Data Stream Mining & Processing

PROCEEDINGS of the

2018 IEEE Second International Conference on
Data Stream Mining & Processing (DSMP)

IEEE Ukraine Section (Kharkiv)
SP/AP/C/EMC/COM
Societies Joint Chapter

IEEE Ukraine Section (West)
AP/ED/MTT/CPMT/SSC
Societies Joint Chapter

August 21–25, 2018

Lviv, Ukraine

Proceedings of the

2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP)

Organized by

IEEE Ukraine Section

IEEE Ukraine Section (Kharkiv) SP/AP/C/EMC/COM Societies Joint Chapter

IEEE Ukraine Section (West) AP/ED/MTT/CPMT/SSC Societies Joint Chapter

IT Step University

Ukrainian Catholic University

Lviv Polytechnic National University

Kharkiv National University of Radio Electronics

Lviv, Ukraine
August 21-25, 2018

Additional copies may be ordered from:

IEEE Conference Operations
445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331 USA

DSMP’2018 Organizing Committee
IT Step University,
83a Zamarstynivs'ka st., 79019, Lviv, Ukraine

E-mail: dsmp.conference@gmail.com

IEEE Catalog Number: CFP18J13-CDR

ISBN: 978-1-5386-8175-6

DSMP'2018 Conference Committee

Honorary Chairpersons

Yuriy Rashkevych, Ukraine
Yevgeniy Bodyanskiy, Ukraine

General Chairs

Dmytro Peleshko, Ukraine
Olena Vynokurova O., Ukraine
Yaroslav Prytula, Ukraine

Technical Program Committee Chair

Dmytro Peleshko, Ukraine

Publication and Finance Chair

Olena Vynokurova O., Ukraine

Technical Program Committee

Aizenberg I., USA
Antoshchuk S., Ukraine
Babichev S., Czech Republic
Balasubramaniam J., India
Berezkiy O., Ukraine
Bidyuk P., Ukraine
Bogomolov S., Australian
Boyun V., Ukraine
Churyumov G., Ukraine
Didmanidze I., Georgia
Du K., China
Dyvak M., Ukraine
Gabsi M., France
Gabsi M., Tunisia
Gozhiy O., Ukraine)
Gryniv R., Ukraine
Hnatushenko V., Ukraine
Hu W.B., China
Kareem Kamal A. Ghany, Egypt
Karlik B., Albania
Khaled G., Tunisia
Kharchenko V., Ukraine
Klawonn F., Germany
Kokshenev I., Ph.D., Brazil
Krylov V., Ukraine
Lu C.W., China
Lytvynenko V., Ukraine
Lyubchik L., Ukraine
Lubinets Ya., Ukraine
Malyar M., Ukraine
Markov K., Bulgaria
Mashkov V., Czech Republic
Mashtalir V., Ukraine
Mikhalyov O., Ukraine
Morklyanyk B., Ukraine
Nakonechny A., Ukraine
Petlenkov E., Estonia
Qu S.C., China
Rekik A., Tunisia
Romanyshyn Yu., Ukraine
Rusyn B., Ukraine
Sachenko A., Ukraine
Setlak G., Poland
Šipeky L., Slovakia
Shelevytsky I., Ukraine
Slipchenko A., Netherlands
Smolarz A., Poland
Snytyuk V., Ukraine
Sokolov O., Poland
Sokolovsky Ya., Ukraine
Souii M., Ph.D., Tunisia
Stepashko V., Ukraine
Štěpnička M., Czech Republic
Schlesinger M., Ukraine
Su J., China
Szymanski Z., Poland
Temani M., Tunisia
Tkachenko R., Ukraine
Tsmots I., Ukraine
Vassiljeva K., Estonia
Voloshyn V., Ukraine
Vorobyov S., Finland
Wójcik W., Poland
Wu J.Q., China
Yanovsky F., Ukraine
Yatsymirskyy M., Poland
Ye Z.W., China
Yegorova E., United Kingdom
Zhengbing Hu, China
Zaychenko Yu., Ukraine

Local Organizing Committee Chair

Taras Rak, Ukraine

PR Manager

Maria Shepel, Ukraine

Event Manager

Yulia Vasylets, Ukraine

Members of Local Organizing Committee

Alekseyev V., Ukraine
Andriychuk M., Ukraine
Batyuk A., Ukraine
Berezko O., Ukraine
Borzov Yu., Ukraine
Doroshenko A., Ukraine
Didyk O., Ukraine
Dumin O., Ukraine
Ivanov Yu., Ukraine
Figura R., Poland
Kostyuk N., Ukraine
Klyuvak A., Ukraine
Kyselova A., Ukraine
Lotoshynska N., Ukraine
Malets I., Ukraine
Menshikova O., Ukraine
Miyushkovych Yu.,Ukraine
Molchanovskyi O., Ukraine
Mulesa P., Ukraine
Panchenko T., Ukraine
Perova I., Ukraine
Pichkalov I., Ukraine
Povkhan I., Ukraine
Seniuk V., Ukraine
Shateyev O., Ukraine
Sviridova T., Ukraine
Sydorenko R., Ukraine
Tsiura N., Ukraine
Tyshchenko O., Ukraine
Veselovsky S., Ukraine
Vysotska V., Ukraine

List of Reviewers

Yu. Rashkevych, Ukraine
D. Peleshko, Ukraine
O. Vynokurova, Ukraine
V. Voloshyn, Ukraine
Ie. Gorovyi, Ukraine
Yu. Romanyshyn, Ukraine
S. Antoshchuk, Ukraine
Ya. Sokolovskyy, Ukraine
I. Perova, Ukraine
O. Didyk, Ukraine
Ye. Pavlov, Ukraine
N. Kulishova, Ukraine
I. Shelevytsky, Ukraine
L. Lyubchyk, Ukraine
M. Yatsymirskyy, Poland
A. Dolotov, Ukraine
D. Puchala, Poland
P. Tarasiuk, Poland
Ie. Burov, Ukraine
O. Karabin, Ukraine
G. Kriukova, Ukraine
N. Lamonova, Ukraine
V. Lytvyn, Ukraine
Ya. Todorov, Finland
G. Ponomaryova, Ukraine
O. Gorokhovatskyi, Ukraine
A. Chernodub, Ukraine
Ye. Bodyanskiy, Ukraine
O. Gozhyj, Ukraine
I. Aizenberg, USA
T. Panchenko, Ukraine
R. Ali, Tunisia
V. Hnatushenko, Ukraine
V. Mashtalir, Ukraine
V. Alieksieiev, Ukraine
O. Berezsky, Ukraine
E. Yegorova, United Kingdom
B. Tiwana, USA
O. Dumin, Ukraine
V. Lytvynenko, Ukraine
G. Churyumov, Ukraine
T. Rak, Ukraine
A. Slipchenko, Netherlands
K. Stokfiszewski, Poland
A. Berko, Ukraine
V. Volkova, Ukraine
N. Gandhi, USA
L. Kirichenko, Ukraine
A. Kuzyk, Ukraine
U. Ozkaya, Turkish
R. Upadhyay, Tatarstan
O. Menshikova, Ukraine
S. Babichev, Czech Republic

Partners

Exclusive partner

SoftServe
www. softserve.ua

Gold partner

GlobalLogic
www.globallogic.com

Perfectial
www.perfectial.com

Silver partner

ROMB

Partners

Lviv City Council
http://city-adm.lviv.ua/

Lviv Convetion Bureau
http://www.lvivconvention.com.ua/en/

Kyivstar
https://kyivstar.ua/

Skhidnytska 118
http://skhidnytska.ua/

The DSMP’2018 is co-supported by program “Scientific Lviv”.

Welcome Letter

Dear Colleagues,

We would like to personally encourage each of you to join us at IEEE Second International Scientific Conference Data Stream Mining and Processing (DSMP'2018), which is held in Lviv – Kryve Ozero, UKRAINE, 21-25 August, 2018. Our main goal is not only to provide an opportunity for networking and learning recent scientific achievements but also a chance to be involved in real time panel discussions with IT representatives to review and discuss their practical outcomes on real projects.

The DSMP is organized by IEEE Ukraine Section, IEEE Ukraine Section (Kharkiv) SP/AP/C/EMC/COM Societies Joint Chapter, IEEE Ukraine Section (West) AP/ED/MTT/CPMT/SSC Societies Joint Chapter, IT Step University, Ukrainian Catholic University, Lviv Polytechnic National University, and Kharkiv National University of Radio Electronics.

Agenda of the DSMP'2018 is very rich. This year we have nominated a 120 number of accepted papers coming from about 27 countries which makes DSMP a truly international high impact conference. Major highlights of DSMP'2018 are its keynotes speakers. This conference proved to be extremely important given the fruitful dialog and a chance to exchange ideas and sharing valuable hands-on experience.

This year program is based on the following topics: Hybrid Systems of Computational Intelligence, Machine Vision and Pattern Recognition, Dynamic Data Mining & Data Stream Mining, Big Data & Data Science Using Intelligent Approaches and also panel with participation of IT Companies.

We are proud of the fact that DSMP proceedings have been included into the IEEE Xplore Digital Library as well as other Abstracting and Indexing (A&I) databases (Scopus, Web of Science and etc.). High quality of the DSMP program would not be possible without the contribution of authors, keynote speakers, organizers, students, 53 reviewers who devoted a lot of enthusiasm and hard work to prepare papers, presentations, organization infrastructure and carefully review all submissions. We are very grateful for their efforts.

We would like to thank each of your for attending our conference and bringing your expertise to our gathering.

We would like to express our gratitude to our partners and sponsors for being so generous and sponsoring our conference.

We wish all participants an excellent conference, fruitful discussions and pleasant stay in Lviv and Conference venue.

Sincerely

Yuriy Rashkevych Yevgeniy Bodyanskiy

General List of Topics

Table of Contents

IEEE Second International Conference on Data Stream Mining & Processing
August 21-25, 2018, Lviv, Ukraine

Informational System of Project Management in the Areas of Regional Security Systems' Development

Oleksandr Prydatko
Department of Project Management, Information Technologies and Telecommunications
Lviv State University of Life Safety
Lviv, Ukraine
o_prydatko@ukr.net

Yurii Borzov
Department of Project Management, Information Technologies and Telecommunications
Lviv State University of Life Safety
Lviv, Ukraine
borzovuo@ukr.net

Ivan Solotvinskyi
Department of Information Technologies and Technical Means of Training
Lviv State University of Life Safety
Lviv, Ukraine
jonh7282@ukr.net

Olga Smotr
Department of Project Management, IT and Telecommunications
Lviv State University of Life Safety
Lviv, Ukraine
olgasmotr@gmail.com

Oleksii Didyk
Kherson National Technical University
Kherson, Ukraine
olexii.didyk@gmail.com

Abstract — **the analysis of the subject area shows the complexity of the project management in the areas of regional life security systems development due to large data streams and far-flung network of communications between them. Structural-logical scheme has been constructed in the form of a graph of possible system conditions. The scheme opens the full essence of data streams management in the projects of regional security systems development. The structure of interconnection inside the data streams set has been investigated. The structure of the information system of project management in the areas of regional security systems' development has been developed.**

Keywords — ***data stream, information system, project management, life safety.***

I. Introduction

The concept of regional life security systems' development, in accordance with the state policy, should be considered as a complex organizational and technical system, which has many data communications. Management of such systems should be considered in terms of a project-oriented approach, since the development and management of complex systems requires the implementation of individual projects, portfolios, or even programs that cannot be realized without analyzing and processing large data streams. The set of development projects of such systems includes many projects that vary in multisectoral objectives, resource constraints, team models, time frames. However, before moving on to the process of substantiating the volume of data streams for the successful implementation of these projects, an analysis of existing achievements in this area should be conducted. Questions related to the declared topics are studied both in the light of information technologies and project management. In particular, the development of information technologies for operational management in emergency situations, where the life security systems are used actively, is considered in [1, 2]. The basic scientific aspects of project management for the complex systems development are described in [3, 4, 5]. A number of scientific works are devoted to project management issues for regional life security systems development, in particular [6, 7, 8]. An overview of scientific works can be continued for a long time; however, even the above list shows that there is clearly an unexplored field of the overall problem, namely the development of informational systems for collecting, structuring, storing and processing of data in order to support the process of making effective decisions on the regional life security systems development. There is a number of works devoted to the development of algorithms for processing many simulated data, in particular in the papers [9, 10, 11], a multi-model algorithm for target tracking maneuvering based on the second-order Markov chain is proposed. The results of the work demonstrate the effectiveness of multimodal interaction algorithms in comparison with algorithms of interaction of several models and algorithm of a reliable model that can be used for efficient processing of data flow. As to the basic concepts of portfolio management and development programs, they can be found in the works [12, 13, 14]. Scientific concepts of managing changes in complex organizational and technical systems can be found in a number of works on project management, in particular in papers [15, 16] where a significant part is also devoted to issues of regional development. Consequently, according to the announced problem and the existing achievements in the research area, the aim of the study is as follows: to explore the plurality of data streams and to develop the structure of informational decision-making system for the developing of regional life security systems.

II. Analysis Of The Data Stream Content

For a good understanding of the complexity of the regional life security systems development, consider its main stages using the graph of possible system conditions. Thus, the sequence of the process of restructuring the existing regional systems can be described as a graph *G (X, U)*, using the expression (1):

$$X = \{r_1, d, f_1, t, v, g, n, r_2, f_2, s, k, p, l, z\};$$
$$U = \{u_1, u_2, u_3, u_4, u_5, u_6, u_7, u_8, u_9, u_{10}, u_{11}, u_{12}, u_{13}, u_{14}, u_{15},$$
$$u_{16}, u_{17}, u_{18}, u_{19}, u_{20}, u_{21}, u_{22}, u_{23}, u_{24}, u_{25}\}, \quad (1)$$

where r_1 - information gathering about the road network of the region; d - information gathering about the location of existing rescue units; f_1 - information gathering about the rescue equipment on the balance sheet of rescue units; t - information gathering about the most remote settlements of the region; v - distribution of areas of responsibility between existing and projected rescue units; g - determination of staffing number and optimal places of rescue teams' disposition; n - information gathering about the fire and manmade load of the analyzed region; r_2 - information gathering on the features of the analyzed region (water sources, hi-rise buildings, etc.); f_2 - determination of the types and required quantity of rescue equipment; s – determination of the optimal staff structure of the unit; k – determination of the qualification requirements for the personnel of the team; l - training of staff at specialist educational establishments, p - organization of property complexes' transfer; z - organization of property complexes' procurement; u_1-u_{25} - edges describing transitions between system conditions.

For a good understanding of the connections between the possible system conditions the graph *G (X, U)* is matrix-based. The aim of the matrix-based representation is to indicate communications between the elements (subsets) of the development process. That is why the adjacency matrix is presented for a non-oriented graph:

$$G = \begin{array}{c} \\ r_1 \\ d \\ f_1 \\ t \\ v \\ g \\ n \\ r_2 \\ f_2 \\ s \\ k \\ p \\ l \\ z \end{array} \begin{array}{c} \begin{array}{cccccccccccccc} r_1 & d & f_1 & t & v & g & n & r_2 & f_2 & s & k & p & l & z \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix} \end{array}. \quad (2)$$

The adjacency matrix (2) reflects the connections between the stages of the regional life security systems development. However, for a better representation of the sequence of this process, it is necessary to show the transition routes between possible system conditions in the form of an incident matrix that takes the form:

$$G = \begin{array}{c} \\ u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \\ u_7 \\ u_8 \\ u_9 \\ u_{10} \\ u_{11} \\ u_{12} \\ u_{13} \\ u_{14} \\ u_{15} \\ u_{16} \\ u_{17} \\ u_{18} \\ u_{19} \\ u_{20} \\ u_{21} \\ u_{22} \\ u_{23} \\ u_{24} \\ u_{25} \end{array} \begin{array}{c} \begin{array}{cccccccccccccc} r_1 & d & f_1 & t & v & g & n & r_2 & f_2 & s & k & p & l & z \end{array} \\ \begin{pmatrix} -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & -1 \end{pmatrix} \end{array}. \quad (3)$$

The matrix representation of the graph *G (X, U)* opens the full essence of the interconnections between the various stages of the regional life security systems development. The resulting adjacency matrix and the incident matrix, based on it, allow us to construct a graph of possible system conditions in a geometric form. The geometric representation of the graph with the existing transition routes between possible system conditions is presented in Fig. 1. The subsets described by the expression (1) are shown as the graph nodes. The geometric representation illustrates graphically the possible information connections and the role of a particular set in the structure of the development process.

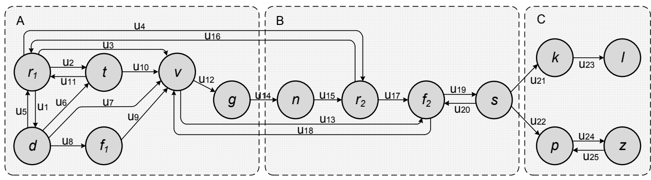

Fig. 1. Graph of possible system conditions in a geometric form

Figure 1 illustrates the connections and the relationships between the different conditions of the development process, which is divided into three main stages. The figure shows all the complexity of the process, which requires the establishment of appropriate information support at each stage. The following is a description of each of the stages in the context of its place in the system.

The first stage (A) determines the normative quantity and optimal places for the rescue teams. At this stage such criteria as the road network of the region$\{r_1\}$, the location of existing rescue units $\{d\}$, the rescue equipment on the balance sheet of rescue units $\{f_1\}$, the time of arrival to the most remote settlements of the region $\{t\}$ (it should not exceed 20 minutes) must be taken into account. According to these criteria, the areas of responsibility of existing and projected (reformed) rescue units $\{v\}$ should be formed. This must provide the basis for determination of staffing number and optimal places of rescue teams' disposition $\{g\}$.

The second stage (B) involves determining the structure of existing and projected (reformed) rescue units. The main criteria determining the structure of existing and projected (reformed) rescue units are: the fire and manmade load of the analyzed region $\{n\}$ (for example: the presence of critical infrastructure, the average daily temperature in summer, the area of woodlands and dry woodland grass, the avalanche hazards, etc.), features of the region $\{r_2\}$ in terms of water sources' availability, quantity of high-rise buildings, etc. These criteria give grounds for determination of the types and required quantity of rescue equipment $\{f_2\}$. This will provide the basis for building the optimal staff structure of the unit $\{s\}$ (the required number of drivers, rescuers, etc.).

Assembling (equipping) of projected rescue teams (C) is the final stage in regional life security systems' development. The final stage involves determination of the qualification requirements for the personnel of the team $\{k\}$, training of the personnel at educational establishments of SES of Ukraine $\{l\}$, organization of property complexes' transfer from the state to communal property $\{p\}$ (real estate, fire and rescue vehicles, equipment, etc.), or, in the case of impossibility, their procurement $\{z\}$.

At the moment, three main issues of informational support are clearly expressed. Two of them are: determination of staffing number and optimal places of rescue teams' disposition (at the first stage), which depends on the information gathering and processing by the criteria $\{r_1\}$, $\{d\}$, $\{f_1\}$, $\{t\}$; determination of the types and required quantity of rescue equipment, as well as determination of the optimal staff structure (at the second stage), taking into account the criteria $\{n\}$, $\{r_2\}$. At the third stage (C), in addition to regulating the legal framework for the property complexes' transfer and training of staff at specialist educational establishments, the development of training programs in accordance with the proper qualification requirements must be performed. It depends on the criterion $\{k\}$. It is safe to declare that solving these tasks is impossible without proper informational support. Informational support for this process consists in collecting the necessary information, forming the knowledge base on it and using it as a source data for calculating $\{v\}$, $\{g\}$, $\{f_2\}$, $\{s\}$, $\{l\}$, $\{p\}$, $\{z\}$. Due to the complexity of the identified informational support process, a detailed analysis of the volume of data streams using the conceptual apparatus of the set theory should be conducted. The declared task is presented in the next section.

III. Analysis Of The Volume Of The Data Stream

The volume of the data stream in the investigated case is proposed to analyze using the conceptual apparatus of the theory of sets, where the volume of relevant information, required for the work of the system, is presented in the form of sets (subsets). We will start the analysis from the geometric representation of the sets (A), (B) and (C) with the corresponding subsets. The model for collecting and processing information is considered in the form of universum U. The universum includes three sets with corresponding subsets, namely a set of information for determining the normative quantity and optimal places for the rescue units (A); a set of information for determining the structure of existing and projected (reformed) rescue units (B); a set of information support for assembling (equipping) of projected rescue teams (C). Combining operations exist in the system of presented sets. They are commutative; therefore, taking into account the ratio of sets to the universum, their interconnection can be represented as follows:

$$U \supseteq \bigcup_{i=1}^{3}(A,B,C) \neq \varnothing. \tag{4}$$

For a good understanding of the investigated environment and the structure of the model, we describe each of the sets in more detail.

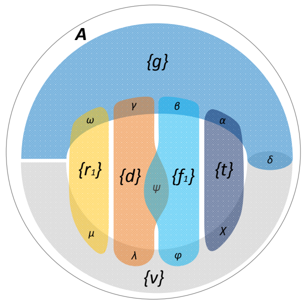

Fig. 2. A set of information for determining the normative quantity and optimal places for the rescue units

The set (A) in the model is represented as a comprehending set and contains the following subsets:

$$A = \{r_1, d, f_1, t, v, g\}, r_1 = \overline{1,c}, d = \overline{1,i}, f_1 = \overline{1,j}, t = \overline{1,q}, v = \overline{1,m}, g = \overline{1,a}, \tag{5}$$

where c - the volume of data on the road infrastructure; i - volume of data on the network of existing rescue units; j - the volume of data on varieties and volumes of available rescue equipment in existing rescue units; q - the volume of data about time and routes of arrival within the area of responsibility; m - the volume of data on the methodology for determining the boundaries of areas of responsibility; a - the volume of data on the methodology for determining normative quantity and optimal places for the rescue teams.

The next set (B) is also endowed with a number of combining and intersection operations.

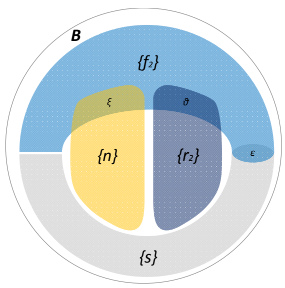

Fig. 3. A set of information for determining the structure of existing and projected (reformed) rescue units

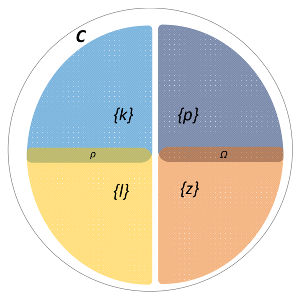

Fig. 4. A set of information for projected rescue teams' equipping

Similar to the previous case, the set (B) is represented as a comprehending set and contains the following subsets:

$$B = \{n, r_2, f_2, s\}, n = \overline{1,x}, r_2 = \overline{1,e}, f_2 = \overline{1,y}, s = \overline{1,u}, \tag{6}$$

where x - the volume of data on fire and manmade load of the analyzed region; e - the volume of data on the features of the analyzed region; y – the volume of data on methods for determining the types and required quantity of rescue equipment; u – the volume of data on methods for determining the optimal staff structure of the rescue unit.

And the last set (C) expresses the assembling (equipping) of projected rescue teams. Let's analyze this set. The set (C) is also represented as a comprehending set and contains the following subsets:

$$C=\{k,l,p,z\}, k=\overline{1,o}, l=\overline{1,h}, p=\overline{1,b}, z=\overline{1,w}, \quad (7)$$

where o - the volume of data on determining the qualification requirements for the personnel of the team; h - the volume of data on personnel training programs due to qualification requirements; b – the volume of data on mechanisms for the property complexes' transfer; w – the volume of data on the mechanisms of the property complexes' procurement.

IV. Simulation Of The Structure Of Interconnections In Information Flows

The analysis of the volume of data streams gives us only a generalized presentation about the structure of the informational support process. For a more detailed study of these processes, it is necessary to study the interconnections of the data streams set and their structure. Considering the significant amount of obtained results, we will present only the final results of the research. In the set (A) both combining and intersection operations between subsets exist. Taking into account the peculiarities of sets and their interconnections, we make a generalized description of the existing connections between the data streams in the set (A):

$$[r_1 \cap (g \cap v)] \cup [d \cap (g \cap v) \cap f_1] \cup [t \cap (g \cap v)] \Rightarrow$$

$$A \supseteq [r_1 \cup (d \cap f_1) \cup t] \cap (g \cap v) \neq \varnothing. \quad (8)$$

Expression (8) shows that determining normative quantity and optimal places for the rescue teams is closely connected (intersecting) with determining the boundaries of areas of responsibility. In turn, the sets $\{g\}$ and $\{v\}$ depend on the combining of $\{r_1\}$, $\{d\}$, $\{f_1\}$ and $\{t\}$. In the following a generalized description of the existing connections between the data streams in the set (B) is studied. It is submitted in a form of a model:

$$B \supseteq (n \cup r_2 \cup s) \cap f_2 \neq \varnothing. \quad (9)$$

Expression (9) clearly shows the complementarity of information (combining) between subsets $\{n\}$, $\{r_2\}$ and $\{s\}$ in the set (B), as well as their resulting effect (intersection) on the subset $\{f_2\}$. Although, in a time perspective, the volume of data on determining the optimal staff structure of the rescue unit is based on previously obtained data on the list of required rescue equipment. A generalized description of the existing connections between the data streams in the set (C) is as follows:

$$C \supseteq (k \cap l) \cup (p \cap z) \neq \varnothing. \quad (10)$$

Expression (10) shows a complementary connection between two intersections. As a result, the reformed rescue team can be produced by the qualified personnel $\{k\}$, $\{l\}$ and the necessary property and equipment $\{p\}$, $\{z\}$. Thus, the study of the interconnections of the data streams set and their structure in the investigated system shows the entire complexity of the regional security systems' development. Data streams sets include combining and intersection of different sources of information that have the resulting influence on related information centres. It is necessary to note that most elements of the data stream are fundamental to the implementation of the next stage in the development system. Based on the result of this study we have formulated the necessity of developing the information system allowing to perform the data flow management in the projects of regional security systems' development

V. Structure Of The Informational System

The structure of the informational system should reflect the interconnections between input data stream that is processed using the proper techniques and the methods for obtaining (modelling) the final result. The final result is usually presented in the form of proposals for the number, location, structure and logistics of the rescue units. The prototype of an informational decision-making system should fulfil the following functions:

- gathering, arrangement (clustering) and preservation of data arrays about the features of the analyzed region;
- updating and editing data depending on external conditions;
- processing the input data depending on the task and the region;
- implementation of methods for determining key indicators regarding the number, location and optimal structure of rescue units;
- interaction with existing methods and approaches to the definition of individual components of the development process;
- validity check of the obtained results;
- formation of reports with proposals for the adoption of management decisions.

The above functions of the system allow the user formulating managerial decisions on the planning of activities for the regional life security systems' development. In accordance with the described sets of the data streams and the main functions of the informational system, the structure of such system should include:

- a unit of the user, which is responsible for input the initial data and obtaining the results in the form of the final report;
- a database for organizing, structuring and clustering the collected information;
- a knowledge base for appropriate processing of initial data;
- a module for estimation factors and initial modelling (determination of staffing number and optimal places of rescue teams' disposition);
- key modelling module (determination of the optimal staff structure of the unit);
- module of final modelling (proposals of equipping of projected rescue teams);
- module for analyzing the final result.

In accordance with the main elements of the structure of the informational system of project management in the areas of regional security systems' development, there is a need to construct a graphical model. The structure is depicted in Figure 5.

VI. Conclusion

Through mathematical and geometric description of the basic processes of regional life security systems' development, the structural-logical scheme has been constructed in the form of a graph of possible system conditions. This scheme discovers the sequence of informational support of creating and reforming the rescue units. Geometrical description for the data stream model in the process of regional life security systems' development has been presented. For this purpose the conceptual apparatus of the theory of sets has been used. The structure of interconnections inside the data streams set has been grounded. Using the simulation methods, the structure of the informational system of project management in the areas of regional security systems' development has been prepared. This system allows gathering, preservation and processing of initial data in order to make effective managerial decisions. Substantiation of appropriate methods and procedures for processing the initial data set, as well as development of software for the practical implementation of the declared informational system, has been further developed.

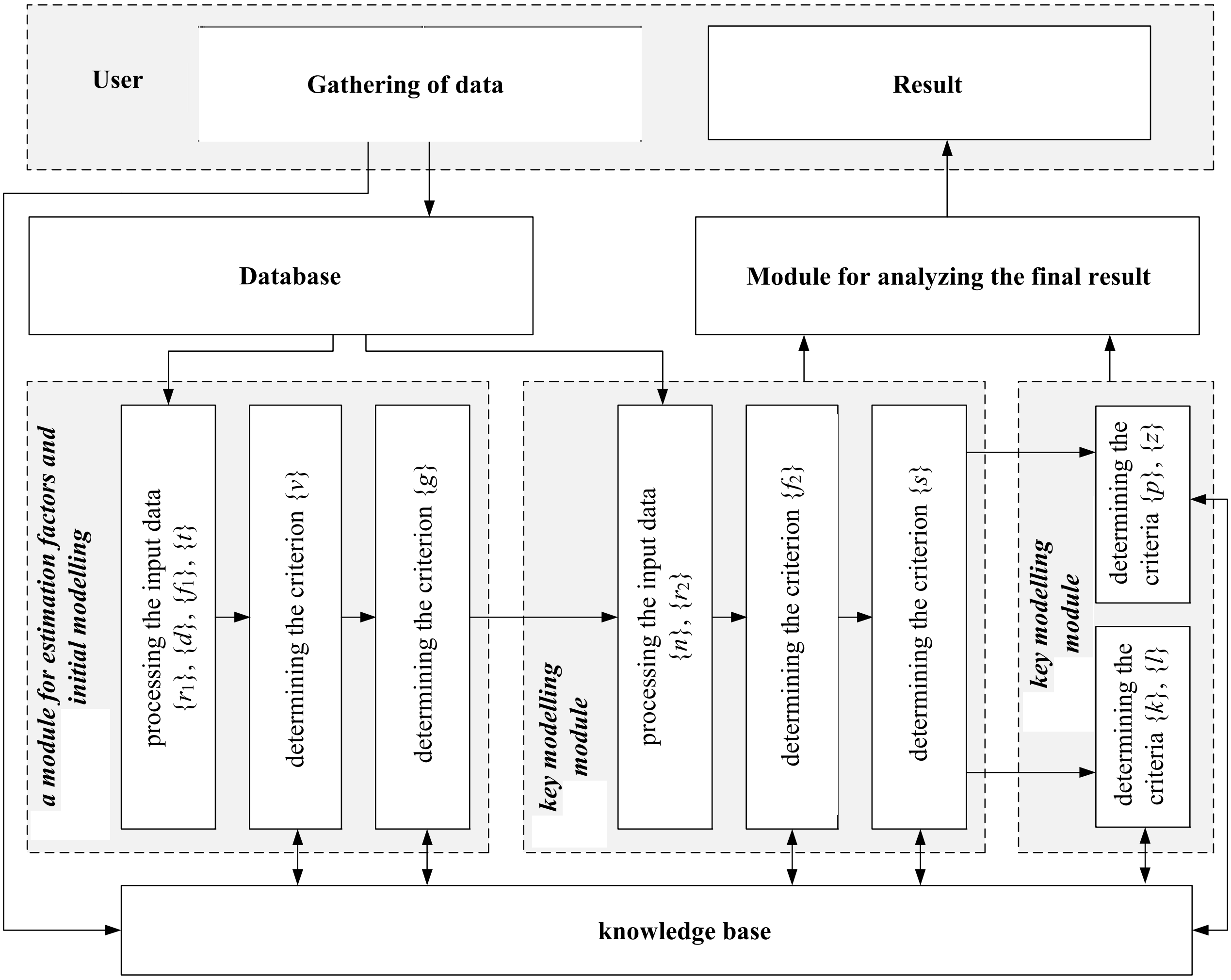

Fig. 5. The structure of the informational system of project management in the areas of regional security systems' development

References

[1] T. Ye. Rak, "Information technologies for assessing the professional level of operators for work in conditions of risk," Proceedings of IPEM of NAS of Ukraine, no. 62. pp. 202-207, 2012.

[2] T. Ye. Rak, "Information technologies for monitoring the state of active production systems in extreme situations," Proceedings of IPEM of NAS of Ukraine, no.63. pp. 189-195, 2012.

[3] O. B. Danchenko, and V. V. Lepskyi, "Modern models and methods of project, portfolio and program management", Management of the complex systems' development, no. 29, pp. 46-54, 2017.

[4] O. G. Timinsky, and I. O Marushchak, "Analysis of the value approach-based project of the regional network proactive creation," Management of the complex systems development, no 28, pp. 53 – 67, 2017.

[5] A. A Beloshchitskyi, Yu. I. Minaeva, and G. A. Filimonov, "Comparative models under uncertainty conditions for solving management problems," Management of the complex systems development, no. 25, pp. 91 – 95, 2016.

[6] O. V. Bugrov, and O. O. Bugrova, "Functional analysis of regional development programs," Management of the complex systems development, no. 26. pp. 30 – 36, 2016.

[7] Yu. I. Gritsyuk, I. O. Malets, and T. Ye. Rak, "Mathematical models of portfolio management for improvement of life safety systems," Computer Science and Information Technologies: Bulletin of the National University "Lviv Polytechnic", no. 672, pp. 110-119, 2010.

[8] Yu. P. Rak, and O. B. Zachko, "Methods of analysis and estimation of the level of safety of vital activities of regions of Ukraine in

conditions of realization of regional development projects," Project management and production development, no. 2 (26), pp. 29-39, 2008.
[9] J. Lan, X. R. Li, , Vesselin P. Jilkov, Chundi Mu. "Second-Order Markov Chain Based Multiple-Model Algorithm for Maneuvering Target Tracking," IEEE Transactions on Aerospace and Electronic Systems, vol. 49, no.1, pp.3−19, 2013.
[10] J. Lan, X. R .Li, and Chundi Mu, "Best Model Augmentation for Variable-Structure Multiple-Model Estimation," IEEE Aerospace and Electronic Systems, vol. 47, no.3, pp.2008−2025, 2011
[11] J. Lan, and X. R. Li, "Equivalent-Model Augmen-tation for Variable-Structure Multiple-Model Estimation," IEEE Aerospace and Electronic Systems, vol. 49, no.4, pp.2615−2630, 2013.
[12] A. A. Matveev, D. A. Novikov, and A.V. Tsvetkov, "Project Portfolio Management Models and Methods," PMSOFT, Moscow, Russia. 2005.
[13] A Guide to the Knowledge of Project Management (PMBOK®) – Fourth Edition [electronic resource]. – Available from http://www.uapa.ru/ media /uploads/ attachment/ source/ 2012/ 12/ PMbok4.pdf
[14] Standard for project and program management P2M [electronic resource]. – Available from http:// www.pmaj.or.jp /ENG/p2m/p2m_guide/p2m_guide.html
[15] B. J. Weiner, "A theory of organizational readiness for change," Implementation Science, vol. 4, pp. 1-9. 2009. available at: www.ncbi.nlm.nih.gov/pmc/articles/PMC2770024/ (accessed December 14, 2012),
[16] K. Malik, Human Development Report 2013. The Rise of the South: Human Progress in a Diverse World. Published for the United Nations Development Programme (UNDP), 2013.available: http://hdr.undp.org/sites/default/files/reports/14/hdr2013_en_complete.pdf.

Author’s Index

Printing by Publishing House of
Lviv Polytechnic National University
2 Kolessa str., Lviv, Ukraine, 79013, vlp@vlp.com.ua

softserve

GlobalLogic

Perfectial
EMPOWER YOUR IDEAS

РОМБ
проектно-будівельна компанія

Lviv Convention Bureau

КИЇВСТАР

СХІДНИЦЬКА 118

altexsoft
software r&d engineering

IT-JIM
signal and image processing

LMX

Hey Machine Learning

teragence™
YOUR NETWORK YOUR EXPERIENCE

UNIVERZITA J. E. PURKYNĚ V ÚSTÍ NAD LABEM

SPOŁECZNA AKADEMIA NAUK
UNIVERSITY OF SOCIAL SCIENCES

BENI-SUEF UNIVERSITY

iSi
Research Lab

BANKING UNIVERSITY

SEVERENITY
www.severenity.com

ТЕРНОПІЛЬСЬКИЙ НАЦІОНАЛЬНИЙ ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ
ТНЕУ

ХНТУ
ХЕРСОНСЬКИЙ НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ

LVIV IT CLUSTER

IT B.E.A.N.S.
student community

PM Business Solution

GD
Game & Design

LVIV DATA SCIENCE CLUB

AI UKRAINE

UAevent

ISDMCI 2018

AI &Big Data DAY

#ODSC

Lviv City Council

LVIV
OPEN TO THE WORLD