Ministry of Education and Science of Ukraine

Lviv Polytechnic National University, UKRAINE

IEEE Ukraine Section

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

IEEE 2019 14th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT)

PROCEEDINGS

17-20 September 2019
Lviv, Ukraine

Organized by:

Institute of Computer Science and Information Technologies, Ukraine

Technical University of Lodz Poland, Institute of Information Technologies, Poland

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

Technical Co-Sponsors:

Lviv Polytechnic National University

IEEE Ukraine Section

2019 IEEE 14th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT)

PROCEEDINGS

Part Number: CFP19D36-PRT
ISBN: 978-1-7281-0806-3

Міністерство освіти і науки України

Національний університет «Львівська політехніка»

Українська секція IEEE

Західноукраїнський об’єднаний осередок IEEE

Матеріали
XIV-ої Міжнародної науково-технічної конференції

КОМП’ЮТЕРНІ НАУКИ ТА ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ CSIT 2019

17-20 вересня 2019
Львів, Україна

УДК 004
ББК 32.965.3
П279

Організатори конференції:

Національний університет "Львівська політехніка", Україна
Інститут комп'ютерних наук та інформаційних технологій
Лодзький технічний університет, інститут інформаційних технологій, Польща
Західноукраїнський об'єднаний осередок IEEE

Organized by:

Lviv Polytechnic National University, Ukraine
Institute of Computer Science and Information Technologies
Technical University of Lodz Poland, Institute of Information Technologies, Poland
IEEE Ukraine Section (West) MTT/ED/AP/EP/SSC Societies Joint Chapter

П279 **Матеріали XIV-ої Міжнародної науково-технічної конференції "Комп'ютерні науки та інформаційні технології (CSIT -2019)".** Том 2. – Львів, 2019. – 206 с.
ISBN 978-1-5386-6463-6

Подано матеріали конференції, присвяченої проблемам у галузі комп'ютерної техніки та інформаційних технологій.

Видання призначене для науковців, аспірантів та студентів старших курсів

УДК 004
ББК 32.965.3

Відповідальний за випуск – к.т.н. Шестакевич Т.В.
Responsible for the issue Tetiana Shestakevych

ISBN 978-1-7281-0806-3
Part Number **CFP19D36-PRT**

Національний університет «Львівська політехніка», 2019

CSIT 2019 INTERNATIONAL PROGRAMME COMMITTEE

Yu. Bobalo	**Conference Honorary Chairman,** Lviv Polytechnic National University, **Ukraine**
M. Medykovskyy	**Conference Executive Chairman**, Lviv Polytechnic National University, Ukraine
Ie. Pichkalyov	head of IEEE Ukraine
M. Andriychuk	IEEE MTT/ED/AP/CPMT/SSC, West Ukraine Chapter, Ukraine, MTT/ED/AP/CPMT/SSC West Ukraine Chapter, Ukraine
P. Antonov	Technical University of Varna, Bulgaria
A. Arkhangelska	Palacky University in Olomouc, Czech Republic
R. Bazylevych	Lviv Polytechnic National University, Ukraine
P. Bidyk	National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Ukraine
O. Bisikalo	Vinnytsia National Technical University, Ukraine
V. Boyun	Glushkov Institute of Cybernetics of National Academy of Sciences of Ukraine, Ukraine
S. Bushuyev	Kyiv National University of Construction and Architecture, Ukraine, Ukraine
A. Camacho	Universidad Complutense de Madrid, Spain
G. Chetverikov	Kharkiv National University of Radioelectronics, Ukraine
T. Czachorski	Institute of Theoretical and Applied Informatics Polish Academy of Sciencesh, Poland
J. Cardiff	Institute of Technology Tallaght (ITT), Ireland
P. Cañizares	Universidad Complutense de Madrid, Spain
Z. Čekerevac	"Union - Nikola Tesla" University in Belgrade, Serbia
R. Danel	Technical University of Ostrava, Ostrava, Czech Republic
R. Dupas	University of Bordeaux, France
D. Fedasyuk	Lviv Polytechnic National University, Ukraine
V. Filatov	Kharkiv National University of Radioelectronics, Ukraine
E. Gelenbe	Electrical and Electronic Engineering at Imperial College, London, United Kingdom
O. Gozhyj	Petro Mohyla Black Sea State University, Ukraine
J. Gospodarczyk	University of Economy, Bydgoshch, Poland
Y. Haxhimusa	Vienna University of Technology, Austria
M. Korablyov	Kharkiv National University of Radioelectronics, Ukraine
Ye. Krasowski	Polish Academy of Sciences Branch in Lublin, Poland
N. Kunanets	Lviv Polytechnic National University, Ukraine
O. Levchenko	Lviv Polytechnic National University, Ukraine

CSIT 2019 ORGANIZING COMMITTEE

Mykola Medykovskyy	Chairman, Director of Institute of Computer Sciences and Information Technologies of Lviv Polytechnic National University, Ukraine
Tetiana Shestakevych	Conference Secretary. ISN Department, Lviv Polytechnic National University, Ukraine
Natalia Shakhovska	Publication Chair. AIS Department, Lviv Polytechnic National University, Ukraine
Olena Vovk	Treasurer. AIS Department, Lviv Polytechnic National University, Ukraine
Olexa Skorohoda	Member, ASC Department, Lviv Polytechnic National University, Ukraine
Vasyl Dubuk	Member, ASC Department, Lviv Polytechnic National University, Ukraine
Max Seniv	Member, SW Department, Lviv Polytechnic National University, Ukraine
Nataliia Veretennikova	Member, ISN Department, Lviv Polytechnic National University, Ukraine
Zoriana Rybchak	Member, ISN Department, Lviv Polytechnic National University, Ukraine
Khrystyna Dmytriv	Member, AL Department, Lviv Polytechnic National University, Ukraine
Iryna Zavuschak	Member, ISN Department, Lviv Polytechnic National University, Ukraine

PREFACE

Welcome to XIVth International Scientific and Technical Conference **Computer Sciences and Information Technologies** CSIT 2019, which is organized by IEEE Ukraine Section, IEEE West Ukraine AP/ED/MTT/CPMT/SSC Societies Joint Chapter, Lviv Polytechnic National University, Institute of Computer Science and Information Technologies, supported by Technical University of Lodz Poland, Institute of Information Technologies, patronized by Ministry of Education and Science of Ukraine.

The international conference **Computer Sciences and Information Technologies**, established in 2004, is annually organized with the principal aim to discuss modern trends in computer sciences, information technologies, applied linguistics, and others related areas. To achieve this goal, various aspects of computer science will be presented in such major topics:

- Artificial Intelligence
- Cyber-Physical Systems
- Software Engineering
- Applied Linguistics
- Intelligent Management Technologies
- Mathematical Modeling
- Big Data and Data Science
- ICT in Higher Education
- Data and Knowledge Engineering
- Project Management

CSIT 2019 Program Committee evaluated over 250 submitted papers from China, Czech Republic, France, India, Ireland, Japan, Kazakhstan, Poland, Serbia, Turkey, Slovakia, Spain, and Ukraine to crystallize a high-level technical program of oral presentations. To continue previous successful practice, CSIT 2019 hosts three international scientific workshops: *International Workshop on Inductive Modelling IWIM-2019*, *International Workshop on Project Management IWPM 2019*, and *International Workshop on Information modeling, Data and knowledge engineering IWIMDKE 2019*, all supported by IEEE.

The sincerest, boundless gratitude of organizers is sent to members of International Program Committee, who supported CSIT 2019 conference by participating in it, their comprehensive reviews allowed the conference to participate in the promotion of science and technological excellence. It should be proudly mentioned, that some papers are common for several institutions, and even countries, involved in the conference. Such examples of international cooperation, that we have noticed in papers, submitted this year, has inspired CSIT 2019 International Program Committee and Organizing Committee to encourage the cooperation.

Conference CSIT 2019 and satellite Workshops will be held in Lviv which is the largest city in Western Ukraine and the seventh largest city in the country overall. The historical heart of Lviv city is famous for its old buildings. The city center is on the UNESCO World Heritage List.

Lviv is one of the most important cultural centers of Ukraine, famous for art, literature, music and theatre. It hosts more than 100 festivals annually, has 60 museums and 10 theatres. With regard to its urban fabric and architecture, Lviv is an outstanding example of the fusion of the architectural and artistic traditions of Central and Eastern Europe with those of Italy and Germany. The CSIT 2019 conference will be held in early autumn, and Lviv will be at its best: the city is famous for its welcoming and hospitality, its beautiful parks, diverse cuisine, fascinating history and charismatic architecture. Please, be sure of our warmest gratitude for you interest and participation in the conference.

We are looking forward to welcoming you in Lviv and at CSIT 2019!

Sincerely yours,

Mykola Medykovskyy
Director of Institute of Computer Sciences and
Information Technologies of Lviv Polytechnic
National University, Ukraine
CSIT 2019 Executive Chair

Lviv 2019

CONTENTS

INTELLIGENT MANAGEMENT TECHNOLOGIES

BIG DATA AND DATA SCIENCE

SOFTWARE ENGINEERING

CYBER-PHYSICAL SYSTEMS

Safety-focused Stakeholder Management in Civil Protection Projects

Andriy Ivanusa, Sergiy Yemelyanenko, Roman Yakovchuk
Lviv State University of Life Safety
Lviv, Ukraine
e-mail: ivaaanusa@gmail.com, ldubgd@i.ua, juniorrs@i.ua

Zoryana Ivanusa
Lviv State University Internal Affairs
Lviv, Ukraine
e-mail: zoryana_pz@ukr.net

***Abstract* — An information analysis of successful practices in the implementation of life safety projects has been carried out, which has enabled determination of the necessary models and methods of safety-focused stakeholder management in civil protection projects. Using system analysis and topological synthesis of flexible technological lines, the mathematical apparatus which describes stakeholder management in a civil protection project, the requirements of the regulatory framework in terms of ensuring safety of people in protective constructions, the ultimate placement of people in shelters has been calculated, which subsequently made it possible to implement the project of ensuring safety of people at the facilities which draw large crowds and are located in the vicinity of the Lviv State University of Life Safety**

Keywords* — *safety-focused management, civil protection, project stakeholders, evacuation of people, emergency

I. INTRODUCTION

Protection of the population from the weapon of mass destruction, and in peacetime from man-made and natural emergencies, is one of the most important tasks of the state. A possible way to solve this problem is to create various types of protective constructions, designed to shelter people, in human settlements and at enterprises. Therefore, implementation of projects aimed at ensuring safety of people in emergencies and during the martial law is of primary concern today.

In order to ensure safe conditions for people to stay at public gathering places, it is necessary to organize the interaction of projects, programs and their stakeholder management, which is characterized by considerable complexity, instability and chaos. Implementation of infrastructure projects, which require creation and management of stakeholders in the event of emergencies, is possible due to new approaches to managing and adapting existing patterns of interaction between projects and their environment to the newly emerged conditions. In fact, there is a fundamental need to determine the nature and direction of interaction between a project and its environment, search for the minimum negative impact of the environment on the project successful implementation.

Since one of the main objectives of civil protection activities is to provide shelter to population in protective constructions [1], which include storage spaces, radiation protection shelters and fast built protective constructions, it is necessary to consider the existing state of the protective constructions and the methodology of stakeholder management in civil protection projects.

As for the state of preparedness of protective constructions (shelters) in Ukraine, 40% of them are estimated as "not ready" for their intended use, 50% are "partially ready" and only 10% are "ready". The main reason for the unsatisfactory technical condition of protective constructions is lack of funding for their maintenance from budgets of all administrative levels. At present, less than 50% of the total number of protective constructions of different ownership forms has been inventoried [2]. One of the main reasons for low indicators of technical inventory of protective constructions is the lack of financing for such work (budgets of all administrative levels have provided only 44% of the funds required for inventorying shelters).

Development of scientific and methodological principles of time and stakeholder management in projects has been given considerable attention in [3-6]. In these works, the methodology, principles, methods, models of risk-focused approach, which provide solution of tasks concerning risk management, resources, finance, time and quality assurance of projects and programs are suggested.

The problem of risk-focused approach in the project management of macro systems (complex systems) is brought into focus in [7-9]. The author's scientific school developed methodological foundations, methods and models of risk-focused approach that allow solving difficult administrative tasks in civil protection projects and programs implementation: management of risks, resources, quality and time of projects resistant to risk manifestations.

The issue of human safety in buildings and constructions of various kinds is discussed in more detail in [10-15]. These works claim that the individual fire risk of human death from a fire at public gathering places exceeds the permissible value, therefore there is a need to develop additional fire prevention measures aimed at increasing the level of safe operation of a facility. Their analysis of the results of fire risk assessment showed that the risks of human deaths in public gathering places largely depends on the duration of the maximum permissible values of dangerous fire factors that make it impossible to conduct safe evacuation of people.

However, today, there is no universal and systematic approach to the implementation of projects for the safe operation of public gathering places which are characterized by uncertainty, turbulence of the external environment, lack of classification principles in the process of information selection automation in the decisions taken by top managers to ensure the conditions of life safety. Therefore, the scientific and applied task of developing new models and methods of managing the stakeholders in civil protection projects in emergency situations remains relevant.

Based on the mentioned above, the objective of our work is to develop models and methods for managing stakeholders in civil protection projects.

II. RESULTS AND DISCUSSION

As the experience of responding to emergencies shows, one of the most effective ways to ensure people's safety is to create conditions for their timely evacuation into a safe place, which undoubtedly is a protective construction (shelter). Therefore, it is advisable to consider the legal framework, which regulates the design and operation of protective constructions as well as management of stakeholders, resources in case of emergency or martial law.

Design of new construction or reconstruction of protective constructions is carried out in accordance with [16]. Facilities or premises which are adapted for protective constructions must, in all cases, comply with the requirements of these regulations. A completed construction or reconstructed protective constructions are put into operation and maintained in peacetime in accordance with the requirements [17].

Improving the effectiveness of the implementation of the program of the creation and development of a safety system at public gathering places, which include protective constructions, requires the use of methods and models based on information technology, system approach and safety-focused management. Since the protective constructions are classified into categories, according to which they can accommodate people, there are different parametric requirements and other characteristics that have to be taken into account at design, operation, and development stages. Research into the stage of effective functioning of the facilities included in the civil protection system is possible in the context of conducting research on existing mechanisms and their development programs, as well as in determining the best world practices in the implementation of safety-focused management projects.

To construct stakeholder management models, based on the analysis of causative relationships and use of the Japanese project management knowledge system (P2M), a conceptual model of safety-focused project management in the civil protection system was initially constructed. It takes into account the state of the turbulent environment of civil protection projects implementation, the scale of emergency, key success factors of civil protection projects, Ukrainian legal framework, global project management methodology, psychological and physiological state of people, strategic objectives, and performance indicators. The implementation scheme of such a model is presented in Fig.1.

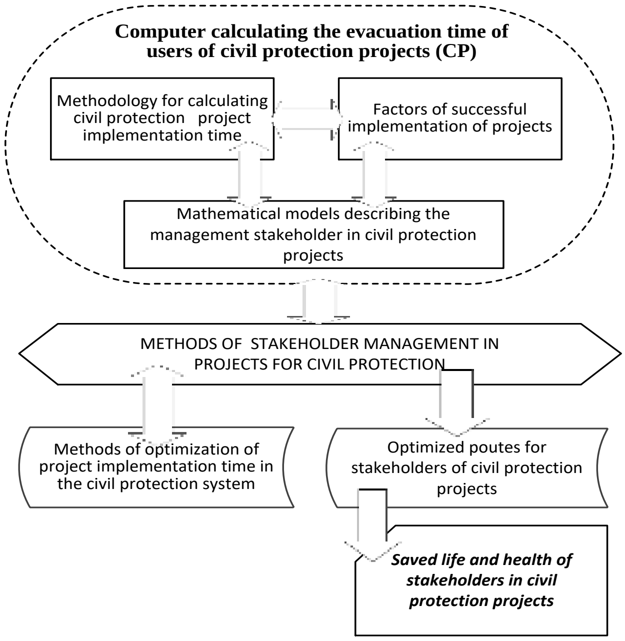

Fig. 1. Conceptual model of safety-focused project management in the civil protection system

The model suggests that the result of successful implementation of civil protection projects are preserved human lives and health of people who act as stakeholders while staying in protective constructions. Stakeholder management models reflect the evacuation routes of human flows from the public gathering places to the shelter, as well as the parameters that influence the movement of people in separate evacuation areas that need to be taken into account when calculating the time for civil protection projects implementation.

Using models of project stakeholders' management, existing mathematical models that describe the flow of people in public gathering places and focusing on the factors of successful implementation of civil protection projects, it is possible can create a software product that will provide automation of the necessary calculations. The results of the calculations will demonstrate the capability of the evacuation system to ensure the timely evacuation of people from the facilities within the regulated time and the need for optimization of flows of the project stakeholders.

Given that the process of stakeholders' participation in the projects is characterized by dynamic parameters such as the density *D*, the speed *V*, the number of users *N*, the geometric parameters of the stairs *M*, the direction of motion *S*, the architecture of the construction *A*, the length the evacuation route *L*, the psychological state of the users *E* and the information provision of users *I*, etc., the target function of the flow of project stakeholders during the evacuation into a safe zone can be shown in the form of a tuple:

$$F(x) = \langle D, V, N, M, S, A, L, E, I, O, P, ES \rangle \qquad (1)$$

where: O is the natural conditions, P is the level of sports competitions (local, state, international), ES is the type of emergency.

Effective management of project stakeholders is ensured by the methodology for project management of the safe evacuation of human flows, built using critical paths, where the optimization synthesis of the evacuation route of people is considered as a topological scheme of the technological line, and the evacuation path is divided into separate operations (blocks). In such a methodology, the stakeholder management depends on the time that takes a flow people to reach a safe area (shelter). The procedure for calculating the determination of the total evacuation time of people from different types of destinations is given in [18], which is valid in Ukraine. However, it does not fully describe the dynamics of human flow, so when making calculations it is necessary to use an additional mathematical apparatus that can describe the processes of spreading, combining and reformatting flows of people [13, 19]. Since the flow of people during the movement within public gathering places can modify, it is expedient to calculate by breaking into areas with uniformity of movement, which simplifies the process of computing.

As a stream of people during motion on building is a characteristic to mutate, then for realization of calculations expediently to break up him on areas in that there is homogeneity of his motion that will simplify the process of realization of calculations. At determination of time of motion of people, a width and length of every area are accepted in accordance with a project or actual values of parameters of existent building. Length of stair cage or rampant equals length of march, and a path length in the door opening equals a zero. If opening in a wall exceeds 0,7 м., then he must be examined as horizontal evacuation way. Thus, breaking up an evacuation route on areas with the homogeneous stream of people, estimated time of general evacuation of users from building of buildings in a safe zone will determine after the simplified analytical model of motion of human stream. Taking into account that an evacuation route is broken on some elementary areas, then common time of exit of users of buildings will be determined as

$$t_{\text{ev}}^{\text{zag}} = \frac{l_1}{V_1} + \frac{l_2}{V_2} + \ldots \frac{l_n}{V_n} = \sum \left(\frac{l_i}{V_i}\right), i = 1,2..n \tag{2}$$

where: l_i is the is length of i area of evacuation way; V_i – value of rate of movement of users of buildings on i- and to the area of evacuation way, m/min. In the case when the accumulations of people appear on an evacuation route, then for determination of time of possible delay of motion of people of star will use a mathematical vehicle driven to [13, 18] and it is determined as

$$t^{\text{szr}} = N_i \cdot f\left(\frac{1}{q_{D=0,9} \cdot \delta_{i+1}} - \frac{1}{q_i \cdot \delta_i}\right) \tag{3}$$

where: N_i is the an amount of users of buildings is on the initial area of evacuation way, persons;

f is the area of ichnography of man (0,25 m^2/ m^2); δ_i – width of i- of area of evacuation way, m; q_i – intensity of motion of streams of users of buildings on i- and to the area of evacuation way, m/ min; D_i – closeness of motion of users of buildings on i- and to the area of evacuation way, pers./m^2. Analysing the modified stream of people in building of buildings, and, de-fining his descriptions, it was set that timing of evacuation of users of buildings $t_{\text{pr}}^{\text{Erl}}$, is on his separate areas, in a safe zone it is expedient to conduct by means of the use to the model of individually-stream motion of man that is driven to [13], as the modified function of Erlango

$$t_{\text{pr}}^{\text{Erl}} = \frac{1}{t^2 \cdot S_V \cdot \sqrt{2\pi}} e^{-\frac{(\frac{1}{t_{lp}} - \bar{V}_{pr})^2}{2S_V^2}} \tag{4}$$

where S_v is the dispersion of casual size that is determined after a formula

$$S_V^2 = S_{V_0}^2 (1 - \alpha_i \ln \frac{D_i}{D_0})^2 \tag{5}$$

where t_{lp} is the time that describes the change of location of man in a stream domain; V_{pr} – rate of movement of users of buildings for the lobby of buildings and it is determined as

$$\bar{V}_{pr} = \bar{V}_{0i}^{E} (1 - \alpha_i \ln \frac{D_i}{D_{0i}}) \tag{6}$$

where V^E_{0i} is the casual size of rate of free movement that depends on the type of way of j and level of the emotional state of E of man; α_i - it is a coefficient that determines the degree of influence of fluency of users of buildings at to motion for i- and to the area of evacuation way;

D_{0i} is the threshold value of fluency of users of buildings, at the achievement of that a closeness grows into a factor that influences on the rate of movement. Value V^E_{0i} , α_i , D_{0i} is the well-known data certain as a result of frequent natural supervisions [13].

Thus, taking into account it is higher marked, common time of evacuation of users of buildings in a safe zone will be determined as

$$t_{\text{ev}}^{\text{zag}} = \sum \left(\frac{l_i}{V_i}\right) + \frac{1}{t^2 \cdot S_V \cdot \sqrt{2\pi}} e^{-\frac{(\frac{1}{t_{lp}} - \bar{V}_{pr})^2}{2S_V^2}} \tag{7}$$

In the case when on the evacuation route of users of buildings from certain reasons there will be a delay of motion, then common time of evacuation will be determined in obedience to dependence

$$t_{ev}^{zag} = \sum\left(\frac{l_i}{V_i} + N_i \cdot f\left(\frac{1}{q_{D=0,9}\cdot\delta_{i+1}} - \frac{1}{q_i\cdot\delta_i}\right)\right) + \frac{1}{t^2\cdot S_V\cdot\sqrt{2\pi}}\, e^{-\frac{\left(\frac{1}{t_{tp}}-\bar{V}_{pr}\right)^2}{2S_V^2}} \qquad (8)$$

In order to check the adequacy of the suggested mathematical model in practice it is expedient to choose a real facility of public gathering. With this aim, an administrative building of the Lviv State University of Life Safety (LSU LS) and its adjacent territory (microdistrict) were selected as locations with daily capacity of about two thousand people. Subsequently, an analysis of all premises that could be used as protective constructions, adhering to the regulatory requirements (see Fig. 2) was carried out, namely:

Spr is the total area of the main premises of the protective constructions (0.5 m^2 in two-level deployment of bunk beds and 0.4 m2 in a three-level deployment);

Hpr is the height of the main premises of protective constructions (at height of premises from 2.15 to 2.9 m with assumed two-level deployment, and at an height of 2.9 m and more - three-level);

Npr is the total number of people in the main premises of the protective structure;

Vpr is the the internal volume of premises per person (not less than 1,5 m^3).

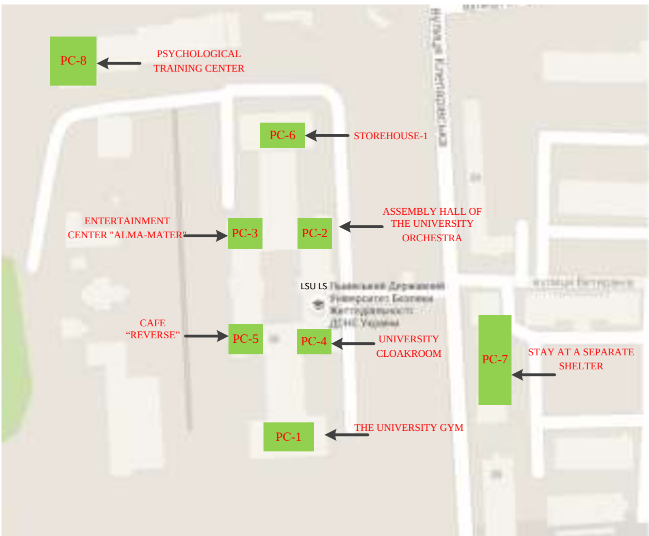

Fig. 2. Mapping location of protective constructions in the district of LSU LS

After analyzing the location of the protective constructions of the LSU LS with an anchor to the surrounding area, using the valid legal framework for the operation of protective constructions and topological modelling, a topological model for managing the stakeholders of the safety improvement project in protective constructions in emergency situations has been developed, and is presented in Fig. 3.

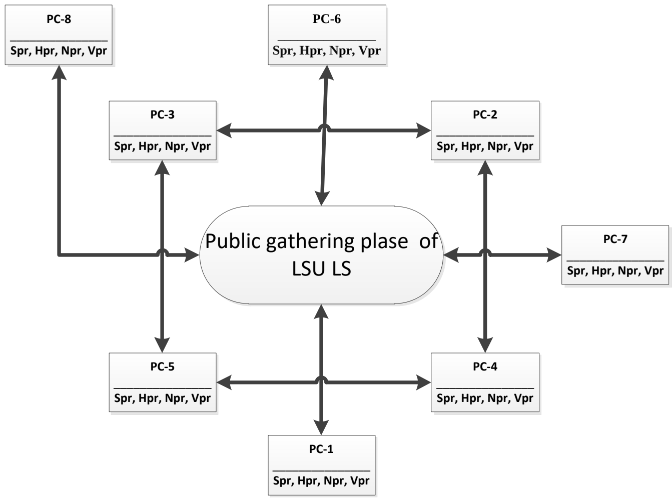

Fig. 3 The topological model of safety-focused stakeholder management in civil protection projects

Topological modelling is used in the case of predefined key parameters of the system elements, for its synthesis. The developed topological model made it possible to carry out the ultimate distribution of personnel located within the micro district LSU LS, the results of which are presented in Table 1.

TABLE 1. EFFECTIVE INDICATORS OF SAFETY-FOCUSED STAKEHOLDER MANAGEMENT OF IN CIVIL PROTECTION PROJECTS

Perso-nnel of LSU LS	Protective construction (Location, 35 Kleparivska Str.)	Number of protect-tive construc-tions	Num-ber of people	Evacua-tion time, min.	Actual area, m^2
1-FS	the university gym	PC-1	125	8,7	220.9
2-FS	assembly hall of the university orchestra	PC-2	138	10,5	148.5
3-FS	entertainment center "alma-mater"	PC-3	128	10,3	174.02
4-FS	university cloakroom	PC-4	180	8,8	312.6
	psychological training center	PC-8	97	6,9	
5-FS	cafe “reverse”	PC-5	86	10,2	120
5-CP			86	10,2	
4-CP			144	8,4	
1-CP, PS	storehouse-1	PC-6	139		299.7
2-CP	stay at a separate shelter	PC-7	161	7,6	104
3-CP	entertainment center "alma-mater"	PC-3	134	7,3	174.02
Sup-port per-sonnel	psychological training center	PC-8	459	10,5	730

III. Conclusions

A method and a model of safety-focused stakeholder management in civil protection projects in the conditions of an emergency or martial law have been developed grounding on the calculations, using the topological modelling and requirements of the legal framework. The proposed method and model made it possible to calculate the ultimate placement of people in protective constructions and to implement the project of ensuring safety of people at public gathering places.

References

[1] Code of Civil Protection of Ukraine, Electronic resource: https://zakon.rada.gov.ua/laws/show/5403-17 (in Ukrainian).

[2] The State Emergency Service of Ukraine. National report on the status of man-made and natural security Ukraine in 2014, Ukrainian Scientific Research Institute of Civil Protection, 2015 (in Ukrainian).

[3] O. B. Zachko, D. S. Kobylkin CSIT, 2, pp. 152-154, (2018).

[4] A.I. Ivanusa, Y.P. Rak EEJAT, 1/10 (61), pp. 145-147, (2013).

[5] O. Zachko, R. Golovatyi, A. Yevdokymova EEJAT, 2/3 (86), pp. 15–24, (2017).

[6] S. Yemelyanenko, A. Ivanusa, H. Klym CSIT, 1, pp. 305-308, (2017).

[7] S.D. Bushuev, N.S. Bushueva, I.A. Babayev, S.D. Bushuev, "Creative technology project management and program, Karl "Samyt-Book", 2010, pp.768 (in Russian).

[8] V.A. Rach, A.V. Rossoshanskij, E.M. Medvedev, "Project management: practical aspects of regional development strategies", Lugansk: K. London, 2010, pp. 276 (in Ukrainian).

[9] Chernov S.K. Risk management system in organizational projects [Text] / S.K. Chernov // Bulletin of the National University of Shipbuilding, – Mykolaiv: NUS, 2006. – No.2. – P. 163-168. (in Russian).

[10] N.N. Brushlinskiy, Y. M.Gluhovenko, V. B.Korobko, S. V. Sokolov M.: Bulletin of National Academy of Sciences and fire safety, 47 pp., (2004).

[11] S. Yemelyanenko, Y. Rudyk, A. Ivanusa CSIT, 1, pp. 17-20, (2018).

[12] A.M. Gulida, O. I. Bashinskiy, I.O. Movchan // Fire safety: Collection of scientific works. - Lviv: LDU BZD 20, pp. 150-154 (2012).

[13] V.V. Holshevnikov, D.A. Samoshyn Academy GPS MCHS of Russia, 212 pp., (2009).

[14] Ivanusa A. «Project of forming «culture and safety» of the buildings» // MATEC Web of Confer-ences, V. 247, 00045 (2018).

[15] D. Shilds, K. I Boys, V.V. Holshchevnikov, D. A. Samoshyn Fire explosion safety, 1, pp. 44-52. (2005).

[16] SBC (State Building Code)B 2.2.5-97 "Protective structures Civil Defense", Electronic resource:

https://undicz.dsns.gov.ua/files/2017/11/14/%D0%94%D0%91%D0%9D%20%D0%92.2.2-5-97.pdf

[17] SBC (State Building Code) A. 3.1-9-2000 "Acceptance of completed protective constructions in the field of civil protection and their maintenance", Electronic resource:

https://dbn.co.ua/load/normativy/dbn/1-1-0-245 (in Ukrainian)

[18] GOST 12.1.004–91, Electronic resource: http://document.ua/ssbt.-pozharnaja-bezopasnost.-obshie-trebovanija-nor3057.html (in Russian).

[19] Order of the Min. of Emerg. Situat. of Russia, (2009). (in Russian).