and also can't be predicted. Though specific risks and conditions of their emergence aren't defined, experts in the sphere of project management know that the most part of risks can be predicted.

The risk has three main attributes. Characteristics of actions for determination of attributes of risk are provided in tab. 7.1.

Table 7.1

Characteristics of actions for determination of attributes of risks of the project

Risk attribute	Necessary actions
<i>Case</i>	It is necessary to understand the nature of risk and to define in what situations it can arise
<i>Probability of emergence</i>	To measure in quantitative (the probabilistic assessment of an event within 0-100% is conducted), is more rare in quality indicators
<i>Consequence</i>	To estimate how important will be consequences (influence of risks on cost, quality and duration of performance of work in case copes occurs)

Risk exposure — indicator which can be used in the course of decision-making and as the mechanism of risks control in the project:

$$VR = A * q,$$

where: VR - importance of risk;

A - threat (investigation, action) of risk (undesirable event)

q - probability of its occurrence.

Risk probability is a measure of an opportunity that a consequence (action) of risk will occur.

Risk impact is a measure of gravity of negative consequences, level of losses or an assessment of the potential opportunities connected with risk.

Table 7.2.

Types of risks, occurring at different stages of project life cycle

Stage	Risk types
<i>Pre-investment</i>	<ul style="list-style-type: none"> • An inaccuracy in development of the project concept • Wrong definition of the project arrangement • The attitude of local authorities to the project • Decision-making on expediency of investment
<i>Investment</i>	<ul style="list-style-type: none"> • Solvency of the customer • Unforeseen expenditures for construction works • Excess of terms of construction, equipment cost • Inopportuneness of supplies of equipment • Non-performance of contract obligations by contractors • Untimely training of personnel

<i>Operational</i>	<ul style="list-style-type: none"> • Emergence of an alternative product (service) • Insolvency of consumers • The volume and a segment of the market on which the project product is implemented are incorrectly determined • Change in price for raw materials and materials, transportations; salary • Change of capital cost and rate of inflation • Threat of ecological safety • Change of the population attitude to the project implementation
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7.2. Planning of project risks management

Project management assumes not only ascertaining of the fact of existence of uncertainty and risks and the analysis of damage. It is possible and it is necessary to operate risks of the project. Risk management - set of methods of the analysis and neutralization of factors of risks. Risk management is a subsystem of project management.

Risk management is the processes connected with risk identification and analysis and decision-making which include maximization of positive and minimization of negative consequences of risk events.

The purpose of project risks management is to increase probability of events, positive for the project, and decrease probability of adverse events.

Risk management is continuous process which happens at all stages of project LC.

According to PMBOK allocate the following processes project risks management:

1. **Risk management planning** - the choice of approaches and planning of activities for risk management of the project

2. **Identification of risks** - determination of the risks capable to influence the project, and documenting characteristics of these risks.

3. **The qualitative analysis of risk** - high-quality risk analysis and conditions of their emergence in order to define their influence on success of the project.

4. **Quantitative risk analysis** - the quantitative analysis of probability of emergence and influence of risks consequences on the project. Purpose of risk analysis - granting an assessment to all possible types of risks of projects

5. **Planning of response to risks** - development of the possible options and actions promoting increase in favorable opportunities and decrease in threats for achievement of the objectives of the project

6. **Monitoring and control is risk** - risk monitoring, determination of remained risks, implementation of the management plan by project risks and an assessment of actions efficiency on minimizing risks.

RISK MANAGEMENT PLANNING

Risk management planning - decision-making process on application and planning of risk management for the specific project.

At this stage of risk management the necessary and important are:

1. **Methodology.** Determination of approaches, tools and data sources which can be used for risk management in this project.

2. **Roles and responsibility distribution.** The list positional for execution of each type of the operations included to risk management plan, assignment of employees on these positions.

3. **Development of the budget.** Separation of resources and estimation of cost of the actions necessary for risk management.

4. **Periods.** Determination of periods and the frequency of execution of risks management processes, their inclusion to the project schedule.

5. **Categories of risks.** Structure on the basis of which systematic and all-round identification of risks with the necessary level of detailing is carried out.

For an assessment of risks the scale of risks measurement is accepted. Consider a scale of estimation of a risk probability (three-level (the tab. 7.3) scale of estimation of risk consequences (tab. 7.4).

Table 7.3.

Three-level distribution of probability of risk

Interval of probabilities	Value of probability	Verbal formulations	Numerical assessment
1-33%	17%	low	1
34-67%	50%	average	2
68-99%	84%	high	3

Table 7.4.

Scale of an assessment of risk influence for four purposes of the project

Project	Probability				
	Very low	Low	Average	High	Very high
The risk of failure to achieve project goals	0,05	0,10	0,20	0,40	0,80
Consequences					
Cost	Insignificant increase in cost	Increase in the cost <10%	Increase in the cost 10-20%	Increase in the cost 20-40%	Increase in the cost >40%
Terms	Insignificant increase in time	Increase in time <5%	Increase in time 5-10%	Increase in time 10-20%	Increase in time >20%
Content	Hardly noticeable reduction of contents	Influence on minor areas of contents	Influence on main areas of contents	Reduction of contents is unacceptable for the sponsor	The final product of the project is almost useless
Quality	Hardly noticeable decline in quality	Influence only on the most demanding applications	Decline in quality requires the sponsor's consent	Decline in quality is unacceptable for the sponsor	The final product of the project is almost useless

7.3. Identification of risks

Risks Identification defines what risks are capable to influence the project and documents characteristics of these risks. Identification of risks won't be effective if it isn't carried out regularly during the project implementation.

Purpose of Risk Identification & Quantification process is too definite what risks can influence the project and to document their characteristics.

There are such methods of risks identification:

1. Analysis of documentation (plans, archives of the previous projects)
2. Experience of experts.
3. Analysis of check lists.
4. Analysis of assumptions.
5. Display methods by means of charts.

3. Methods of creative generation of the ideas:

- "brainstorming" (10-15 people, 2 hours) (several meetings at division of the project into parts);
- the Delphi method (participants don't communicate, leader makes lists of questions and answers and distributes them)
- a method of nominal group (7-10 people, lists are formed anonymously and secretly, then discussed, and anonymously and secretly ranged)
- Crawford's cards (the group of 7-10 people, 10 questions which everyone has to answer differently, 10 times the same question is set).
- chart of affinity.
- TIPS (theory of inventive problem solving).

7.4. Analysis of project risks

Risk analysis - procedure of identification of factors of risks and an assessment of their importance, in fact, the analysis of probability that there will be certain undesirable events and they will negatively influence achievement of the project objectives.

Purpose of risk analysis - to give to potential partners necessary data for making decisions on expediency of participation in the project and development of measures for protection against possible financial losses.

QUALITATIVE ANALYSIS OF PROJECT RISKS

The qualitative analysis of project risks is definition of indicators of risk, stages of works at which there is a risk, definition of potential zones of risk and identification of risk; the description of all estimated risks of the project, and also the factors influencing their level.

High-quality risk analysis includes arrangement of priorities for the identified risks which results are used subsequently, for example, during quantitative risk analysis or planning of response to risks.

The main results of high-quality risk analysis are:

- Ranging of the general project risk.

- The list is risk on a priority.
- The list is risk for the additional analysis and management.
- Trends in results of risk analysis.

The main method - classification of risks (the qualitative description of risks on various signs).

High-quality risk analysis assumes quick and low-cost establishments of priorities of the revealed risks, proceeding from probability of their emergence and the corresponding their influence on the project purposes in case risks arise. It also lays the foundation for scheduling with risks and for their quantitative analysis if such is necessary (fig.).

Probability	Threats					Opportunities				
0,9	0,05	0,09	0,18	0,36	0,72	0,72	0,36	0,18	0,09	0,05
0,7	0,04	0,07	0,14	0,28	0,56	0,56	0,28	0,14	0,07	0,04
0,5	0,03	0,05	0,010	0,20	0,40	0,40	0,20	0,010	0,05	0,03
0,3	0,02	0,03	0,06	0,12	0,24	0,24	0,12	0,06	0,03	0,02
0,1	0,01	0,01	0,02	0,04	0,08	0,08	0,04	0,02	0,01	0,01
	0,05	0,10	0,20	0,40	0,80	0,80	0,40	0,20	0,10	0,05

Matrix of probability and influence

In the table of risks the next colors are used to visualize priorities of risks:

1. Green = Low risk.
2. Yellow = Average risk.
3. Red = High risk.

QUANTITATIVE ANALYSIS OF PROJECT RISKS

The quantitative analysis of project risks - direct calculations of changes of project efficiency in connection with risks; defines probability of risks emergence and influence of risks consequences on the project, helps group of project managers to make truly decisions and to avoid uncertainty.

The quantitative assessment of risks allows defining:

- Probability to achieve an ultimate goal of the project

- Extent of risk influence on the project and volumes of contingencies and materials which can be necessary
- Risks requiring the fastest reaction and bigger attention, and also influence of their consequences on the project
- Actual expenses, estimated completion dates.

The main results of quantitative risk analysis are:

1. The list of quantitative risks on a priority
2. Possible analysis of the project
3. Trends in results of quantitative risk analysis.

Various methods of quantitative risk analysis on the project are used (the tab. 7.5).

Table 7.5.

Characteristic of the most widespread methods of quantitative risk analysis of the project

Method	Method characteristic
Probabilistic analysis	The probability of emergence of losses is defined on the basis of statistical data which preceded risky period, sufficiency of investments, risk coefficient
Expert analysis	The method is applied in case of absence or the insufficient volume of initial information and consists in involvement of experts for an assessment of risks
Method of analogs	Use of the database after the realized similar projects in order to transfer their effectiveness on the developed project
Analysis of scenarios of project development	The method assumes development of several options (scenarios) of project development and their comparative assessment. The pessimistic option of possible change of variables and optimistic and most probable option are calculated
Method of "tree of decisions"	Provides step by step branching of the project implementation process by assessment of expenditures, losses and advantages
Analysis of indicators of limit	Determination of stability level on the project in relation to possible changes of conditions of its implementation
Analysis of project sensitivity	The method allows to evaluate how resultant indicators of project implementation change in case of different values of the given variables necessary for calculation
Imitating methods	Are based on step by step finding of value of a resultant indicator due to carrying out repeated experiences with model

7.5. Risk response planning

Risk response planning – is a development of methods and technologies of decrease in negative impact of risks on the project.

Takes the responsibility for efficiency of project protection against influence of risks on it. Planning includes identification and distribution of each risk on categories.

Planning of risks response is a definition of steps which should be undertaken to strengthen positive consequences of risk events and to weaken their negative consequences.

Planning includes identification and distribution of each risk on categories. Efficiency of development of reaction directly defines whether there consequences of risk impact on the project will be positive or negative.

The strategy of response planning has to correspond to types of risks, profitability of resources and parameters in time. The questions discussed during headquarters have to be adequate to tasks at each stage of the project and be coordinated with all members of project management team. Of course several options of strategy of risks response are necessary.

You shouldn't develop a set of anti-crisis measures on each possible and impossible risk in the project. Otherwise you will receive the huge list of works on the project, increasing the term of its performance at least twice.

Risks include the threats and favorable opportunities capable to influence success of the project implementation, and ways of reaction are considered for each type separately.

There are several strategies of risks response (tab. 7.6.). For each risk it is necessary to choose strategy or a combination of various strategies the most effective to work with it.

Table 7.6.

Strategy of response to risks

Strategy group	Strategy type
1. Strategy of response to negative risks (threats)	<ul style="list-style-type: none"> ❖ Avoidance ❖ Transfer ❖ Reduction
2. Strategy of response to positive risks (favorable opportunities)	<ul style="list-style-type: none"> ❖ Use ❖ Sharing ❖ Strengthening

3. The general strategy of response to threats and favorable opportunities	❖ Acceptance
4. Strategy of response to unforeseen circumstances	

In practice usually allocate four methods of risk decrease:

1. Avoidance - simple evasion from activity or circumstances which contain risk;
2. Transfer - transfer of responsibility for risk to other party;
3. Minimization - carrying out own special measures to restrict the extent of risk, creation of special systems to prevent risk;
4. Acceptance - preservation of responsibility for risk, readiness and ability to cover all possible losses at the expense of own means.

7.6. Risks monitoring and control

‡ **Risks monitoring and control** is a process of identification, analysis, planning of new risks, tracking the identified risks, and also those which are in the list for constant observation, check and performance of operations of risks response and for estimates of their efficiency during project life cycle.

Purpose of risks monitoring and control process – to develop options and actions which would raise opportunities and reduce threats for the project.

One of the main tasks of monitoring and control during a project cycle is identification of risks, determination of residual risks, ensuring implementation of the risk plan and an assessment of its efficiency taking into account decrease in risk. The indicators of risks connected with the plan implementation are fixed.

The purpose of monitoring and control is to define whether:

- the system of risks response is used according to the plan;
- reaction is effective or changes are necessary;
- there is a change of risks in comparison with the previous value;
- there is an influence of risks;
- necessary measures are taken;
- influence of risks was planned or it was random result.

After identification of risks and development of preventive measures for their overcoming the risk has to improve its parameters. In the course of monitoring and risk management various techniques are used, for example *the analysis of trends and deviations* for which data on execution collected in the course of project implementation is necessary and visualization of risks migration (it is carried out in a matrix of risks).

TOPIC 8. Project Quality Management

8.1. A concept of quality in the context of design management.

8.2. Project Quality Planning

8.3. Project Quality Ensuring.

8.4. Project Quality control

8.1 Concept of quality in the context of design management.

The word "**quality**" is often used to designate elitism, high cost, compliance to the most exacting wishes of consumers.

The international ISO 8402 defines quality as set of the properties and characteristics of an object guaranteeing his opportunity to satisfy obvious and implicit needs of consumers.

It is necessary to understand accurately a difference between quality and a grade. Quality is "degree in which set of internal characteristics conforms to requirements".

‡ **The Grade** is a category or a rank which is appropriated to production having identical functional properties, but various requirements to qualitative characteristics.

Poor quality is always a problem, a low grade - No. For example, the program can be of very high quality - without obvious mistakes and with the good description, but of a low grade as it has a small number of functions, or it can be of poor quality - frequent failures, insufficiently complete description, but of a high grade thanks to variety of functions.

The project manager and project management team are responsible for definition and ensuring both the quality, and grade demanded levels.

🏠 **Project Quality** is degree of compliance of all its characteristics to project requirements.

The quality of a product is the main parameter of project quality, being result of project implementation. **Product Quality** of the project means compliance to requirements of the consumer (the customer's purposes).

Distinctions between Project Quality and Product Quality:

- A high-quality product - a product which completely satisfies specifications.
- The high-quality project - the project which remains in project triangle at the end and is executed according to rules of the performing organization.

Key aspects of quality:

1. Product quality of the project as compliance to market requirements and expectations of consumers.
2. Development and project planning quality.
3. Quality of performance of work on the project according to planned documentation.
4. Resources quality involved in project implementation.
5. Quality of product operation of the project.
6. Quality of production development of the project.
7. Quality of product utilization and processing after use.

In foreign practice concerning quality of the project allocate two basic elements.

1. Compliance to the project objectives.
2. Compliance to requirements of consumers.

The philosophy of TQM is fully reflected in the principles of TQM:

1. Orientation of the organization to the customer.
2. Leading role of the management.
3. Involvement of employees.
4. Process approach.

5. System approach to management.
6. Approach to decision-making, factual.
7. Relations with suppliers.
8. Minimization of the losses connected with low-quality work.

Main components of **TQM** (Fig. 8.1.).

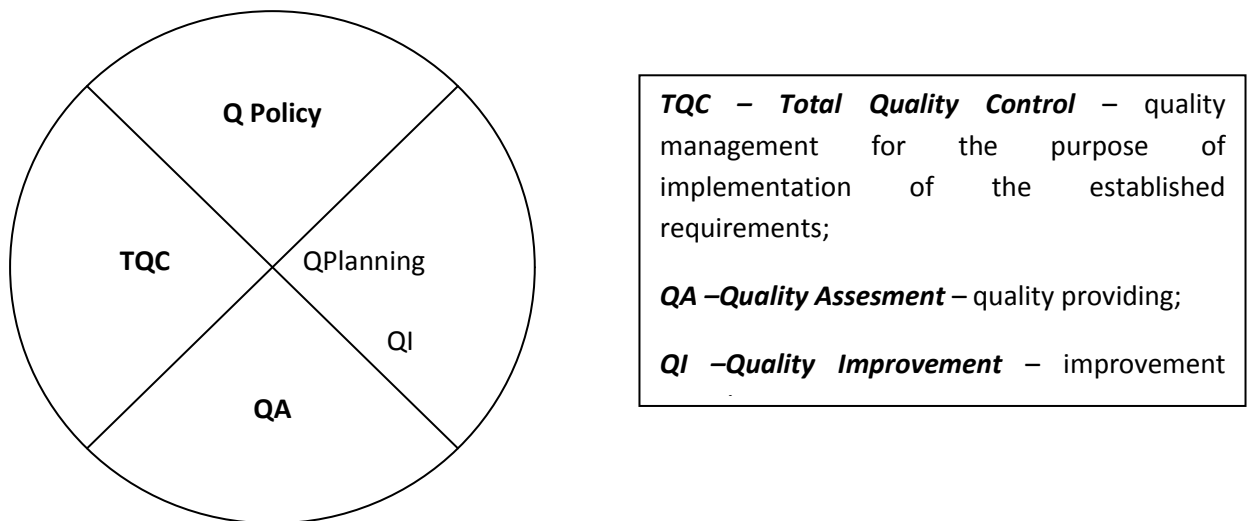


Fig. 8.1. The main concepts of quality management

8.2. Project Quality Planning

The main work which faces the project team at the planning stage - to set the accurate objectives of the project in the field of quality and to make the plan of their achievement.

👑 **Quality Planning** defines what quality standards need to be applied to this project and how to achieve compliance to them; process of requirements definition and/or the quality standards for the project and a product, and also documenting of how the project will show compliance to the established requirements and standards.

One of the fundamental principles of modern quality management - quality is planned, but not checked.

For effective quality planning it is necessary to have the following basic data:

- *Quality Policy* - common goals and the directions of the organization with emphasis on quality are formally expressed by management of the top level. If in the

organization which is carrying out the project there is no official quality policy or many executive organizations are involved in the project (as in joint venture), then the project management team needs to develop immediately quality policy for this project.

- *The description of contents of the project* is key parameter when planning quality as the main results and objectives of the project are documented in it - necessary information to define the main requirements of interested persons.

- *Description of a product*. Though elements of the product description can be included in the description of project contents, the description of a product often contains details of technical results and other important details which can influence quality planning.

- *Standards and norms*. The International Organization for Standardization defines standards and norms in the following way:

⌚ **The standard** is the document of the general and reusable use approved by the relevant organization having rules, the managements or characteristics for products, processes or services and is not obligatory for observance.

⌚ **Norma** is a document which is the cornerstone of the required properties of a product, process or services, including applied administrative procedures, and this document is obligatory for observance.

- *Results of other processes of planning*. For the description of contents of the project and product the results of processes in other branches of knowledge of project management have to be considered as a part of planning of the project.

There are a number of **methods of quality planning** in projects:

1. "Quality chain".
2. Repeated Improvement (PDCA cycle).

This method is the practical embodiment of the principle of continuous quality improvement in realization of the well-known PDCA cycle developed by Edward Deming

3. Principle of zero defects
4. Price of discrepancy and price of compliance

5. Analysis of an income / expenses.
6. Comparison with a sample
7. Schedule of streams
8. Causative - consecutive charts, or Ishikava's charts, or the "fish bones «chart, showing how various reasons and sub reasons connected with emergence of potential problems or consequences.
9. Statement of experiments
10. Check cards
11. Development of flowcharts.

Results of quality planning are:

- Management quality plan
- Quality metrics
- Check lists of quality - the structured document which usually belongs to a concrete element which is used to confirm the execution of all planned actions.
- Plan of project improvement
- Updates of project documents.

⌘ **The quality management plan** is a document which regulates concrete measures in the quality sphere, resources and their sequence about production, project or the contract.

8.3. Ensuring quality of the project.

⌘ **Ensuring quality** is a regular check in the course of project implementation to establish compliance to the quality requirements defined earlier; it is system of the consecutive planned and realized works for confirmation that the project satisfies the corresponding standards; an assessment of the general project implementation on a regular basis for confirmation that the project satisfies the quality standards.

Purpose of the project - introduction of the planned, systematic operations which provide use in the project of all processes necessary for implementation of quality requirements.

The result of planning quality is created plan of organizational and technical actions for providing the project quality system where the aspects of ensuring quality in the project are listed in the table and where they need to be included:

- *The description of control and research procedures*, and also the list of control indicators on all works and types of production. The quality plan can also include technological cards of separate difficult processes;

- *Ensuring quality* - regular check in the course of project implementation for confirmation that ensuring quality of the project meets the quality requirements. This process comes out earlier approved quality plan, and also data on quality received as a result of control.

There are a number of management methods which can be used for ensuring quality of the project.

- 1) Benchmarking.
- 2) Riverside games.
- 3) Cyclic correction.
- 4) Quality circles.
- 5) Tools and methods of quality planning and quality control

8.4. Project quality control

⌚ **Quality control** is a tracking of certain results on the project to establish whether they conform to the quality standards, and to define ways to eliminate the reasons of unsatisfactory execution; tracking's of concrete results of activities for the project to define their compliance to quality standards and requirements and to define ways to eliminate of the reasons of discrepancies.

Quality control uses such methods and tools:

- 1) Quality audit

⌚ **Audit of quality** is the systematic and independent analysis allowing to define compliance to the planned activity and results in the quality field and also efficiency of their introduction and extent of achieved goals; it is structured, independent check

which defines whether operations of the project correspond the rules established within the project or the organization, processes and procedures.

Audit allows to establish the reasons of discrepancies and to develop measures for their elimination. Quality Audits are divided into *planned* (at least once a year) or *unplanned* (in case of uncertainty in efficiency of quality system functioning).

1) Check lists. Are used for collecting large volume of primary information for the purpose of the further statistical analysis.

⌚ **Check list** is a simple table in which it is necessary to mark existence or numerical value of some parameter (parameters) with the given frequency (for example., once in an hour).

3) Checkcards.

⌚ **Checkcards** - the graphic representation of nature of quality indicator change in time.

They are:

- checkcards on quantitative features
- check cards on qualitative features.

4) Pareto's charts.

⌚ **Pareto's chart** is the histogram ordered on the frequency of emergence of certain factors by each result, it allows to concentrate attention on the few important factors.

5) ⌚ **Histogram** is the vertical stylar chart displaying distribution of variables. Each column represents the parameter or property of a problem / situation. Height of each column designates the relative frequency of property. This tool illustrates the most frequent cause of problems of process by quantity and relative height of columns.

6) Trend charts. As well as the check card without the reflected borders, the trend chart reflects history and the nature of changes. The trend chart represents the linear schedule reflecting points of the data located on graphics as their emergence. The trend chart gives an idea of tendencies, fluctuations in time, and also about positive and negative changes of process in time.

7) Self-assessment. The self-assessment can be carried out as single complex action with development and adoption of recommendations for activity improvement.

8) Inspection is a check of work product for definition of compliance to the documented standards.

Quality control in the project can be completed with such actions:

- Adoption of results of works or project in general;
- Identification of violations and realization of actions for management of inappropriate processes and results;
- Processing of results for the purpose of the subsequent control;
- Correction of processes.
- measures for quality improvement.
- introduction of changes to processes.

TOPIC 9. Human resource management in the project

- 9.1. *Processes of human resource management.*
- 9.2. *Project team selection*
- 9.3. *Project team development*
- 9.4. *Team motivation*
- 9.5. *Conflict management*

9.1. Processes of human resource management.

Generally, *project human resources* is a set of professional, business, personal qualities of project participants and team members of the project and their opportunities (influence, "weight", communications, etc.) which can be used at project implementation. A manpower is a part of human resources, is considered as the measured resource in the project. The personnel are concrete individuals whose part is their qualification, execution is functional duties, etc., it is described within the staff list of the project.

‡ **Project human resource management** includes processes of organization and management of project team.

Processes of project human resources management (tab.9.1.):

- Planning of human resources management - process of identification and documenting of roles, responsibility, required skills and the accountability, and also creation of the human resources management plan.
- Project team selection- process of confirmation of human resources availability and the team necessary for tasks performance on the project.
- Development of project team - process of improvement of competence, interaction of project team members and the general operating conditions of team to increase efficiency of project implementation.
- Project team management - the process of tracking of team member's activity, providing feedback, the solution of problems and management of changes directed to optimization of project implementation.

The main spheres of human resource management in projects are:

- project manager leadership;
- development of team and group work;
- motivation of individuals and group;
- conflict management.

🏠 **The manager** - the head holding a constant position in project team has authority in the field of decision-making on concrete types of activity.

🏠 **Leadership** is an ability to exert impact on certain individuals and groups, directing their efforts to achievement of set goals; it is ability to mobilize potential psychological needs of followers (subordinates) and to rely on them at the time of sharp rivalry or conflict.

9.2. Project team selection

🏠 **The project team** is a group of the employees who directly work on the project implementation and are subordinated to the project manager; it is group of the people having high qualification in a certain area who are the most devoted to an overall objective of activity of the organization for which achievement they act in common, mutually coordinating the work .

Allocate the following types of management teams: traditional and informal teams, formal and project teams (tab. 9.1.).

Table 9.1

Types of management teams

Team type	Voluntary association	Formal regulation of activity	The nature of the structure	Unity of the purposes and tasks	Leadership
Traditional team	No	Yes	Stable	Middle	head of department
Informal team	Yes	No	Stable	High	The informal leader who has real levers of power
Formal team	No	Yes	Stable	Absent or not coordinated	Formal leadership
Project team	No	Yes	Temporary	Depends on motivation	Project Manager

The traditional team is a stable group of people under direct supervision of the head who solves tactical and strategic problems of structural department. *The informal team* consists of the employees of various departments which are at the different levels of hierarchy but are united voluntarily and it allows solving the tactical and strategic problems facing the leader. *The formal group* is future team or unsuccessful attempt of formation of management team. In formal group there are expressed signs of problem team, employees occupy psychological, but not administrative niches. *The project team* consists of the employees of various structural departments and enterprises (partners and customers) who are integrated within the project. The team exists till the project realization. After achievement of the project objectives team is disbanded. Thus, the project team is temporary, formally regulated group of experts created for existence of a project plan and is subordinated to the project manager. *In organizational structure of large projects and in their management three types of project teams are possible:*

1. The Project Team (PT) - the organizational structure of the project created for implementation of the project or one of phases of its life cycle. A task of the project team management is development of policy and the adoption of strategy of the project for achievement of its objectives. The project team includes persons representing the interests of various project participants (including stakeholders).

2. The Project Management Team (PMT) - organizational structure of the project, including those members of PT who are directly involved in project management, including representatives of some project participants and technical staff. In rather small projects PMT can include practically all members of PT. A problem of PMT is performance of all administrative functions and works in the project in the course of its implementation.

3. The Project Management Team (PMT) - organizational structure of the project, headed by chief manager of the project and created for project implementation or its life cycle phase. The project team includes individuals who are directly involved in managerial and other functions of project management. The main tasks of project management team are implementation of policy and the strategy of the project, realization of strategic decisions and tactical (situational) management.

🏠 **Project team selection** is a process of confirmation of human resources availability and the team necessary for performance of project tasks.

Process of "project team selection" should be carried out together with the processes of decomposition of project activities: development of the control events plan, list of project actions etc.

Complexity of creation and development of effective PMT is connected to the fact that it takes a triple position in case of project implementation:

1. from the standpoint of systematic approach: PMT is the subject of management in relation to processes and management objects (subject - object relations) in the project with all its tasks and functions.
2. from the standpoint of psychological approach: PMT is self-governed and self-developed subject - subject relations). Within PT it is defined by self-developed, self-oriented and self-motivated PMT.
3. from the standpoint of project approach: PMT is a developing technology element of the project.

On the other hand, PMT is a basis of any technology of project management and represents the integrated set of diverse elements.

Main goal of team formation is independent management and solutions of the

problematic issues arising during project implementation. This process can't be implemented at once, but for a long time. Quite often manager prevents the effective team work.

Results of team project selection:

1. Appointment of the project personnel.
2. The resource calendars. To specify the availability of resources in resource calendars the periods of time are documentally fixed during which each member of the project team can participate in the project.
3. Renewal of the project management plan. Project management plan elements which can be updated include, among other things, the human resources management plan.

9.3. Project Team Development

‡ **Project Team Development** includes either increase in opportunities of its certain members to make the contribution to success of the project, and improvement of interaction in project team; it is process of professional development of project team members, improvement of interaction between them and improvement of the general operating conditions of team to increase efficiency of the project.

Project managers must be able to identify, form, support, motivate, lead and inspire the project team to improve their performance and achieve the project objectives.

The purposes of project team development:

- improvement of knowledge and skills level of team members to enhance their ability to achieve results of the project during reduced cost, short terms and improved quality;
- strengthen the sense of trust and cohesion among team members to increase moral spirit, reduce conflict and improve teamwork;
- creation of dynamic and cohesive team culture to improve both individual and team productivity, stimulate team spirit and cooperation and also creation of the opportunities for mutual training and mentoring aimed at exchange of knowledge and experience among team members.

Professional development is a process of preparation, retraining and advanced training of employees in order to perform new production functions, tasks and duties at a new position in the project.

There is a significant amount of methods and forms of development of professional knowledge and skills. In practice allocate two main groups (tab. 9.2.):

1. training methods used in the course of work (training at a workplace);
2. training methods out of a workplace (except duties);
3. methods which are equally suitable for any of these options.

There are 5 stages of team development.

1. **Forming.** Team participants get acquainted with the project scale, the formal roles and responsibilities. On this phase they are, as a rule, independent from each other and not open; they begin to establish basic rules, try to define what behavior it is necessary to observe in the project and in interpersonal relationships.

2. **Storming.** The team begins to study project works, technical solutions and approaches to project management. If team members aren't ready for cooperation and aren't open for various ideas and prospects, the situation can become destructive. High degree of internal contradictions is connected with this stage. Workers agree that they are a part of group of the project, but opposed to restrictions which the project and group impose on their identity. There is a contradiction on who will lead group and how decisions will be made. When this contradiction is solved, and leadership of the project manager is accepted, the group passes to the following stage.

3. **Normalizing.** Team members begin to work together, adjusting their working habits and behaviors so that to promote teamwork. Team members begin to trust each other, the team shows unity. This stage comes to the end when the structure of team is strengthened, and the general system of expectations and criteria how members have to work together is made.

4. **Performing.** Team which have reached the Performing stage function as well-organized unit. They are independent, and, at the same time, are capable to solve problems effectively.

5. **Transforming.** At this stage the team finishes work and passes to the following project.

Table 9.2

Methods of personnel training in projects

Training at a workplace	Training out of workplace
Copying - the worker is attached to the specialist, studies, copying his actions. Instruction - an explanation, work demonstration directly in a workplace. Method of the complicating tasks – a special program of work actions based on their degree of importance, volume expansion and increase in complexity of tasks. Mentoring - manager teaches personnel during daily work, helps, gives advice. The delegation - transfer of the employees clearly a limited number of tasks with the power to decide on the agreed range of issues. Rotation - the employee is transferred to a new job or a position for further expansion of professional skills and experience for a period of several days up to several months. The use of education methods, guidelines.	Business games - analysis of an educational example during which participants of a game receive roles in a business situation and consider consequences of decision-making. Educational situations - the real or thought-up administrative situation with questions for the analysis. Modeling - reproduction of real working conditions. Sensitivity training - participation in group in order to increase human perception and improve interaction with others. Lecture - a monologue of the instructor during which the audience perceives material aurally. Independent training - the worker himself chooses rate of training, the number of repetitions. Role-playing games - the worker puts himself to the place of another for the purpose of obtaining practical experience.

9.4. Team Motivation

The personnel management system of the project will not work effectively if the effective model of motivation isn't developed.

⌚ **The motivation** is a stimulation of the person or group of people to intensify work for achievement of the objectives of the organization (project); it is set of forces that encourage the person to be engaged in activity with the consumption of some effort at the certain level of diligence and conscientiousness with a certain degree of persistence directed to achievement of certain goals.

Basic principles of motivation:

- the motivation represents force, which makes people behave definitely;
- this force is directed to achievement of certain goals;
- motivation is better understood within a certain system.

To strengthen the motivation of team members and overcome difficulties of project implementation use factors called 5 "P":

- purpose;
- proactivity;

- profit sharing;
- progression;
- professional recognition.

Purpose. The worker must have conviction in importance of work which he performs and to understand the role in the organization. It levels shortcomings of influence of motivation factors in matrix structure.

Proactivity. As development of career - rather indistinct, the worker himself wants to operate development of the career. Delegation of powers depending on a task gives to subordinates the chance to feel responsible for the development. An important factor is also providing to the worker the right to choose the following project in which he will participate, as encouragement for achievements during the embodiment of the previous project.

Profit sharing. Many organizations give the chance to workers to participate in profits, it stimulates better productivity of their work, and they show an initiative as they feel the direct influence on results of activity of the organization.

Progression. When the person reaches top of Maslow pyramid (self-realization), considers each new project as an opportunity to expand the knowledge and experience.

Professional recognition. It is the indicator of workers achievement. As in planar structures the chief manager has no direct contact with performers, it is important for them to make the results of their work and professional qualities know.

9.5. Conflict Manager

In the conditions of the project conflicts are inevitable. A lack of resources, arrangement of priorities by drawing up the schedule or personal style of work can become sources of the conflicts. Existence of the principles, norms and established practices of project management accepted in team, for example planning of communications and definition of roles, promotes decrease in number of the arising

conflicts. Successful settlement of the conflicts results in more high efficiency and positive working relationship.

‡ **Conflict** — lack of a agreement between two or several subjects, collision of the opposite sides, forces which can be concrete persons or groups of workers, and also internal discomfort of one person.

Conflict can be positive if it:

- is a basis to start a discussion on different issues;
- in solving an issue;
- improves relations between people;
- enables to remove tension;
- enables employees fully disclose their potential.

Conflict can be negative if it:

- prevents people from solving important issues;
- causes a feeling of dissatisfaction in the team;
- leads to personal or group isolation and prevents understanding.

Conflict stages:

- I. The emergence of objective conflict situation
- II. Understanding of the conflict
- III. Conflict actions
- IV. Removal or resolutions of conflict.

‡ **Conflict management** is a deliberate action on elimination (minimization) of the reasons of the conflict emergence, or correction of participants behavior.

Success of project managers in project team management often depends on their ability to resolve the conflicts. Different project managers can have different styles of conflicts resolution.

There are a large number of methods of conflict management. In less detail they can be presented in the form of two groups:

I structural (explanation of requirements to work, use of coordination and integration mechanisms, establishment of the common organizational complex goals, use of system of remunerations).

II. Interpersonal (5 styles of behavior):

1. Avoidance;
2. Adaptation;
3. Compromise;
4. Forcing;
5. Solution (*tabl.9.3*).

Table 9.3.

Five models of conflict management

<i>Model</i>	<i>Result</i>
Avoidance	Temporary, doesn't solve a problem
Adaptation	
Compromise	
Forcing	Provides conflict resolution
Solution	

Avoidance method. When a person tries to move away from conflict avoid the situation that provokes controversy and avoid discussions that lead to conflict.

Adaptation method. This style is characteristic at natural unwillingness to avoid the conflict, it is necessary to encourage a sense of community in the group.

Compromise method. It is characterized by adoption of the point of view of other party, but to a certain limit. The project manager can effectively use it at official negotiations on the contract and at informal negotiations with participants of the project.

Forcing method. Forced to adopt a point of view. This style is effective when the head has the big power over subordinates.

Solution method. The recognition of differences of opinion and willingness to get acquainted with other points of view to understand the cause of conflict better and to find the way o acceptable to all. The solution is synthesis of all methods of conflict management and is used when there is enough time and there is a trust between the conflict parties.

Conflicts solution is elimination in whole or in part of the reasons which provoke a conflict situation.

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