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K.V. Kolesnikova,
PhD, docent,
Odessa National
Polytechnic University
e-mail:
amberk4@gmail.com

E.V. Vlasenko,
master, assisnant,
Odessa National
Polytechnic University
e-mail: olena.vlasenko@
gmail.com

D.V. Lukyanov,
teacher,
Belarusian State
University
e-mail:
dlukiano@gmail.com

T.M. Olekh,
mathematician,
Odessa National
Polytechnic University
e-mail:
olekhseta@yandex.ua

ROCESS MODEL OF COMMUNICATION IN PROJECTS USING MARKOV CHAIN

K.V. Kolesnikova, E.V. Vlasenko, D.V. Lukyanov, T.M. Olekh. Process model of communication in projects using Markov chain. Developed model communication processes in projects using Markov chain with discrete states and time.

К.В. Колеснікова, Е.В. Власенко, Д.В. Лук'янов, Т.М. Олех. Процесна модель комунікацій в проектах із застосуванням марківських ланцюгів. Розроблена модель комунікаційних процесів в проектах із застосуванням марківського ланцюга з дискретними станами і часом.

Introduction. Communications project team members with each other and other members of the design process, mainly in the external environment projects, is one of the main parts of management processes, as evidenced by the inclusion of internal and external communications in the basic standards of project management [1]. System Knowledge Project Management Institute PMI, known as PMBoK, project management defines communication as a field that uses the processes required to ensure timely and accurate creation, collection, distribution, storage, retrieval and final sort of project information.

Relevance of research. Projects and programs being implemented in Ukraine with participation of the European Union in the fields of education, environment, health are the most difficult type of project activities through their social orientation, and also because of the specific goals aimed at achieving a positive effect not only through application of innovative technologies, but also through the introduction of modern mechanisms of project-oriented management [2]. So urgent scientific challenge for Ukraine is the formation of a new paradigm of project management using mathematical models to assess the level and quality improvement projects based communication processes.

Dynamics of development and updating of knowledge management projects aimed at creating a new science-based approaches to communications proektyzatsiyi in projects [3]. Modern scientific study and practice of project management worked out some form of communication that are widely reflected in different standards and systems of knowledge management projects. The use of traditional approaches to formulation and implementation of communications, based on the principles of process representation is insufficient for effective achievement of projects implemented [4]. Projecting communications are applied to all kinds of projects. But the most important is proektyzatsiya communications in international projects to achieve understanding between members of international projects from many countries despite linguistic, professional, political, cultural and institutional differences. [2] To succeed in a competitive environment must combine established business processes with targeted outcome design approaches [4].

Analysis of publications. The term "communication" (from the Latin. *Communicare* – make common message transmission) in the semantic aspect of the project – is the exchange of ideas, information, ideas, transfer of certain content from one project participant (collective or individual) to another via messages. Communication is a design process that reflects the structure of the project and do it connective function [4].

Mass communication – a systematic dissemination of messages (through print, radio, television, film, audio and video) among large, dispersed audiences to strengthening spiritual values and of the ideological, political, economic or organizational impact assessments, opinions and behavior. Unlike mass communication special significance for project management with managerial communication.

Managerial Communication – a collection of information ties between management vertical, horizontal (internal environment) and external turbulent environment.

For organizations effectiveness of market competition through the implementation of projects is environmental elements, the main ones are: personnel, technology, resources, management, market and projects. Availability and the potential impact on these elements of the competitive environment are different [1]. Thus, the elements of the environment: personnel, technology, resources, markets and projects in a globalized economy are equally accessible to all and can only slightly improve efficiency projects. While improving management provides the potential for improving the effectiveness of projects in the fold. This project management undertaken by communications is a priority of sustainable development organizations [2].

Economic globalization and the development of international trade and production linkages create conditions for increasing requirements for communication processes, especially is essential in international projects [2].

The concept of "communication" has a dual interpretation:

- First, it captures the static interaction, such act, written document that contains information that performs functions: informative, emotive (induces emotions,

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motivation, interaction), managerial (leads to specific actions or processes) and therefore establishes and supported by actual contact between the project participants.

- Secondly, captures the dynamic process of interaction, contacts, relationships.

Interaction has an objective and a subjective side.

The standard model of communication, which is considered in most studies is generally consists of the following elements [3]:

source -> Messages -> Encoding -> transfer-> decode -> recipient.

Start building modern project management methodology associated with the development of space programs and refers to the 50-ies of the last century, when, a new scientific discipline - Project Management (Project Management) - which explores the phenomenon and essence, relationships and patterns in process control projects during the life cycles of both managed social or organizational and technical systems with features unique, limited in time, money and resources focused on achieving certain useful results and values by creating products. According to the definition proposed in [3], under the project in general is defined as "limited in time purposeful change a single system with the established requirements for quality results, possible scope of costs and resources and a specific organization."

ICB system knowledge is used to formalize knowledge in project management in the preparation and certification of professional competences of project managers on a 4-level system of the International Project Management Association IPMA [2]. System knowledge ICB includes 20 technical knowledge elements that relate to the content of project management, 15 behavioral elements of knowledge relating to interpersonal relationships between individuals and groups involved in projects, programs and portfolios of projects, 11 of contextual knowledge elements that related to the interaction design team with the environment of the project and the organization in which the project.

Communication under ICB, consisting of effective exchange of information and understanding between the parties. Effective communication is vital to the success of projects, programs and portfolios correct information should be communicated to stakeholders, accurately and consistently to meet their expectations. Communication must be useful, clear and timely.

System knowledge P2M - one of the most recent developments in the field of project management methodology and software [3]. Methodology P2M, developed by the Association of Engineering of Japan and the Japanese Association of Project Management. Along with the fact that the main vector P2M application is to create added value or value of the project (program) using creative mechanism, it should be noted that P2M designed to provide integrated management of projects and programs based on proven practices in the world, which is based on work project managers in a dynamic project environment. P2M argues that communication management as a way that promotes better understanding among stakeholders is a major factor in shaping the success of the project.

Program and project management has been successfully used by the European Union to achieve basic constitutional objectives, such as sustainable and balanced development, protection of rights and interests of the EU, the identification of the EU on the world stage. These objectives are reflected in the strategic plan (2007-2013), which is implemented through tools: transnational, cross-border and regional programs that have their own priorities for the selection of relevant projects for future funding. Thus there are programs that implement priority cooperation and neighborhood, which may take part, and Ukraine, for example, "Romania - Ukraine - Republic of Moldova", "Poland – Belarus - Ukraine", "Hungary - Slovakia – Romania - Ukraine", "Black Sea », TEMPUS, ERASMUS MUNDUS, 7FP.

Problem assess the quality of communications. The practice of preparing and implementing European projects within these programs shows that communication management is crucial condition for successful implementation of these projects in terms of the international remote teams. That mission in terms of communication "imputed" project managers rejecting the Ukrainian project secretariat of a European program.

The main part.

Famous model communications reflect elementary acts of interaction communicants, not general characteristics of communications systems. This approach to the evaluation of communication links is not productive. Communications system is holistic (emergent) properties that are not inherent to individual acts of communication.

Therefore, the properties of the system is the sum of the properties of the individual parts that make up it.

To develop mechanisms for evaluating the effectiveness of communications for the entire project, rather than individual pieces - a single send and receive project information can be used cybernetic approach when building the relationship between the input and output process without a detailed study of the internal characteristics of the object. Such models of communication that reflect the processes of communication for the entire project can be constructed using Markov chains [4].

Quantitative evaluation (measurement) as a communications belong to the most difficult problems is the least explored, while the relevance and practical importance of such work, especially for communications in the formation of international research projects grants are sufficiently important.

Standard project management PMBOoK determine project communication function as the exchange of specific project information to create understanding between the sender and receiver of information [1]. In this case, a recognized Japanese standard P2M [3] puts function based communication providing mutual understanding among people involved in the project, lighting real situations, events and activities of the project, the creation method / way to perform tasks based on specific conditions.

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Realizing the importance of effective communication processes in international projects funded by the European Union, the European Commission has developed a series of documents called "Communication Recommendations", in which certain basic steps and make planning successful (from the point of view of the European Commission) communication processes.

Communication processes of European projects mainly are based communication methods PMBOoK [1], but can be successfully use knowledge standards P2M, PRINCE2, ICB, ISO 10006, ISO 9001.

The model of communication in European projects.

Generalization official project documentation and standards of project management allows you to select a typical facing project manager with an international project team within all phases of the "life project." Such processes twenty-one and every one of them "stitched" from the other by any means of communication (Fig. 1).

Each of these processes generates field communication messages transmitted in accordance with the logic of the project to other project processes. This communication interactions develop as a random process that has a Markov property: the future of the system is determined by the current state and does not depend on when and how the system came into this state, communication, implemented in some moments translate the system into a new state.

Result communications appear in the form of probability states of the system that is exposed to random processes, the course and outcome of which depends on the number of random factors that accompany these communications.

To construct a Markov model of communication should not only display the system in the form of marked-graph indicating possible transitions between states in one step, but also to determine the conditional probability of transitions. Presentation of project communications in a Markov chain model allows quantitative parameters of effectiveness of communication in projects.

The structure of the processes is based on a matrix principle. In the category axis deferred nature of the project: PEOPLE - COMMUNICATION - DRAFT - REZULT. These categories are assigned to specific stages of project INITIATION - PLANNING - IMPLEMENTATION - CONTROL - IMPROVEMENT - END.

On the grid formed by these parameters are 18 process recommended by the official documentation and standards of project management.

As you know, the topology of the different systems reflect using directed graphs $A = \{S, G\}$, ordered pairs of vertices S and the set of arcs oriented G, which they connect. Each process corresponds to a specific vertices. Ribs designated areas of communications processes necessary to manage the project (Figure 1). In general, each process corresponds to a class of communications. The total time T of the project:
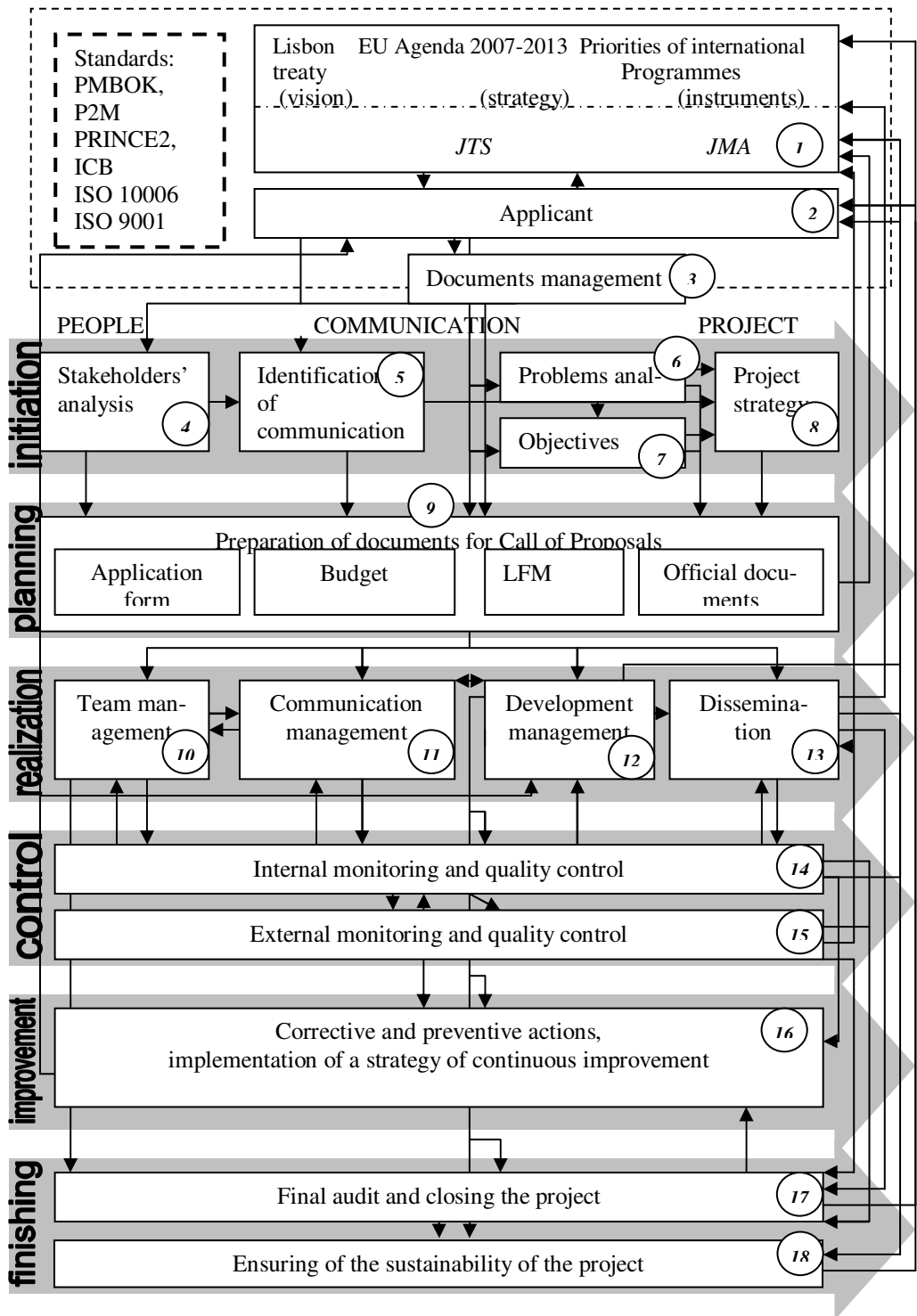
Fig. 1. Scheme communication processes in international projects

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$$T = \sum_{s=1}^{n} t_s \qquad (1)$$

where t_s - time of the project in the s, $s = 1, 2 \ldots n$;

n - the number of processes.

Each process communication system may be a while in the performance of the project. This time is proportional to the probability of finding the system in this state. The ratio $p_s = t_s/T$ makes sense frequency (probability) stay project in some process s.

The sum of probabilities of being in each of a plurality of states n:

$$\sum_{s=1}^{n} p_s = \sum_{s=1}^{n} \frac{t_s}{T} = \frac{1}{T} \sum_{s=1}^{n} t_s = 1 . \qquad (2)$$

For any step k (at time t_1, t_2, ... t_k) is the probability π_{ij} transition from some state and $\{i = 1, 2, ..., n\}$ in any other j $\{j = 1, 2, ..., n\}$, and a possible delay of the system in this state π_{ii}, which is a Markov property system. Because of some of the $S_i^{(k-1)}$ a transition from one step to any state from the set $S_1^{(k)}$, $S_2^{(k)}$, ..., $S_i^{(k)}$, ..., $S_n^{(k)}$, where n is the number of vertices in the graph, these events are incompatible and form a complete group (Fig. 2). Therefore, we can write:

$$\sum_{j=1}^{n} \pi_{ij} = 1 . \qquad (3)$$

Each communication links for state s: $s = 1, 2 \ldots n$ project with states j: $j = 1, 2 \ldots n$ project manager may be a while in the performance of the project. This time is proportional to the probability of execution of the project manager of this communication.

The ratio $\pi_{ij} = \dfrac{\tau_j(s)}{t_s}$, $\{ i = s : s = 1,2, \ldots n \}$ is meaningful probability (frequency) communications.

The sum of probabilities of being in each of a plurality of states n:

$$\sum_{j=1}^{n} \pi_{ij} = \sum_{j=1}^{n} \frac{\tau_j(s)}{t_s} = \frac{1}{t_s} \sum_{j=1}^{n} \pi_j(s) = 1, \quad \{ i = s : s = 1,2, \ldots n \}. \qquad (4)$$

Thus, these states form a group of incompatible events.

Matrix, which includes all possible transition probability Markov chain with 21 nodes when presenting his complete graph looks like:

$$\left\| \pi_{ij} \right\| = \begin{Vmatrix} \pi_{1.1} & \pi_{1.2} & \pi_{1.3} \cdot & \cdot & \cdot & \pi_{1.17} & \pi_{1.18} \\ \pi_{2.1} & \pi_{2.2} & \pi_{2.3} \cdot & \cdot & \cdot & \pi_{2.17} & \pi_{2.18} \\ \pi_{3.1} & \pi_{3.2} & \pi_{3.3} \cdot & \cdot & \cdot & \pi_{3.17} & \pi_{3.18} \\ \cdot & \cdot & & & & \cdot & \cdot \\ \cdot & \cdot & & & & \cdot & \cdot \\ \cdot & \cdot & & & & \cdot & \cdot \\ \pi_{17.1} & \pi_{17.2} & \pi_{17.3} \cdot & \cdot & \cdot & \pi_{17.17} & \pi_{17.18} \end{Vmatrix}. \tag{5}$$

To graph, shown in Fig. 1, some of the transition probabilities Accept zero, indicating lack of communication between the vertices.

Based on the matrix of transition probabilities of states, provided that the initial state of the system is known, we can find the probability of states $p_1(k)$, $p_2(k)$, …$p_n(k)$ after any k-th step. For this we write the general solution of the mathematical description of the Markov chain with 21 states:

$$p_i(k) = \sum_{j=1}^{m} \left[p_i(k-1) \cdot \pi_{ji} \right]\Big|_{m=21}; \quad i = 1, 2, \cdots, 18 \cdot \tag{6}$$
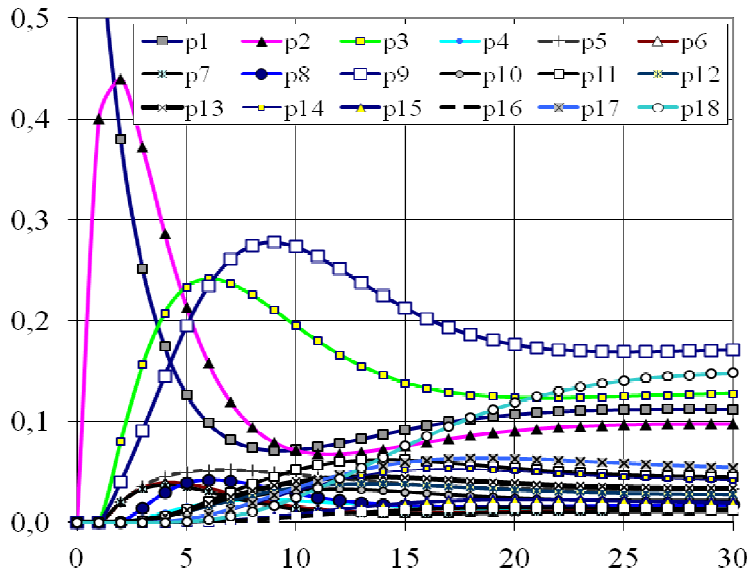

Fig. 2. Changes states probabilities communication processes for the basic version of the project (refer to states according to Fig. 1.)

Based on expert assessments obtained values of transition probabilities. Executed on this data calculations change will become an example of the communication process as a Markov chain shown in Fig. 2.

Modeling of communication processes using homogeneous Markov chains with discrete states and eventually display a complex interaction of information flow in the projects. State probabilities of communication processes in step 30 are

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divided into two groups. For the first group of processes $pi(30) < 0.05$, for three times - $pi(30) > 0.1$. The most important are the communication processes 9, 18 and 3.

Conclusion. Designed Markov model change system states can determine the quantitative characteristics of communication processes in international projects. Direction of future research is to identify the model of the development of the method of determining the values of the transition probabilities for different types of projects.

Literature

1.A Guide to the Project Management Body of Knowledge. Third Edition (PMBoK® Guide) [Text]. - An American National Standard ANSI / PMI 99 — 001—2004.

2.Bushuyev, S.D. National Competence Baseline, NCB UA Version 3.1 [Text] / S. D. Bushuyev, N. S. Bushuyeva. – К. : ІРІДІУМ, 2010. – 208 p.

4.Руководство по управлению инновационными проектами и программами предприятий. Японская ассоциация управления проектами PMAJ (ua) [Текст]. — К. : Науковий світ, 2009. — 175 с.

4.Vlasenko, O.V. Model "Diamond" estimates of internal communications in European projects [Text] / O.V. Vlasenko, D.V. Lukianov, V.D. Gogunsky // Eastern-European journal of enterprise technologies. - № 1/10 (61). – 2013 – P. 86 – 88