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TECHNICAL RISKS

LECTURE NOTES

Recommended by the Methodological Council
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in the educational program "Electromechanical and Mechatronic systems of energy-intensive industries"
on specialty 141 "Electricity, electrical engineering and electromechanics"

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TECHNICAL RISKS

LECTURE NOTES

Technical risks: Lecture notes. [Electronic resource]: textbook for master's candidates for the educational program "Electromechanical and Mechatronic Systems of Power-intensive Industries" / O. M. Terentiev, A.Y. Kleshchov, V.O. Polishchuk; Igor Sikorsky Kyiv Polytechnic Institute - Electronic text data (1 file: 0.167 MB). - Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2019. - 77 p.

The presented lecture notes outlines the main provisions of the discipline "Technical Risks" in the production. Specific examples of their calculation are given. The attention has provided to the peculiarities of prediction and prevention of typical emergencies in the operation of technical innovations in the production. The material is intended for students of higher educational establishments, postgraduate students and engineers who participate in the creation and operation of electromechanical and mechatronic systems of energy-intensive industries, specializing in "Electricity, electrical engineering and electromechanics".

CONTENT

List of symbols, units, abbreviations and terms

Duration is the average weighted duration of the repayment of funds received with the account of the cost of payments discounted now [14].

Leverage (operational) - an indicator of what proportion of fixed costs (costs) in the operating cycle of the production process [14].

Hedging is the practice of concluding futures or options exchanges of urgent deals for the sale or purchase of currency or securities for insurance against possible future fluctuations in prices or interest rates [14].

Selengh is a two-way process, which represents a specific form of duty, which is regulated by a contract of property hiring and consists in the transfer of the owner of his rights to use and dispose of his property selengh - a company for a fee. In this case, the owner remains the owner of the transferred property and may, at the first request, return it [14].

SCR - risk management systems.

CAPM (capital asset pricing model) - an assessment of the profitability of assets.

Debt free cash flow is the current value of the debtor's flow.

Net present value (NPV) - Net present value of the project

NPV (Net present value) - Net present value

FV (Future value) - future value.

PMBoK (Project Management Body of Knowledge) - USA Design Standard

PV (Present value) is a true value.

R (Rent) - interest rate.

VaR - Value-At-Risk - risk assessment method.

WACC (Weighted average cost of capital) is the weighted average cost of capital.

INTRODUCTION TO THE MATERIAL OF LECTURES

The purpose of the credit module is to provide students with the knowledge, skills and experience in mastering of the theoretical and practical aspects of industrial safety management. The course of lectures has based on the analysis and prevention of risk situations in the production. During the training, students receive

knowledge:

- physical bases of the theory of determination of operational risks of electromechanical equipment;
- peculiarities of occurrence risk situations at operation of electromechanical equipment;
- the order of trouble-free operation of plants and machines with a certain minimum risk;
- rules of safety, devices and technical maintenance of electromechanical equipment;
- the basics of designing installations with reduced risk of occurrence of emergency events;
- scientific and technical directions and reduction of occurrence of risk situations, protection of the environment and labor protection.

skill:

- technically correct and reasonably determine the risks of operation of installations and systems;
- to carry out calculations of optimal parameters without risky operation of electromechanical equipment;
- to carry out the analysis of trouble-free modes of operation of machines using a PC

experience:

- execution of calculations for the design of installations, the choice of the main and auxiliary equipment for risk prevention;
- determination of the accident-free mode of operation and indicators of equipment operation.

Particular attention has been paining to the methodological and methodological issues of calculating the technical, operational, risks of potentially dangerous objects of the techno sphere. Providing training for students on a set of issues related to the fundamentals of the theory of technical risks in the study of basic parameters, computer modeling, design and operation of electromechanical equipment used in industry, transport, and construction.

The lecture course prepared individual semester research papers (tasks) for the creative work of students on the course work program. They are performing with the support of the teacher outside the classroom work. Their selection and execution allow them to prepare scientific publications in professional journals for enhancing of the creative component in the assessment of student knowledge.

Students as desired select topics for individual assignments. The implementation of individual research tasks has been aiming at consolidating the skills of design work, the preparation of engineering calculations and practical recommendations for the introduction of development in production. During individual classes, students gain experience in the use and consolidation of knowledge and skills of the discipline. After completing the individual semester assignment, the student using any text editor prepares a report with the requirements of DSTU 3.008: 2017 Documentation “Reports in the field of science and technology. Structure and design rules”. It is harmonized with the international standard ISO 5966: 1982 "Documentation-Presentation of scientific and technical reports", and is used by specialists from the most advanced and developed countries such as USA, Japan, France, Germany, Canada, the Netherlands, Belgium and others.

LECTURE 1. QUALIFICATION SYSTEM OF RISKS

INTRODUCTION

The task of the employer, in accordance with the **Law "On Occupational Safety"** (20.06.2001) is a guarantee of safety and protection of the life and health of workers at the enterprise. As well as the organization of the working environment in accordance with the Cabinet of Ministers Regulation No. 379 "**Procedure for conducting internal supervision of the working environment**" (August 23, 2001).

The risk assessment is also provided for by the European Union's basic directive 89/391 / EEC. In addition, subject to it special directives on occupational safety and health (89/654 / EEC, 89/655 / EEC, 89/656 / EEC, 90/269 / EEC, 90/270 / EEC, etc.) and directives on the protection of workers from chemical, physical and biological risks (98/24 / EC, 2000/54 / EC, 2002/44 / EC, etc.). The main provisions of the analysis and risk assessment and management are included in the following international standards:

- environmental Management Standard **ISO 14001** ("Environmental management system standards");
- quality standard ISO 9001 ("Quality systems: Model for quality assurance in design, development, production, installation and servicing" - Model for quality assurance in design, development, adjustment and maintenance);
- occupational Health and Safety Management System **OHSAS18001** (Occupational Health and Safety Assessment series, Hygiene and Safety Assessment).

Documents of the European Union "Health and Safety" (EU DOC / 05/20/97) provide a general approach to the assessment of the risks that may arise in the production environment. These provisions and recommendations have been reflected in the "Guidance on risk assessment at work", Luxembourg: Office for Official Publications of the European Communities, 1996-2000.

1.1 The concept of risk

Risk or **level of risk** is the combination of the frequency or probability and the consequences of a particular hazardous event [1, 2].

That is, the notion of risk always includes two elements:

- probability of an event or frequency with which a dangerous event occurs;
- and the consequences of a dangerous event.

The risk of R has been writing in the symbolic form [1]:

$$R = Q \times p, \tag{1.1}$$

where Q - the probability of an event (frequency with which a dangerous event occurs);

p - consequences (amount of losses).

The risk also has been describing by the equation [2], which takes into account:

- presence of danger;
- avoiding risk;
- severity of risk

$$R = E \times A \times S, \tag{1.2}$$

where E (Existence) - probability of existence of a certain risk;

A (Avoidance) - Likelihood of Avoidance;

S (Severity) - a category that determines the severity of the risk.

1.2 Classification of risks

The most typical of the following risks in the working environment [3]:

- unimagined (unpredictable) risk;
- reasonable (predictable) risk;

- the risk of environmental pollution.

The qualification system of risks includes:

- groups;
- species;
- varieties;
- categories;
- subspecies.

Depending on the possible outcome (risk event), risks have been dividing into two large groups:

- net (clean);
- speculative.

Net risks mean the possibility of obtaining a negative or zero results.

These risks include:

Net risks mean the possibility of obtaining a negative or zero result.

These risks include:

-**natural-ecological** (risks associated with the manifestation of natural factors: earthquake, flood, storm, fire, epidemic);

-**fabricated (produced) and ecological** (risks associated with changes in the environmental situation from uncontrolled human intervention in the environment);

-**political** (risks related to the political situation in the country and the activity of the state.);

-**transport** is the risks associated with the transport of goods by transport;

-**commercial** (risks of losses in the process of financial and economic activity, property, production, trade).

Speculative risks are the possibility of obtaining both a positive and a negative result.

These risks include:

-**financial risks** that are part of commercial risks.

The Risks have can be managed, that is, to use various actions that allow predicting the occurrence of a risky event and taking measures to reduce risk.

1.3 Characteristics of certain categories of risks

The main technical risks and ways to reduce their impact have given in Table 1.1.

Table 1.1. - Technical risks and ways to reduce their impact

Types of risks	Negative impacts	Ways of reducing risks
1	2	3
1. Outdated equipment	Increasing the cost of repairs and upgrades	Reserved material and time resources
2. Instability of quality services	Loss of customers, demand problems and sales.	Insurance (Implementation of Labor, Administrative, Technological, Production disciplines).
3. Use Innovation technologies	Increased costs for their development	Analysis and diagnostics of innovative technologies
4. Unreliability of components	Opportunity of unforeseen emergency	Insurance
5. Lack of reserve capacity	Not covering peak demand	Insurance

If such categories of risks are:

- natural-ecological;
- fabricated (produced);
- ecological;
- transporters do not need additional explanations, then other categories should be described in more detail.

Property Risks are the risks associated with the probability of loss of property through:

- theft;
- sabotage;
- negligence;
- over-voltage of technical and technological systems;

Occupational risks are related:

- with loss from stopping of production due to the death or damage of fixed and circulating assets (equipment, raw materials, transport, etc.);
- introduction into the production of new technology and technology.

Trading risks are related:

- with a loss due to: delayed payments;
- refusal of payment in the period of transportation of goods; lack of goods.

Investment risks include the following subspecies of risks:

- direct financial losses.
- lower profitability;
- lost profit.

The risk of lost profit is the risk of an indirect (adverse) financial loss (loss of profit) because of non-implementation of any measure (eg insurance, hedging, investing, etc.).

UDC code and Terms used in risk assessment .has been giving into Appendix A.

Standards and Guidance Documents has been providing into Appendix B

Questions for self-examination

1.1. List the main European and international regulations covering issues of risk analysis, management and risk assessment.

1.2. To define the concept of "risk" for Balabanov I. T. [1].

Answer. Risk is the combination of frequency or probability and the consequences of a particular hazard event

1.3. Record the notion of "risk" in a symbolic form.

Answer. The risk of R has been writing in the symbolic form:

$$R = Q \times p, \quad (1.1)$$

where Q is the probability of an event;

p - consequences (amount of losses).

1.4. Record the mathematical model of the availability of hazards, risk avoidance and severity risk by the definition of the Project Management Institute.

1.5. What are the types of workplace risk identified by the Project Management Institute?

1.6. What are you understood by the risk classification?

1.7. What does the risk qualification system include?

1.8. Distribution of risks depending on the possible outcome (risk event)

1.9. What does the term "net risks" mean and what are the risks to them?

1.10. What is the term "speculative risks"?

1.11. What has been defining with a preliminary analysis of risks?

1.12. Justify the notion of "property risks".

1.13. What does the term "occupational risks" mean?

1.14. What does the term "trading risks" mean?

1.15. List the types of investment risks.

1.16. Give the definition of "risk of lost profit".

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Basic:

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4. PMI's A Guide to the Project Management Body of Knowledge (PMBOK Guide).

APPENDIX A. UDC code and Terms used in risk assessment

UDC code

330.131.7 - Risk, insecurity from a national economic point of view

62.012.122 - Study of planning and production processes. Investigation of operations (operational research). Linear programming

Terms used in risk assessment

Threats - the threat of such an event that is possible in the future, in the process of which causes damage (losses): damage to health, property or environment.

Consequences - quantitatively or qualitatively result of an accident.

Incident - an event or sequence of events that can lead to an accident, if not stopped.

An event is an event that results in damage (damage), an accident situation, in which, thanks to happiness, people have not suffered.

The impulsive event is the first step in the sequence of events that leads to an accident.

The main event is the main event of an accident, which results in a danger.

Individual risk - the likelihood of death of the individual because of an accident when located at a certain geographical point in relation to a dangerous object.

Social risk - the probability that because of an accident will die no less than "n" people. It characterizes the severity of an accident (a two-dimensional value indicating the

Terms used in risk assessment

The source of risk is a technical object, a social or natural phenomenon, which in certain circumstances can lead to an accident.

Risk areas - an area that has been affecting by unwanted manifestations of an accident.

Risk factors - qualitatively expressed risk factors (criteria).

Risk parameters are quantitative (numerically) expressed risk factors that has been using in mathematical risk models.

Annex B Standards and Guiding Documents

Standards and Guidance Documents Supported by the ARBITR Program Complex:

- GOST 24.701-86. Reliability of automated control systems. Basic provisions. M .: IPK Publishing Standards, 1986, 17 p.
- GOST 27.301-95. Reliability in the technique. Reliability calculation. Basic provisions. M .: IPK Publishing House of Standards, 1996, 15 p.
- RD 03-418-01. Methodical guidelines for conducting risk analysis of hazardous production facilities. // Normative documents of intersectional application on issues of industrial safety and protection of subsoil. Series 3. Issue 10. M.: Gosgortechnadzor of Russia, Scientific-Technical Center "Industrial Safety", 2001, 60 p.
- GOST R 51901-2002 (IEC 60300-3-9: 1995). Reliability management. Analysis of the risk of technological systems. M.:IPK Publishing House of Standards, 2002, 22 p.
- GOST R 51901.14-2005 (IEC 61078: 1991). Risk Management. Method of structural scheme of reliability. M .: Standardinform, 2005, 18 p.
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LECTURE 2. CONCEPT OF RISKS OF TECHNICAL PROJECTS

2.1 Basic concepts of risk theory

Sources that may pose a potential threat have been conventionally dividing into four groups [4, 5]:

- the first group includes **natural sources**, which are conditioned by the potential opportunity to influence the fauna and flora;

- to the second group - **fabricated (produced) sources** that are associated with the accumulation of energy and harmful substances in technical systems that are potentially able to negatively affect the natural environment;

- to the third group **- socio-political**, which are caused by conflicts between different groups and social strata of the population;

- to the fourth group - **sources of military character**, which negatively affect the living space.

A quantitative measure of security is a vector value **- *a risk***.

There are two concepts in the literature [6 ... 10]

- **abstract risk -** the risk, which is measured by the probability of occurrence of an adverse event;
- generalized risk - a risk that has been measuring in probable material losses that arose after an adverse event.

2.2 Initial identification of risks

Under the risk in project management, understand [1]:

- probability of loss of part of resources;
- lack of income;
- the appearance of additional costs during the project implementation.

Project risk is a set of risks that threaten the economic efficiency of a project [2].

In Ukraine, the "typical" classification of project risks is widely used. It have provided in the Methodological Guidelines for the preparation of investment projects, which have be implemented by foreign investors. These Methodological Recommendations had been approving by the Collegium of the Ministry of Economy of Ukraine, Minutes No. 7/16 of 19.12.1994 (Second Edition, 1999). In accordance with this document, all project risks have classified according to the following features [3]:

A. Risks related to the general situation in Ukraine:

- political instability;
- current and future legal framework for investments;
- the prospects of the economy as a whole;
- financial instability;
- impossibility of converting the national currency into a solid currency;
- difficulties with the repatriation of profits - the return of capital abroad from abroad.

B. Risks of the design and construction period:

- increase of rates on a loan;
- increase of construction period;
- non-fulfillment of terms of commissioning of production capacities;
- mismatch of the project specification;
- inconsistency of the project estimate and the cost of construction.

C. Risks of operating period:

1) Occupational risks:

- increase of current expenses;
- disruption of the schedule of supplies of raw materials, equipment, etc.;
- new requirements for ecology;
- shortage of labor resources;
- change of transportation conditions.

2) Market risks:

- change in demand for products;
- loss of positions on the market;

- change of qualitative signs of production;

- the appearance of competing products;

- Untimely access to the market;

- a narrowing of the market "niche" for products.

Depending on the mechanism of preparation and implementation of the project, there are two types of risk: **systematic and non-systematic**.

Systematic risk relates to external factors, for example, the state of the economy as a whole, and is outside the overall control over the implementation of the project. Examples of systematic risk are also political instability, tax conditions, that is, factors associated with the actions of the state.

There is a risk that has directly related to the project:

- the level of profitability of production;
- period of construction start;
- construction process;
- value of fixed capital and productivity.

As far as the influence on the financial position of the firm is distinguished:

- **risks are permissible** (associated with the threat of a certain loss of profit);

- **critical** (associated with possible loss of expected revenue);

- **catastrophic** (arising in case of loss of the entire capital of the firm and accompanied by bankruptcy).

If possible eliminated, the risks have divided into:

- **non-diversified** (not subject to elimination);

- **diversified** (for which there are possible ways to overcome it).

By the measure of influence on the change in real assets of the company have allocated:

- dynamic - risks of unforeseen changes in the value of fixed capital, resulting from the adoption of appropriate management decisions, market or political circumstances [4].

Regarding technical projects, **risks has called** uncertain events.

2.3 Analysis of the causes of risks

The reasons for the possible termination of work are quite diverse; they depend on specific conditions and are not limited to technical aspects.

The authors of the project should take into account such features of the project as:

- technical policy of the management of the firm and the customer;
- their competence;
- their calculation for good luck;
- creditworthiness;
- the reputation of those who offer the order.

Risk of non-fulfillment of the project may also be associated with a change in market conditions.

Contractor insecurity is another example of a project risk. Finally, there are purely ***internal causes of risks***:

- faults in the used environment (software and technical);
- inaccuracy of the proposed requirements;
- unreliability of personnel (accepted by the key role an employee can abandon the contract at the most inappropriate time).

In order to reduce the risk of project development, the specialist should develop **a special plan, named after the risk management plan**.

The content of this plan is identification of project risks and measures that reduce its dependence on risks.

Project Risk Management includes processes that provide:

- risk planning, their identification;
- system analysis;
- development of feedback and control over the life cycle of the project.

2.4 Components of risk situations

When drawing up a risk management plan you have needing to be sure that only the real risks are considered, and not only known problems or conditions.

When describing a risk management strategy, you should follow the recommendations of this standard.

In determining the components of the risk, it is advisable to talk about the trajectories that have been realizing, not about the operational routes, since the routes always refer to all possible extensions of the project.

Risk trajectories are a subset of operational routes allocated in connection with the causes of risks, risks and possible ***consequences of risks.***

Questions for self-examination

2.1. Which groups of sources separate the sources of emergencies, depending on the causes of the negative impact on the environment?

Answer. Risks has divided into four groups [4, 5]:

- the first group - **natural sources**, which are conditioned by the potential opportunity to influence the fauna and flora;

- second group - **man-made sources**, which are related to the accumulation of energy and harmful substances in technical systems;

- the third group - **social and political**, which are caused by conflicts between different groups and social strata of the population;

- the fourth group - **sources of military character**, which negatively affect living space.

2.2. What is a quantitative measure of safety?

Answer. A quantitative measure of security is a vector value **- a risk**.

2.3. Define the concept of "absolute" and "generalized" risks

Answer. For [6 ... 10] there are: **abstract risk -** the risk, which is measured by the probability of occurrence of an adverse event; generalized risk is the risk that is measured in probable material losses that arose after an adverse event.

2.4. Define the concept of "project risk" as interpreted by the Project Management Institute

Answer. Project risk is a set of risks that threaten the economic efficiency of the project, [2].

2.5. Classify project risks

Answer. A. Risks related to the general situation in Ukraine:

B. Risks of the design and construction period:

C. Risks of operating period:

2.6. Types of risks depending on the mechanism of preparation and implementation of the project

Answer. **Systematic risk** relates to external factors, for example, the state of the economy as a whole, and is outside the overall control over the implementation of the project. The risk has directly related to the project through:

- the level of profitability of the production;
- start of construction period;
- construction process;
- a value of fixed capital and productivity.

2.7. How the risks have divided by the degree of influence on the financial position of the firm?

Answer.

- **risks are permissible** (associated with the threat of a certain loss of profit);

- **critical** (associated with possible loss of expected revenue);

- **catastrophic** (arising in case of loss of the entire capital of the firm and accompanied by bankruptcy).

2.8. How are risks to be resolved?

Answer.

- non-diversified (not subject to elimination);
- diversified (for which there are possible ways to overcome it).

2.9. What peculiarities of a project have been considering by developers?

Answer. The authors of the project should take into account such features of the project as:

- technical policy of the management of the firm and the customer;
- their competence;
- their calculation for good luck;
- creditworthiness;
- the reputation of those who offer the order.

2.10. What have been ensuring when drawing up a risk management plan?

Answer. When drawing up a risk management plan you need to be sure that only real risks are considered, not known problems

2.11. According to what standard should distribution of risks into components?

Answer. Distribution of risks to components has made in the PMBoK standard (Project Management Body of Knowledge) [2, 3].

2.12. Definition of "risk trajectory".

Answer. Risk trajectories are a subset of operational routes allocated in connection with the causes of risks, risks and possible consequences of risks.

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LECTURE 3. PROJECT RISK MANAGEMENT PLAN

3.1 Stages of the risk management plan

The first stage of the preparation of a risk management plan **is the identification of risks**. Traditional approaches, both consecutive and conservative iterative, are based on the hypothesis that all risks can be identified. That is to indicate all causes, events and their consequences. Radical fast methodologies say that in solving the problem the risk capability mast be minimizing, and therefore no special risk analysis is required. However, in any case, the uncertainty of the project remains, and it is necessary to overcome the risks. It turns out that they have taken into account and prepared for their overcoming.

The division into causes, actual offensive and the consequences of risks is the first step in such training. To implement it, we recommend the following structural construction, Table 3.1, the use of which should help in identifying real risks:

Table 3.1 - Structural construction of division on causes, offenses, and consequences of risks

As a result (through) <certain event>	- instead, you need to specify the specific cause of the risk that identifies
[risk] may occur	- you need to name the name of the risk
which can lead to <influence>	-it is necessary to substitute variants of what can happen

Real risks are those events that have really characterized by uncertainty. If the cause is deterministically leading to an event, then this is not a risk, and the staffing situation, the plan for overcoming which does not have any relation to risk management. Consequently, an analysis of the connections of causes and events is required.

DETERMINATION (from lat. determination - restriction, definition) of the emergence of qualitative peculiarity between parts of the embryo in the early stages of its development.

As a result of identifying risks, their list is formed.

The second stage of the preparation of a risk management plan in any methodology is the prioritization of risks.

The relative importance of the risks to the project needs to be determined. It is determined how significant each impact on each project can be. It is on this basis that all identified risks are organized. After that, two probabilities have estimated: for the cause and possible impact. Expression of probability - the operation is subjective, and therefore the resulting screening requires verification.

As a result of prioritization, risks are identified which will be monitored in the project. Other risks has not tracked but ignored reasonably. Actually, in the project, you can track no more than 10-15 risks, and therefore you need to choose the most significant of them.

The third stage identifies the possibility of influencing the risks, that is, the causes of the risks and their impact on the project.

3.2 Impact on project risks

Influence can take place at several levels and for each of the risks, the impacts planned for successive implementation at those levels as possible has identified:

- Exclusion of risk (avoid). Some risky situations has be ruled out completely. For example, to dismiss the chief specialist did not significantly affect the continuation of the project; it is advisable from the outset to offer two persons of equal qualifications to perform this role. At the beginning of the project, their discussions are useful for making objective decisions. If one of them abandons the contract, the second one will still be able to continue the deal. A useful discussion is this and the victim, which in many cases is possible to exclude the risk. Unfortunately, duplication has not recommended excluding all risk situations.

Unfortunately, duplication have not be recommended to exclude all risk situations.

In general, the risk aversion is not always feasible, but when planning a work with risks for each one, it is worth trying to find exclusion options. In essence, this technique is to overcome the identified causes of risk.

- Switching risk. This is a separate case of exclusion when the risk has transferred from the scope of the project to the environment. For example, if the market value of the product created seems questionable, it would be more convenient to negotiate with the customer about advance payments for its development, thus forcing it to solve the problem of risk elimination and freeing it from the developers (possibly by reducing the payment of the project). To this level are all variants of contractual agreements, but not only them. When dealing with risks, you always have to try to predict ways to switch.

Unfortunately, this strategy is an exception to the risk only for developers, but not for the project as a whole.

- Reduce risk (mitigate ['mitigeit]). If the risk have not be excluded, you can try to reduce the likelihood of its occurrence in practice (operating reasons). Continuing the example of the dismissal of an employee, to reduce the likelihood of this is to guess the reasons for the act and try to create for the employee more comfortable conditions (increase wages; create incentives; etc.). It is necessary that such decisions have made not in response to the application for release, but in advance. This will preserve some stability in the team, which in itself is a method of reducing risk.

- Switching risk. This is a separate case of exclusion when the risk had transferred from the scope of the project to the environment. For example, if the market value of the product created seems questionable, it would be more convenient to negotiate with the customer about advance payments for its development, thus forcing it to solve the problem of risk elimination and freeing it from the developers (possibly by reducing the payment of the project). To this level are all variants of contractual agreements, but not only them. When dealing with risks, you always have to try to predict ways to switch.

Unfortunately, this strategy is an exception to the risk only for developers, but not for the project as a whole.

Another example of risk reduction is the announcement (for the customer, the management and the team) about the revision of requirements, when it becomes clear that the schedule of work can be torn. As in the previous case, an important point here is the warning, that is, the revision of the requirements is not in response to the violation of the schedule, but as a preventive measure.

PREVENTIVE - 1. PREVENTION. 2. Measures aimed at reducing the risk in property insurance. 3. Preventive measures when it is necessary to reduce risks affecting the results of economic activity.

Risk Warning (accept). When it is not possible to reduce the risk satisfactorily, it is worth getting ready for a meeting with him. That is, to minimize losses, so as to reduce the likelihood of negative effects and reduce the impact itself (operation with consequences). If it succeeds, then the continuation of the project in many cases turns out to be successful. In the example of dismissal, it is as soon as possible to find a replacement for this employee. Naturally, the time of the project will increase (in particular, because the new person must be introduced in the essence of the case), but work will be continued. This is true, but with one condition: at all levels of designing it is possible to separate the results of work from the developers. If the results has personified, then the difficulty of substituting for some roles may be insurmountable.

Questions for self-examination

3.1. What is the first stage in the preparation of a risk management plan in any methodology?

Answer. The first stage of the preparation of a risk management plan in any methodology ***is identification of risks***.

3.2. What is the first step in preparing for overcoming possible risk situations?

Answer. Separation of causes, offenses and consequences of risks.

3.3. Provide a structure for constructing a division into causes, outcomes and consequences of risks

Answer. Structural division of the division into causes, offenses and consequences of risks

As a result (through) <certain event>	- instead you need to specify the specific cause of the risk that identifies
[risk] may occur	- you need to name the name of the risk
which can lead to <influence>	- it is necessary to substitute variants of what can happen

3.4. What events have characterized as real risks?

Answer. Real risks are those events that has really characterized by uncertainty.

3.5**.** As a result, a list of identified real risks has formed.

Answer. Because of identifying risks, a list of identified real risks has generated.

3.6. What is the second stage of risk management plan has development?

Answer. The second stage of the preparation of a risk management plan in any methodology is the prioritization of risks.

3.7. What sign all the risks have identified and organized by?

Answer. Determines how significant any impact of each risk on the project can be

3.8. What are the main levers of the project's risk to prevent or mitigate adverse effects?

Answer. The main leverage is the following:

- exclusion of risk (avoid);
- risk reduction (mitigate);
- risk switching (transfer);
- warning of the risk (accept).

LECTURE 4. PREVENTION OF DAMAGE FROM RISK SITUATIONS

4.1 Planning steps to prevent damage from risk situations

Steps to prevent damage have been planning for this project. Therefore, in order to make as the fastest replacement of the dismissed employee, the project manager must be prepared in advance a list of persons able to take a vacancy. An integral part of this plan is the reservation in the main timetable of the time required for the introduction of a new artist in the course of the case. Examples of contingency planning in the field of engineering may be spare parts.

For all risk situations, the risk management plan provides for measures to overcome the causes of the risk - planned responses to risks. The detail of such a plan can be different; it depends on the responsibility of the project, its importance for the company and the customer, on the one hand, and on the other hand:

- from the degree of novelty of the project;
- exhaust technology of its implementation.

When drawing up a risk management plan, one should not forget that because of a risk event, as well as its impact on the project, the emergence of so called secondary risks. That is, which could not have been without it. They should also be valued, and they need to anticipate impacts.

Project implementers should be aware of possible risks and their management plan. It creates confidence in the success and prepares employees to overcome difficulties. For the project manager, when drafting a plan, the most important thing is not to miss all possible risk situations.

A project with a large part of innovations is always a risky enterprise. For this reason, for him, the risk management plan is mandatory and should be as detailed as possible in the accounting section:

- incorrect decisions;
- errors in the assessment of situations;
- technological difficulties;
- and so on.

Many projects depend on external factors largely than on the organization of affairs and readiness of performers. Risk analysis in such a situation has intended to compensate for external dependence at the expense of internal resources. In addition, here the risk management plan is mandatory in the preparation of the project, but in comparison with the previous case, there are some shifts in emphasis. Yes, the project manager should foresee the actions of developers when:

- equipment supplied with delay;
- there are breaks in financing;
- in other cases negative external influence.

Compared to consistent development, the orientation of the project to phased development makes it more risk-resistant. Since the working product of each stage will have planned, not only when the context of its development have be predicted only in general, and when it is completely determined. However, the risk management plan is appropriate and for the phased development of the project. With the phased development, the most important is the distribution of project requirements implemented in stages in such a way as to minimize the risk of the project as a whole.

4.2 Distribution of resources to overcome risks

Drawing up a risk management plan influences the distribution of resources. It begins with fixing and ranking all possible risk situations and planned reactions to them. The costs and the price of activities planned will have been performing in a risk situation are determined.

Thus, the risk management plan is:

- a list of risk situations with planned reactions to them;
- determining the costs of planned response to risk prevention;
- supplementing the project has cost characteristics;
- clarified the project schedule;
- An expanded scheme of financial and temporary needs of the project.

When planning risk management, had been determined carefully risks for the first phase. Rough assessments and extrapolations of risks for subsequent periods have adjusted before each stage. It is advisable to review the plan of risk management - after the occurrence of a risk situation and its overcoming.

As an example of what will have foreseen, you can point out the redistribution of resources initially allocated to support risk-based interventions. It is useful to analyze the situation before adjusting risk management plans in case of occurrence and overcoming a risky situation, namely:

- the effectiveness of foreseen, executed and unfulfilled preventive measures;
- understand what has organized better
- check the quality of the preliminary estimates.

The experience gained in this analysis has applied directly when viewing the plan. This is very important, since situations like those that have overcome have be repeated in the course of further development of the project.

Below is a list of the main situations that the project manager should avoid. In addition, what he should take into account when preparing a risk management plan:

- delayed start of the project, which is never compensated;
- if the schedule is executed with big violations of terms, it is difficult to expect the creation of a good product;
- if the use of the product is complicated and intuitive and exceeds the level of competence of the consumer of the product, the product will be poorly distributed;
- Lost opportunities require additional efforts at their later implementation and increase costs;
- A product that has not been tested and not certified reduces the reputation of the developer;
- Do not rely on the immutability of consumer intent. You never know what the consumer wants and what he really needs.

As a result, it is necessary to plan the time for processing that at the beginning of the project seemed acceptable.

Questions for self-examination

4.1. What do you need to have a supervisor to do as a fastest and without loss replacing a retired employee?

Answer. There must be a predefined list of people, who can take a vacancy.

4.2. What are the risks management plans?

Answer. Planned reviews for possible risks has foreseen.

4.3. What should I include in the project manager?

Answer. The project manager should foresee the actions of the developers when the equipment have delivered with a delay, there are breaks in financing, in other cases negative external influence.

4.4**.** What makes a technical project pain-resistant?

Answer. Focusing the project on its phased plan development makes it more risk-resistant.

4.5. What is the impact of the risk management plan?

Answer. Drawing up a risk management plan influences the distribution of resources.

4.6. What is the beginning of a risk management plan?

Answer. The preparation of a risk management plan begins with the fixation and ranking of all possible risk situations and planned reactions to them.

4.7. What determines when developing a risk management plan?

Answer. Determine the time expenditures and the price of activities that carried out have planned in a risk situation.

4.8**.** Why should you pay close attention when planning a risk management?

Answer. In the planning for risk management, detailed attention should be given to describing the risk situations at the start of the project, including the first stage of implementation.

4.9**.** List the main situations that the project manager should avoid and take into account when preparing a risk management plan.

Answer. A list of the main situations which the project manager should avoid and which he should take into account when preparing a risk management plan:

- delay in the start of the project is never compensated;

- if the schedule is executed with big violations of terms, it is difficult to expect the creation of a good product;

- if the use of the product is complicated and intuitive and exceeds the level of competence of the consumer of the product, the product will be poorly distributed;

- lost opportunities require additional efforts at their later implementation and increase costs;

- a product that has not been tested and not certified reduces the reputation of the developer;

- do not rely on the immutability of consumer intent.

LECTURE 5. STRATEGY OF MANAGEMENT OF THE PROJECT QUALITY

5.1 Planning of project quality management measures and strategies

The planning of activities and strategies for managing the quality of the product have developed is a traditional part of the preparatory work. This work has carried out either by the project manager or the responsible executor. The necessary steps to ensure quality at all stages of the project development are:

- approval of the project's purpose, in terms of the quality of its implementation;
- determining the criteria for success and achieving the expected results;
- quality checking and tracking;
- removal of defects;
- definition of common quality indicators.

A quality management plan is a list of activities carried out at the control points of the project life cycle to measure and evaluate certain indicators that characterize the results achieved [1, 2].

Of course, such a plan includes:

- the goal, the achievement of which satisfies the customer of the project as a whole:

a) ease of use;

b) system capabilities;

c) performance characteristics;

d) and so on;

- tasks related to product quality, namely:

a) convenient maintenance and repair of the product structure;

b) completeness of the technical documentation;

c) compliance with specifications;

d) reliability of functioning;

- use of quality monitoring tools:

a) what;

b) for what;

c) how they affect quality:

- the organizational procedure for defect detection and elimination;

- quality management tools:

- an agreement describing the processes in a form that is convenient for changing and correcting management programs;

- quality tracking procedure;

- project-specific agreements.

The preparation of a quality management plan should be consistent with the methods of testing and measuring project performance. In essence, such a consensus determines the answer to the question of how this project has controlled by quality.

When drawing up a quality management plan, one cannot ignore the close link between this plan and the overall project plan.

5.2 Risk Map

Fighting technical risks involves eliminating the possibility of occurrence of dangerous events. This is a directed and system-based impact on the safety of the possibility of an unwanted event.

As shown by the statistical analysis [1], only 25% of the total number of risks are so-called external risks:

- unstable economic and political situation;

- problems in legislation;

- corrupt officials;

- crime;

- reliability of production links.

The internal risks that has observed in the middle of the technical design and production are 75%. To internal risks, include:

- non-discipline - violation of labor discipline;

- non-formalization of processes - violation of administrative discipline;
- violation of technological discipline;
- non-fulfillment of contractual discipline - non-compliance by subjects of legal relations, duties stipulated by the agreements;
- violation of internal communications;
- insufficient qualification of the personnel;
- not an effective system of employee motivation.

The motivation system have be locked at the control points of each stage of the project. It is at these points that responsible decisions have made. If this have not done, the resulting risks can lead to the failure of the entire project. One of the effective tools for risk management is a risk map. An example of a risk map fragment have given in Table 5.1.

Table 5.1 - A fragment of risk maps

Name of risk	Methods of prevention / response
1	2
Lack of motivation for project results	Development of incentive schemes based on project results for project implementers.
Lack of periodic reporting on the project, in accordance with the approved regulations, as well as the lack of continuous updating of the information base. Preparation of requirements for periodic reporting by consumers	Development of forms and rules of reporting. Motivation and demotivation for the accuracy and timeliness of reporting.
Lack of authority and levers of project manager influence on project implementers.	Documentation regulation and process execution stages of the project. Maintenance of regulations. Demonstration for failure to comply with the regulations. Principle of payment of internal resources.

End of table 5.1

1	2
The risk of the existence of several sources of information exchange with the Customer (duality and inaccuracy of information)	Adjustment of the rules of document waiving and processes for the implementation of project phases. Periodic discussion of interim results of the project implementation. Creation of a single information base of the project.
Clearly fix the responsibilities of administrators and project curators.	Clear execution of role instructions. Motivation and demotivation.
The risk of bad knowledge of contract terms.	Continuous training, demotivation.
Lack of 10% of the project's reserve and project budget	Justification of 10% increase in the term and budget of the project

It is only possible to correctly assess the impact of risks after:

- it will be clarified who and for what is responsible;

- all processes, both technological and business, will be registered;

- clearly defined responsibilities and roles of each employee;

- a system for encouraging the whole project, and not just the process, has been created.

After establishing the risks at each stage of the project, it is necessary to conduct their ranking based on the probability of occurrence of each risk event and possible losses. It is determined by:

- which are the most important;

- methods of their prevention;

- costs of such a response to the budget of the project.

5.3 Typical design errors that affect product quality

The following list shows some typical design quality errors:

1. **Replacement of the automation of activities by providing funds.** This is a very common mistake by artists. It arises in connection with the fact that when defining the requirements for the product it has fixed that:

- what needs to be provided to the consumer;

but ignores the question of:

- how this product will be introduced into its life.

In order to avoid this error, the quality management plan should provide:

- time to research activities that are automated;

- the possibility of its reconstruction (when automated new, not yet existing activities);

- definition of typical consumer needs and their consistency;

- possibility of checking the effectiveness of the conducted research;

- control of the correspondence between the fixed typical situations and the realized opportunities of the consumer to operate in these situations.

2**. Ignoring environment tools that have used for the automated activity.** In some cases, the means of best performing technological operations to improve the reliability of the product has duplicated. As a result, the cost of development increases, and the consumer has to develop additional tools.

3. **Ergonomic properties of a product that does not match an automated activity**: unusual, complex, inaccurate, etc. The reason for this disadvantage is the same: mistakes with the study of activities that have automated.

This shortcoming is difficult to measure. However, in order to overcome it in terms of quality management it is useful to provide a procedure for comparing variants of ergonomic decisions.

4. **Inadequate response of the system to errors of the consumer product.** The correct point of view of consumer mistakes is to consider them not exceptions, but the usual phenomena that arise at work. In this case, it is possible to achieve the diagnostics of the answer to three questions that arise from the consumer when the system fixes an error:

- What happened? In a diagnostic message, the cause of the error and its consequences has be explained in an understanding accessible to the consumer, without the use of special terms.

- What have be done? The consumer have be given the opportunity to receive information about possible actions that he can count on the correct execution.

- How to fix the situation? It is worth giving the consumer the opportunity to get information about the path to correct the error with clarification of what losses have expected of him.

A system whose diagnostic satisfies this criterion in all false cases should be considered more qualitative. Unfortunately, it's hard to quantify your Quality Score.

Questions for self-examination

5.1 What is the planning of activities and strategies for quality management of the product?

5.2. What measures does the quality management plan provide?

5.3. What is the mandatory component of the quality management plan?

5.4. What part of the total number of risks are external and internal risks?

5.5 What are the internal risks?

5.6. What is an effective risk management tool?

5.7. What have definitely defined and created when drawing up a risk map?

5.8. What do you need to do after setting the risks at each stage of the project?

5.9. Specify typical design errors that affect product quality?

5.10 What are the main three questions for the consumer when the system fixes an error?

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LECTURE 6. ORGANIZATION OF CONNECTIONS IN PROJECTING

6.1 The concept of project risk and methods of forecasting of risk

Project risk is the risk of unwanted deviations from the expected state in the future, from which decisions are made in the present.

There are two types of risk analysis:

- qualitative, the main task of which is to identify the factors of risk, stages, and work, during which it arises. That is, the identification of potential risk areas, after which it becomes possible to identify all possible risks;
- quantitative, which is used to determine the numerical size of individual risks and risks of the project as a whole. Different methods of analysis has used for this purpose.

The most common methods are:

- analysis with beta coefficient;
- determining the probability of the results;
- analysis of scenarios;
- modeling - Monte Carlo method;
- analysis of the sensitivity of response;
- theory of games.

Risk analysis using the beta coefficient (the beta factor has taken as the risk factor in the investment theory). It expresses the "market sensitivity" of an investment. Or how changes in return on investment compared to changes in the market situation. $\beta = 1$ means that changes in yields accurately repeat changes in the market situation. A value less than 1 is typical of low-risk projects whose yield is more stable than the market; the value of more than 1 indicates that the revenues from these projects are subject to very strong influence from even insignificant market fluctuations.

Determination of the probability of the results.

The use of subjective probabilities gives the decision maker a better picture of opportunities and choices than the methods used in practice. Estimation of the probability of this or that outcome of the investment project requires that the person making the investment decision could predict as many possible results of the investment project and assess the probability of occurrence of each of the possible options. A typical situation that reflects the worst and best possible options for development may include the following: "pessimistic" option, "most likely" and "optimistic".

A solution that has several possible outcomes is risky or uncertain. Most approaches to risk and uncertainty not only predict the possible outcome of the decision, but also the probability of the occurrence of each of these results. All this allows you to determine the risk and uncertainty associated with a particular decision from the position of distribution of the probability of the results.

Script analysis takes into account that some variables are interdependent and has modified at the same time. If there is a basic project option, as well as a set of the most important components that change the risk of project implementation, two additional scenarios - "optimistic" and "pessimistic" - have being developed. Both scenarios provide a realistic set of events. The results of the analysis has reduced to the matrix. The distribution of the values of net present value and the internal rate of return on the project has analyzed.

The simulation method is a continuation of the method for estimating the probabilities of possible outputs. The method of estimating probabilities contains an assessment of only one indicator - net present value. Although in practice as many factors as possible determine the success or failure of an investment project. It may include:

- the cost of the project,
- the annual return on investment,
- the rate of profit,
- the period for which the project is calculated;
- it is liquidity value.

The simulation method makes it possible to evaluate each of these factors in terms of its impact on the project risk level. When using the simulation method (also known as the Monte Carlo method), you need:

The simulation method makes it possible to evaluate each of these factors in terms of its impact on the project risk level. When using the simulation method (also known as the Monte Carlo method), you need:

- identify key changes in the investment project;
- identify all possible values that these changes may take;
- determine the probability of occurrence of each value;
- build a model using a computer.

The computer selects the value for each of the key variables based on the probability of occurrence of this or that value. Using these values, the machine calculates the net present value of the project. After a large number of iterations (counting cycles), we obtain the most probable net current value and the distribution of all possible options, indicating the probability of their offensive, which allows us to assess the risk associated with the implementation of this project.

Sensitivity analysis of response. This method is very similar to the simulation method, but not so complex and deep. The purpose of the sensitivity analysis is to identify the most important factors, the so-called critical variables that can affect the project, and check the effect of the successive (single) changes of these factors on the project results.

The factors that vary in the sensitivity analysis have classified as follows:

- affecting the amount of project revenue;
- affecting the number of project costs.

This method has a double value for the estimation of investments and it allows distinguishing:

- variables that have the greatest impact on the outcome of the investment project. And whose values should be determined with maximum accuracy;
- a high risk project due to large changes (or uncertainty) of one or more key variables, as well as to calculate the "expected" present value of these projects.

Sensitivity analysis is also useful as a "precursor" of simulation so that estimates of the variables on which the success of the project largely depends on the project was paid attention during the construction of the model. Difficulties in applying a sensitivity analysis arise when key variables have combined. Part of the problem has be solved by summarizing all mutually related variables to one, which would reflect the connection between these variables

The theory of games can be useful where it is difficult or impossible to determine the probability of occurrence of certain events. Game theory is a conservative approach aimed at minimizing losses or "compassion" from making incorrect investment decisions. Despite the fact that this approach cannot determine the best investment decision, he suggests ways to exclude the most risky options.

One of the methods of game theory - "minimizing the maximum possible losses" - helps to choose the best of all possible outputs that can occur, that is, protects against bad variants. The second method, "minimization of compassion", or "minimization of the maximum possible alternative costs". It has used to reduce alternative costs when making investment decisions.

6.2 Types of project links

The links in the project are always there. They are subdivided into external (dependence of the project on deliveries, financing, used development, etc.) and internal (dependence of the working products of the project from each other).

Both types of connections are a constant concern of the project manager and firm management. The task of the project manager in the field of tracking links is an indication of the actual existing dependencies and their use for the direction of project development, timely neutralization of undesirable impacts. For its solution, it has necessary to have fully comprehended the interrelation of the processes. The simplest in terms of tracking are external connections. They have sufficiently defined in the allocation of project resources. In order to trace them qualitatively, it is obvious to fix the links, reflecting them documented as materials accompanying the plan-graphic project.

In most cases, the project manager is not able to influence the material and information flows of the project's external relations. This means that for critical situations dependent on external relations, the project manager should provide alternative ways of project development. Therefore, if the necessary supplies are late, this should not be a surprise to the project manager. His work is to prevent a simple performer by offering them the right work that have be done in the current environment. Identification of such situations have be ensured in advance so that appropriate measures lead to satisfactory results.

In the external relations plan, which is the project manager in preparation for the start of the project, it is necessary to include all critical situations and possible alternatives for the team (references to them). Mandatory in this plan is a list of works that have delayed or collapsed in a critical situation. Realistic information about the postponed work and alternative work can be specified accurately only after the development of a plan of stages of work. The project manager corrects the external relations plan whenever a critical situation arises, as well as before the start of the next stage of the project.

6.3 Types of internal design links

Internal design links have selected in the following way:

- use of shared resources;
- links on the results obtained during the development of the project;
- other dependencies of work: reflected in the plot-graph by force (to them, for example, it is possible to attribute an indication of dependence, conditioned by the fact that two actually non-connected works are performed by one executor in a row), conveyor works, etc.

These are the links of working product design. It is worth dividing them into acting within the scope of one stage of work and communication that extends between stages. Connections, reflected in the plan-graph, determine the sequence of works. Along with the results link, they have used when it is necessary to trace changes (task statements, task adjustments, etc.) for any project activity: what are the impacts of such changes that additional operations have be performed through these changes (for example, re-testing)? The people affected by these changes.

The linkages of the product products to the results, as well as the connections of the other two types, reflect the design process, but in addition, to a greater extent, they characterize the dependencies between the documents, the dependencies between the software product, the dependencies between the programs and documents that are set during the project activities and are fixed. These links have not be eliminated when the stage is completed. They have used to navigate the project materials.

Communications within one stage of design are more mobile. It may seem that they do not have be documented for small projects. However, if during the next steps it becomes clear that the distribution of changes relates to previously executed project phases, then it will be easier to control the necessary actions in fixed communications. Fixation of bonds seems desirable to the level of detail, which is subject to rapid individual recognition.

6.4 Documentation of project links

In addition to controlling the changes, there is another reason why it is expedient to conduct a document that explicitly captures the links of the project. It is a need to train staff. Training is required to connect a new executor to the work begun earlier, to restore the state of work-delayed work, to transfer the experience of this project that is to re-use the design work products.

Not so long ago, the effectiveness of an explicit description of ties paid little attention. Most dependencies have recorded by the main specialists on the project lines. It remaining beyond the competence of other project implementers. Practice shows the irrationality of such a situation. Documentary fixation of communications helps organizationally: with its help, the spread of changes becomes an entirely technological process and the study of the project materials - an individual activity that does not distract other developers for consultation.

The methodology for describing the relationship of the project chosen by the project leader during the preparation period may be different. It is important only that it achieves the above tasks and have not excessively detailed only useful links need to be describing. Thus, there is no need to trace the interdependence of components that allow only agreed changes, in cases where it is possible to identify the primary component on which other secondary components depend on. The reverse dependencies in this case are redundant if the change of secondary components is possible only when the primary component changes.

6.5 Connection graph

When choosing the method of describing the links, it is necessary to be guided by the graph of connections, which is formed during the designing of the components. The vertices of the graph are the designation of the components, and the directed arches reproduce the specific dependencies. For each arc of such a graph, the information describing the dependence, as it is necessary for a particular project have indicated. Below is a list of dependency attributes:

- **brief description** of the dependency: a designation that includes the pair of components-the source of the dependence and the dependent component;

- **full explanation** of the dependence: explanatory text;

- **type of dependence**: uses results, has total resources;

- **types of dependence**:

a) determines the appearance of the component: the dependent component occurs after the development of the source component (for example: the creation and approval of the specification must be made by the time the module is manufactured);

b) expects the result: what, when - planned and critical dates;

c) expects the ending: when - scheduled and critical dates;

d) the dependence constantly exists;

e) dependence exists within one-step;

f) the dependence covers the various stages (indicate which ones);

- current status of dependence:

a) calm: does not require reaction of developers, because there are no grounds for the emergence of risky situations;

b) active: requires reaction for a certain period (planned date, when the reaction is scheduled and a critical date, when the reaction must be made obligatory);

c) critical: requires immediate reaction;

- responsible for the source component and dependent component: performers from the team of developers and their role;

- dependency tracking history: a communication protocol that contains information about when and how it was used, which violations were detected when, as well as on which tests were tested.

As well as what connections have monitored, weighs on the levels of the design methodology. Usually, they offer recipes for minimizing relationships that work well in their areas of application. In addition, choosing an approach to project management at the level of concepts, it is worth listening to such recommendations, make them the standard of the project and fix it documented. Naturally, methodological recommendations should be adapted to the specifics of the project, adjusted in view of the scale of the project, its projected duration and other conditions of execution.

The development of a communication management plan has not conducted in isolation. We must realize that this plan and plans for managing risks and quality are not an end in themselves, but serve only to preserve the trajectory of project development within the admissibility area. In other words, this and another component of the conceptual framework of the project have considered as methods of project activity in general, regulating the main means of managing the project activity in general: the general plan of the project.

Questions for self-examination

6.1. Define the concept of project risk**.**

Answer. Project risk is the risk of unwanted deviations from an expected state in the future, from which decisions have made in the present.

6. 2. What are the types of risk analysis?

Answer. There are two types of risk analysis:

- qualitative, the main task of which is to identify the factors of risk, stages and work, during which it arises. That is, the identification of potential risk areas, after which it becomes possible to identify all possible risks;

- quantitative, which is used to determine the numerical size of individual risks and risks of the project as a whole.

6.3**.** Name the most common methods of risk analysis.

Answer. The most common methods are:

- analysis with beta coefficient;
- determining the probability of the results;
- analysis of scenarios;
- modeling - Monte Carlo method;
- analysis of sensitivity of response;
- theory of games.

6.4. Explain the features of the risk analysis using the beta factor

Answer. Risk analysis using the beta coefficient (the beta factor has taken as the risk factor in the investment theory). It expresses the "market sensitivity" of an investment, how changes in return on investment compared to changes in the market situation.

6.5**.** Name the groups of possible variants of development of the technical project.

Answer. Possible options for development may include the following groups: "pessimistic" option; "most possible" and "optimistic".

6.6**.** What decision has called risky or indefinite?

Answer. A solution that has several possible outcomes is risky or uncertain.

6.7. What does script analysis contain and how many should be writing for each project?

Answer. Script analysis takes into account a realistic set of events. Two additional scenarios are being developed - "optimistic" and "pessimistic"

6.8**.** What are the results of the analysis of scripts and what have be analyzing.

Answer. The results of the analysis has reduced to the matrix, the distribution of the values of net present value and the internal rate of return on the project has analyzed.

6.9. What does the simulation and probability model have?

Answer. The probability assessment method contains an estimate of only one indicator - net present value, although in practice as many factors as possible determine the success or failure of an investment project.

6.10. When using the simulation method (also known as the "Monte Carlo" method), what needs to be defined and constructed for the successful implementation of an investment project?

Answer. When using the simulation method (also known as the Monte Carlo method), you need:

- identify key changes in the investment project;
- identify all possible values that these changes may take;
- determine the probability of occurrence of each value;
- build a model using a computer.

6.11**.** Formulate the purpose of the method Analysis of the sensitivity of the response of a technical project.

Answer. The purpose of the sensitivity analysis is to identify the most important factors, the so-called critical variables that can affect the project, and check the effect of the successive (single) changes of these factors on the project results.

6.12. Specify the factors that vary in the response sensitivity analysis process.

Answer. The factors that vary in the sensitivity analysis have classified as follows:

- which affects the amount of project revenue;
- which affects the amount of project costs.

6.13. Where in Theory of Risks has been used the Game Theory?

Answer. The theory of games can be useful where it is difficult or impossible to determine the probability of occurrence of certain events.

6.14**.** On what the types of project bundles are subdividing**.**

Answer. The links in the project are subdivided into external (dependence of the project on deliveries, financing, used development, etc.) and internal (dependence of the working products of the project from each other).

6.15**.** Can the project manager influence the material and information flows of the project's external relations?

Answer. The project manager is not able to influence the material and informational flows of the external relations of the project.

6.16. What alternative ways of project development have foreseen by the project manager?

Answer. The project manager should not allow simple performers, offering them the right job, to act in the past with a laid-out plan of critical situations.

6.17**.** What has guiding Manager by when choosing a method for describing project links?

Answer. When choosing the method of describing the links, it is necessary to have guided by the graph of connections, which has formed during the designing of the components.

6.18**.** What has indicated by the vertices and arcs of the graph?

Answer. The vertices of the graph are the designation of the components, and the arc directed reproduced the specific dependencies. For each arc of such a graph, the information describing the dependence, as it is necessary for a particular project has indicated.

LECTURE 7. ANALYSIS AND EVALUATION OF RISK OF TECHNICAL PROJECTS

7.1 Quantitative risk analysis

Risk analysis - procedures for determining and assessing the risk of occurrence of risk sources [1].

The risk has quantitatively characterized by the estimation of the probable expected, the efficiency of the innovation project at the maximum and minimum value of the results of its realization (income).

The expected value of the project's effectiveness is the product of the absolute value of the efficiency indicator with the i-th result (absolute value of profitability) and the probability of obtaining one or another result (probable level of probability) [2]:

$$\overline{A}=\sum A_i \cdot P_i \qquad (7.1)$$

where the expected value of the corresponding indicator of the effectiveness of the project:

A_i is the absolute value of the efficiency indicator at the i-th result;

P_i - the probability of obtaining the i-th result.

To quantify the risk as a measure of uncertainty, it is advisable to establish the nature of the distribution of the yield values and calculate the average deviation from the average yield and the coefficient of variation.

As is known from mathematical statistics, the mean square deviation **σ** is an absolute measure of risk.

$$\sigma = \sqrt{\sum_{i=1}^{n}\left(A_i - \overline{A}\right)^2 \cdot P_i} \, . \qquad (7.2)$$

The higher the mean square deviation, the higher the risk of the project.

The relative risk factor is the coefficient of variation (HF), whose magnitude is directly proportional to the risk of the project:

$$K_B = \sigma / \overline{A} \quad (7.3)$$

The risk level of a project is widely used in the level of security.

His calculation of which on the basis on the break-even point characterizes the stability of the project in conditions of probable changes in its implementation.

The following steps in project risk assessment are:

- analysis of the sensitivity of the project;
- analysis of project development scenarios

7.2 Analysis of the sensitivity of the project

The analysis of the sensitivity of the project is to assess the impact of the factors of the investment project on the change of performance indicators. This type of analysis allows you to identify the so-called critical variables (factors) that significantly affect the feasibility and effectiveness of the project, on which the developer of the project has no unambiguous judgment. Such typical factors are:

- volume of sales;
- cost price and planned unit price;
- investment costs or their components;
- operating expenses and their components;
- term of payment delays for the implementation of the project;
- inflation rate for the period of project implementation;
- interest on loans or loan interest;
- the rate of a possible discount when selling the product.

In the relative sensitivity analysis, the relative influence of the investigated factors has studied (with their change for a fixed value, for example,(± 5% and ± 10%) on the project's performance. The critical factors of the project have identified, based on this analysis, In addition, a set of measures has developed to prevent their negative impact. Changes in these factors have monitored first.

Absolute sensitivity analysis involves determining the numerical value of the deviation of the resultant parameters due to the change in the initial parameters of the variables.

The results of the sensitivity analysis have summarized in a tabular or graphical form.

7.3 Analysis of project development scenarios

For these variants of development, the average values of the effective indicators (taking into account the probability of each scenario) are calculated and the extent of their variation or the mean square deviation is determined. Of the two comparable projects, it is more risky that the scale of the variation of the criterion is greater or more than the value of the mean-square deviation.

The analysis results have been reducing to the matrix, which analyzes:

- distribution of values of net present value;
- internal rate of return on the project.

The disadvantage of analyzing project scenarios is that it takes into account only a few values of the project's performance indicators, although, in reality, they can be much larger. That is why the use of simulation simulates additional analysis capabilities for creating an infinite number of random scripts.

7.4 Method of simulation

The simulation method (also known as the Monte Carlo method) is a continuation of the method for estimating probabilities of possible outputs, which has described above.

The Monte Carlo modeling have called so because this type of analysis arose in the mathematical study of casino games. It combines the response sensitivity and the probability of the distribution of an input variable. At the heart of the model can be any distribution of probabilities of random variables or other functional dependence. The specified specificity, in comparison with the step-by-step nature of the simulation, determines the flexibility and sufficiently high universality of this method. However, such simulation requires computer support. Script analysis can be done using a PC with a spreadsheet program or even using a calculator.

The main purpose of the simulation is to bring hypothetical situations closer to the real ones. Since real future cash flows or discount rates are unknown, cash flows and discount rates has given different allowable values, and then the results are considered. These case-based cases are called simulated events. Simulated events in the feasibility of investments are used to study the Net Present Value (NPV) and the Internal Rate of Return (IRR) of projects with different cash flows.

In the simulation analysis, the program begins to guess the value for each variable the sales price, its volume, variable costs per unit of output, and so on. These values are then merged and calculated by the NPV of the project and recorded in the computer memory. Next, catch a different set of input data and calculate the corresponding value of NPV. This process can be repeated thousands of times and have a thousand values

In the classical version, the valuation of VaR by simulation has carried out as follows [4, 5].

At the first and second stages, the initial series of indicators is determined and a transition to a number of relative values of the considered value is made, similar to the historical and parametric methods described above.

The third step is to determine the form and parameters of the distribution (functional dependence) for the series under consideration.

The fourth stage is the direct simulation of a number of changes, which have distributed in accordance with the obtained parameters.

The results of the simulation are determined by:

- average expected change;

- the worst, within the established trust level, is the expected change in the direction corresponding to the position being analyzed;

- VaR - risk assessment as the absolute value of the difference between these values. In this case, the simulation have carried out both for individual tools, and compatible for all elements of the portfolio. Simulation can take place both for one day and for a longer period.

The Monte Carlo simulation model is a synthesis of sensitivity analysis and scenario analysis based on probability theory.

When applying the Monte Carlo method it is necessary:

- identify the key variables of the investment project;
- determine all possible values of the selected main variables;
- determine the probability of occurrence of each value;
- build a model.

The computer arbitrarily selects the value for each of the main variables, taking into account the probability of their occurrence. Using these selected values, the Net present value (NPV) of the project is calculated. After a large number of iterations (calculation cycles) we get the most probable NPV and the distribution of all its possible values with an indication of the probability of their occurrence, which allows us to assess the risk arising from the realization of this investment project.

In conducting the modeling, one should keep in mind interdependent variables (it has not recommended to include factors in the model, the pair correlation coefficient of which is rather high).

The final stage of this method of analysis is to process and interpret the results obtained. If the number of calculation options for each NPV value is n = 5000, then the probability of one variant of this event is:

$$R = P / n = 100/5000 = 0.02,$$

where P - probability of occurrence of an event,%;

n - number of options for calculating NPV.

As a measure of risk in investment design, it is advisable to use the probability of obtaining negative values of NPV. This probability have estimated as the ratio of the number of results with negative NPV to the total number of results obtained in percentages.

If from n = 5000 variants the negative value of NPV was received N = 3454 times, the risk measure is:

$$R = (N / n) * 100 = 4/5000)\ 100\% = 69.1\%.$$

Advantages of the simulation method:

- the possibility of calculating risks for nonlinear instruments;
- the possibility of using any distributions;
- the possibility of simulating the complex behavior of markets - trends, clusters of high or low volatility, changes in correlations between risk factors, "what-if" scenarios, etc.;
- the possibility of further, virtually unlimited development models.

Disadvantages of the simulation method:

- complexity of realization;
- requires powerful computing resources;
- with the simplest implementations may be close to either the historical or parametric method of valuation VaR, which will lead to deficiencies;
- probability of significant errors in models;
- difficulty for understanding by top management.

7.5 Risk Modeling by the Monte Carlo Method

Application of the statistical test method to calculate the area of the circle of a given radius. This problem belongs to the class of deterministic, since it is difficult to imagine random factors under the influence of which the area of a fixed geometric figure could change.

Solution to the problem

Let the circle have a radius r = 5, and its center is at the coordinate point (1,2). The equation of the corresponding circle has the form:

$$(x-1)\ 2+ (y-2)\ 2 = 25.$$

To solve the problem by Monte Carlo method, let's write a circle in a square. Its vertices will have coordinates (-4, -3), (6, -3), (-4.7) and (6.7). Any point inside a square or on its boundary must satisfy the inequalities (-4 <x <6) and (-3 <y <7). All points in this square may appear with the same probability, that is, x and y have evenly distributed with the probability density:

$$f(x) = \left\{ \frac{1/10 - for\ 4 \le x \le 6}{0 \text{ in another case}} \right\}$$

$$f(y) = \left\{ \frac{1/10\ \ for\ 3 \le y \le 7}{0 \text{ in another case}} \right\}$$

Having passed a certain number of tests (that is, having received a set of random points belonging to a square), we will calculate the number of points that hit the inside or the circle. If the sample consists of n observations and m point’s fall into or on the circle, then the estimate of the circle's area have obtained from the ratio:

$$Sk = Sk \cdot m/n\ =\ 100 \cdot m/n$$

Table 7.1 shows the estimates of Sk obtained for different values of n, with 5 runs for each one (the exact value Sk = 78.54 cm):

Table 7.1 - Results of estimation of square of a circle by
a method of statistical tests

Number I run	Estimated Square Circle Sq				
	100	200	1000	5000	10000
1	78	79,5	78	79,5	78,2
2	70	77	79	77,88	78,8
3	81	77,3	80,2	79,5	79,1
4	70	79,12	79,29	78,22	78,6
5	79	77,72	77,76	79	78,26
Medium	75,6	78,3	78,85	78,23	78,59
Dispersion	21,84	0,9982	0,789	0,44	0,11

Questions for self-examination

7.1 Give definitions for the concept of "expected return on project profit".

7.2. Explain the meaning of the concept of "relative risk of a project".

7.3. What characterizes the break-even point when evaluating the risk of the project?

7.4. What are the stages of project risk assessment?

7.5 Identify the typical factors of the sensitivity analysis of the project

7.6. What determines when analyzing the sensitivity of a project?

7.7. What is the use of project scenario analysis?

7.8. What have calculated when analyzing the project development scenarios?

7.9. What needs to be determined when using the Monte Carlo simulation method?

7.10 What allows assessing the risk caused by the implementation of this investment project?

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LECTURE 8. PECULIARITIES OF METHODS OF ASSESSMENT OF RISK

8.1 Actuality of management and evaluation. The choice of method for risk assessment

The success of a technical project depends on the correctness and validity of decision-making at all levels of management, which in turn is impossible without taking into account the risk [1, 2]. Engineers of modern enterprises need to be able to analyze the risk, evaluate its degree and do not exceed the permissible limits. That is, an engineer should not avoid risk, but anticipate it, trying to lower it to the lowest possible level. At the same time, it was impossible to completely avoid risk, even for the most ferocious work of the personnel, which takes into account all or almost all adverse events. In this regard, the task of assessing and managing risk becomes relevant.

There are many approaches to risk assessment and management. Among which there are those that are already "classics" and those that are "newcomers." One such "newcomer" is the Value-At-Risk (VaR) method that had developed in the 80's and 90's [3, 4]. The VaR feature is that it is not a single indicator, but a whole methodological complex that provides a wide range of opportunities, including in the assessment of risks in a transformational, transition economy. In particular, in today's Ukrainian environment, models that use the VaR methodology appear to be an effective and promising risk management tool.

Value at Risk (VaR) - Risk Amount - The easiest risk measure used in insurance, finance, banking and investment. It has become widespread since the mid-1990s for the quantitative measurement of market risk. The methodology was first recommended by The Global Derivatives Study Group, G30 in 1993 in the "Derivatives: Practices and Principles" study. In the same year, the European Council in the EEC 6-93 directive recommended that financial institutions use capital reserves to cover market risks using VaR models.

In 1994, the bank of International Settlements recommended banks to disclose their Val var. In 1995, the Basel Committee on Banking Supervision offered banks to use their own VAR assessment models as the basis for calculating the amount of capital that has been reserving to cover potential losses that may result from unfavorable financial market conditions. In 1996, the US banking regulation organizations approved the proposal of the Basel Committee.

The idea of the method is to construct an upper estimate of capital, which may be lost because of an unfavorable coincidence of circumstances. That is, it is about capital, which will be lost in the "worst case". At the same time, choose some level of probability a, estimate the capital that can be lost with this probability. Usually a $\alpha = 0.05$ is selected. We can say that VaR is the upper limit of the trust half interval of the amount a, which can be lost. Thus, VaR is a quantile of the level α of the loss distribution function (Fig. 8.1).

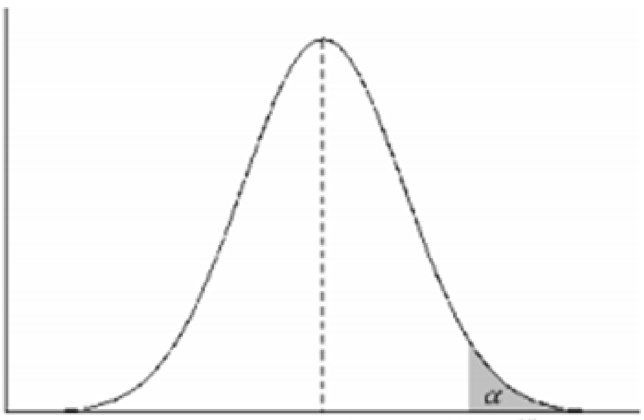

Figure 8.1. - Value at Risk (VaR) - The amount at risk is the normal distribution density

If the losses have normally distributed with the mathematical expectation E (X) and the dispersion σ (X):

$$VaR_a(X) = E(X) + F^{-1}(1-\alpha)\cdot\sigma(X)$$

where - F^{-1} (1-α) is the quantile of the standard normal distribution of the level(1-α).

Quantum is one of the characteristics of random variables. If the X distribution of a random variable is continuous, then the quantal Kp of order p is defined as a number for which the probability of the inequality X < Kr is equal to p. From the definition of the quantum of, it turns out that the probability of the inequality Kr <X <Kp 'is equal to p' - p. $K_{1/2}$ is the median of the random variable X. Quantiles $K_{1/4}$ and $K_{3/4}$ are called quartiles, and K0.1, K0.2, K0.9 are deciles [1, 5]

Note that the resulting criterion has often used independently, regardless of the distribution functions and the confidence intervals:

$$R(X) = E(X) + \beta \cdot \sigma(X)$$

where E (X) is a mathematical expectation;

σ (X) - dispersion;

β > 0 is a certain coefficient (sometimes it is called the "pessimism coefficient"), which is chosen by the researcher in relation to the conditions of the task.

If you are not thinking about losses, but about income, then you can define a similar criterion. In this case, VaR has defined as the income in the worst-case scenario.

Consider the question of the basis of which methods one can determine the laws of distribution in random variables describing the consequences of the solution. Of great significance is the central limit theorem of probability theory (Lyapunov's theorem), which shows that the distribution of many variables depending on the case does not differ much from the normal distribution law. This happens, in particular, when the corresponding random mechanism has put into effect by a greater number of more or less independent random factors that has superimposed on each other. The practical conclusion that follows from this theorem is as follows: if the law of distribution of this particular random variable have not known, then for obtaining the previous, average characteristics of this quantity, we can assume that it has a normal distribution law. In other words, in practice, any quantity normally distributed can be considered as long as there is not enough reason to believe that this value has another distribution law. [1,5].

A normally distributed X has characterized by the following distribution function:

$$F(X) = 0{,}5 + \Phi\left(\frac{x-\alpha}{\sigma}\right)$$

where is $\Phi(X) = \frac{1}{\sqrt{2\pi}}\int_0^x e^{-t^2/2}dt$ Laplace function;

α is the mathematical expectation of the value of X;

σ is the mean square deviation, α.

This means that we will know everything about a normally distributed quantity if only two of its parameters are known - mathematical expectation and variance. One of the simplest methods for determining the parameter σ of the normal law is the "rule of three stigmas": if the random variable is normally distributed, then the absolute value of its deviation from the mathematical expectation does not exceed the triple mean square deviation. [1,5].

Thus, if we assume that the value of X has a normal distribution law and the observed range (observed data) has the form ((α - Δ, α + Δ), that is, with reliability γ=0,9973, the mathematical expectation of the value of X is exactly **α**, and the mean square deviation σ = Δ/3. Thus, the assumptions made allow us to find the parameters of the normal distribution law.

In the case where the distribution law have not known, Chebyshev's inequality have be used to determine σ:

Let X be any random variable whose mathematical expectation is exactly α =E(X), σ is the mean square deviation. Then, the probability that the value of X will take any value outside of the range (α - Δ, α + Δ) does not exceed the values of σ^2/Δ^2.

In other words, true inequality

$$P(|X-\alpha| \geq \Delta) \leq \frac{\sigma^2}{\Delta^2}$$

In this case, we can take the value of σ and as a measure of risk. In this case, you can also put σ = Δ/3, but with this the reliability of the estimate is reduced to 8/9. The level of significance α = 1-γ = 1/9.

8.2 Features of risk assessment Value-At-Risk (VaR)

The Value-At-Risk Risk Assessment Method allows you to estimate the magnitude of the maximum possible loss (loss) with a certain probability level [6]. The loss in this case is a negative change in the cost of the project to be invested (P) at the time t and at the time and-1, that is: $\Delta P = P_I - P_{I-1}$.

The probability level has chosen differently, depending on the attitude to risk. When choosing the probability level, the worst results have rejected. That is, when choosing 99% of the confidence interval, the VaR score will take into account all the results, except for 1% of the worst, and when choosing 95% of the confidence interval, 5% of the most undesirable results will not have taken into account.

Valuation of VaR can occur both by determining the magnitude of absolute losses, and by determining the value of losses relative to the average income. The time horizon for which the VaR have calculated have often chosen based on the minimum real time period during which the tool have be realized without significant damage.

There are three main methods of calculating Value-At-Risk:

- method of historical modeling;

- method of parametric estimation, which is more widely distributed in the form of a variation-covariance model;

- a simulation model, often referred to as the main model used in its framework, by the Monte Carlo method.

8.3 Method of historical modeling

The idea of the method is to use historic price changes for the components of a portfolio of financial instruments to build a distribution of future changes in prices, potential returns and portfolio losses in general.

Valuation of VaR by this method has carried out as follows.

In the first stage, the initial series of indicators is determined - the values of the portfolio value under consideration, for all recorded in the historical period of market conditions.

At the second stage, the resulting time series have translated into a number of relative indicators.

In the third stage, the values obtained have arranged, and they have cleared to the part of the worst values that exceeds the accepted confidence level.

The worst of the remaining values corresponds to the maximum probability within the accepted confidence level of the loss value that is VaR - in accordance with the calculation procedure in the form of a relative change in value.

At the last fourth stage, the relative valuation of VaR has given to the absolute monetary equivalent.

Advantages of the historical modeling method:

- relative ease of implementation of the method;
- computing speed;
- the opportunity to get rid of modeling errors;
- the possibility of correct accounting of risks of nonlinear instruments;
- stability of estimates;
- Ease of understanding for top management.

Disadvantages of the Historical Modeling Method:

- Incorrect results if the sample obtained in the base period is not representative;
- inability to use predictive values of volatility and correlations;
- impossibility of application at significant fluctuations of values of the corresponding indicator in the market.

8.4 Method of parametric estimation

This VaR assessment approach has presented as a variation - covariant model.

The analysis has based on the assumption that the actual distribution of the random variable (market index) corresponds to the theoretical regularity of the normal distribution of probabilities. Accordingly, on the market index, the conclusions had drawn, which are made based on calculations on theoretical distribution.

Valuation of VaR by this method has carried out as follows.

At the first and second stages, the initial set of indicators is determined and the transition to a number of relative values is analogous to the historical modeling.

In the third stage, the determination of the parameters of normal distribution, which best approximates the actual distribution of the indicator, is carried out.

Then the value of the inverse normal distribution is determined in accordance with the previously obtained parameters and the established confidence level.

At the final stage, the obtained relative valuation VaR has reduced to the absolute monetary equivalent in accordance with the form of the initial statistical series (similar to the fourth stage of historical simulation).

The described algorithm meets VaR estimates for one tool. For component portfolios, calculation had carried out according to a similar scheme, but with the use of more complex matrix mathematical and statistical apparatus.

Advantages of the parametric method:

- relative simplicity of implementation;
- computing speed;
- allows you to use different variants of values of volatility and correlations.

Disadvantages of the parametric method:

- impossibility of using other distributions, except for normal;
- impossibility of correct accounting of risks of nonlinear instruments;
- probability of significant errors in models;
- difficulty for understanding by top management.

Questions for self-examination

8.1. What is the method of risk assessment and management developed in the 80-90 years of the 20th century?

8.2. Specify the main features of the Value-At-Risk (VaR) method of risk assessment and management.

8.3. What, besides the risks, allows you to evaluate the Value-At-Risk (VaR) method?

8.4. What have meant by losses, in an analytical form, when using the Value-At-Risk risk assessment method?

8.5. What are the worst risks of a project identified, give an example?

8.6. What do the risk-assessment methods determine when assessing the Value-At-Risk (VaR)?

8.7. Name the three main methods of calculating Value-At-Risk.

8.8. What is the idea of the Value-At-Risk method?

8.9. Describe the four stages of risk assessment using the Value-At-Risk method.

8.10 Advantages of the Historical Modeling Method - Value-At-Risk Risk Assessments

8.11. What is the Value-At-Risk Assessment When Using the Parametric Risk Assessment Method?

8.12. Specify the advantages and disadvantages of parametric risk assessment

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LECTURE 9. USE OF THE RISK ASSESSMENT METHOD
Value-At-Risk (VaR)

9.1 Justification of the expediency of using the VALUE-AT-RISK method

In the general case for valuing risks using the VALUE-AT-RISK (VaR) method, the following is true: if the investigated index has a positive ingredient, that is, it seeks to maximize it, VaR can be founded by the formula [1]:

$$VaR = m\text{-}k\sigma,$$

where t - mathematical expectation;

σ - mean square deviation (risk measure);

k - coefficient, which depends on the chosen confidence probability (price risk).

If the investigated parameter has a negative ingredient, that is, it seeks to minimize it, VaR is calculated by the formula:

$$VaR = m + k\sigma.$$

Example

Let us decide on a wholesale purchase of the iPhone 5S lot of D = 10,000 devices at the price of P1 with a view to selling it at the price of P2. It have known that the wholesale price of one phone varies in the range of 10 UAH up to 12 UAH. Accordingly, the range of retail prices is 13-16 UAH. Find the bottom line of the volume of revenue at the level of value a = 1/9.

We have:

$$Y = D\,(P_1 - P_2),$$

$$P_1^0 = 11,\ \Delta P_1 = 1,$$

$$P_2^0 = 14{,}5,\quad \Delta P_2 = 1{,}5.$$

Then

$$\Delta Y = D \cdot (\Delta P_1 + \Delta P_2) = 10000 \cdot (1 + 1{,}5) = 25\ 000,$$

$$a = E(Y) = 35\ 000,\ \ \sigma(Y) = \Delta Y/\ 3 = 25000/3 = 8333.3.$$

$$D = \sqrt{\frac{\sum_{i=1}^{n}\left(s_i - S_{cp}\right)^2}{(n-1)}} =$$

$$\sqrt{\frac{(10.1-10.07)^2 + (10.2-10.07)^2 + (9.8-10.07)^2 + (9.9-10.07)^2 + (9.7-10.07)^2}{4}}$$

$$= \sqrt{\frac{0.0009 + 0.0169 + 0.0729 + 0.0289 + 0.1369}{4}} = \sqrt{\frac{0.2565}{4}} = 0.064125$$

It has known that the wholesale price of one phone varies in the range of 10 UAH up to 12 UAH. Knowing and getting, we find the lower boundary of the revenues for 24 779 UAH with the reliability of 8/9.

The main advantage of VaR is its simplicity. To his drawbacks have be attributed to the fact that because of its simplicity, he ignores most of the information contained in the distribution function of the analyzed size.

VaR does not respond to the distribution of the magnitude of the losses occurring with probabilities, smaller they have considered unlikely and ignored. In some areas, for example, in insurance, one have not be discouraged by large losses that occur with little probability because they account for a significant proportion of payments.

In this connection, attempts have made to supplement VaR with any characteristics of the distribution tails. For example, as a measure of risk, a mathematical expectation has proposed, if the loss exceeds a certain level:

$$R (X) = E (X \mid X> t),$$

where X - random value of damage, it is a certain number.

In insurance, such a risk measure is sometimes have called EPD (Expected Policyholder Deficit).

If we choose t = ax + βσx as t, then we get the degree of risk, which have called the Tail Conditional Expectation (Tail Conditional Expectation - TSE) [6]:

$$R (X) = E (X \mid X>VaRa (X)).$$

9.2 Semiariation and semicircular deviation when used Value-at-Risk method

In the following, the case where the investigated index has a positive ingredient is considered. If the random variable (investigated index) $X = \{x_1; ...; x_p\}$ represents the returns (X = X +), that is, has a positive ingredient) and the value of X_j<M (X) (the estimate of profit x_j is the realization of a random variable and is less than the expected value of profit), this is a sign of an unfavorable situation. At the same time, a positive deviation indicates that the realization of a random variable (profit) is greater than the expected value, and this is a favorable situation [2].

Note that the risk is associated with adverse situations, and for its evaluation, it is enough to take into account only the adverse deviations from the expected value, and not all deviations. At the same time, at risk, it has proposed to take a Semiariation [3], which for a discrete random variable X is have calculated as follows:

$$SV(X) = \sum_{j-1}^{n} a_j p_j \left(x_j - M(X)\right)^2$$

where n is the value of the random variable X;

x_j is the value of the random variable, j = 1, ..., n;

p_j - relevant probabilities;

M (X) - mathematical expectation of random variable X;

a_j - indicator of adverse deviations;

a = 0, in the case of a favorable deviation;

a = 1, in the case of an unfavorable deviation.

For our example, if the random variable X = {x}; ...; x_n} represents the profit ($X = X^+$), then

$$0,\ x_j > M(X^+)\ ;\ j = \overline{1,n}.$$

$$1,\ x_j < M(X^+)$$

From a practical point of view, it is more convenient to apply a semicircular deviation, which is: $SSV(X)=\sqrt{SV(X)}$

Then for VaR the following is true:

$$VaR = m - kSSV$$

where t - mathematical expectation;

SSV - semicircular deviation (risk measure);

k - coefficient, which depends on the selected confidence probability (price of risk).

9.3 Using VaR asymmetric distribution indicators

One of the weaknesses of VaR is the assumption of the normality of distribution and, accordingly, the presence of symmetry in the distribution. However, in most cases the distribution of the studied indicators is asymmetric. In addition, for the base of calculations it have suggested instead of the mathematical hope to choose a fashion or median [4]

If the center of the grouping of the values of the investigated indicator to use the median of a random variable, then in absolute terms, the risk of median can be used median semi variation and semicircular deviation from the median. For a discrete random variable X, the median semi variation has calculated by the formula:

$$SV_{M_e}(X) = \sum_{j-1}^{n} a_j p_j \left(x_j - M_e(X)\right)^2$$

where a_j is an indicator of adverse deviations that determine how

a = 0, in the case of a favorable deviation;

a = 1, in the case of an unfavorable deviation.

n - number of values of the random variable X;

[x] is the value of the random variable.

J - 1, ..., n, p] - the corresponding probabilities;

Me (X) is the median of the random variable X.

The semiaxial deviation from the median will be:

$$SSV_M(X) = \sqrt{SV_M(X)}.$$

Then the formula for calculating VaR has be rewritten as follows:

VaR = Me-kSSVM

where Me is the median;

SSVM - Semi-square deviation from median (risk measure);

k - coefficient, which depends on the selected confidence probability (price of risk).

For a fashion, you can make similar calculations.

To date, the VaR methodology is, of course, a successful solution to the risk assessment problem, and maybe the best of the developed [9-13]. However, the assumption of normal distribution and the absence of asymmetry in distribution limits the use of VaR The proposed approach to using semivariation and semicircular deviation instead of the usual variations and the mean square deviation, as well as the mod or median instead of the mathematical expectation, extends the limits of using the VaR method. Further research has be aimed at reducing the limits laid down in the VaR methodology.

Questions for self-examination

9.1. Specify a mathematical model for risk assessment using the VaR method as if the researched indicator has a positive ingredient.

9.2. Specify the mathematical model of risk assessment using the VaR method, if provided that the test result have a negative ingredient.

9.3 Record the mathematical model of the risk measure for adverse deviations from the expected value.

9.4. Specify the mathematical model of the risk of adverse deviations from the expected value, which is more expedient to use for practical calculations.

9.5 Define VaR for adverse deviations from the expected value.

9.6. Specify the features of the VaR method when asymmetric distribution of the studied indicators.

9.7. Provide a mathematical expression of a semicircular deviation from the median with an asymmetric distribution of the studied risk indicators.

9.8. Record a mathematical model for determining the risk by the VaR method in the asymmetric distribution of the studied risk indicators.

9.9. What constrains the widespread use of the VaR method in risk assessment?

9.10 What makes the VaR method more effective in assessing risks?

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