Виконано огляд гендерних компонентів соціо-просторового контенту безпечного міста. Висвітлено геолокаційний потенціал для виявлення координат безпечності/небезпечності міських локацій та оцінки рівня якості міського середовища. Візуалізовано гендерно-сегреговані та гендерно-чутливі просторові данні, необхідні для виконання гендерного моніторингу безпеки міста, у вигляді ГІС-шарів. Розроблено «модель багатокритеріальної оцінки гендерно-сенситивного змісту» для управління міськими інфраструктурними проектами

Ключові слова: безпечне місто, гендер, ГІС, матриця відстеження вимог, урбан-проекти, управління змістом

Выполнен обзор гендерных компонентов социо-пространственного контента безопасного города. Описан геолокационный потенциал для выявления координат безопасности/опасности городских локаций и оценки уровня качества городской среды. Визуализированы гендерно-сегрегированные и гендерно-чувствительные пространственные данные, необходимые для выполнения гендерного мониторинга безопасности города, в виде ГИС-слоев. Разработана «модель многокритериальной оценки гендерно-сенситивного содержания» для управления городскими инфраструктурными проектами

Ключевые слова: безопасный город, гендер, ГИС, матрица отслеживания требований, урбан-проекты, управление содержанием

THE SAFE CITY: DEVELOPING OF GIS TOOLS FOR GENDER-ORIENTED MONITORING (ON THE EXAMPLE OF KHARKIV CITY, UKRAINE)

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1. Introduction

In today's context of increasing urbanization, cities are considered as important locations for solving problems of gender inequality [1] and achieving sustainable development goals [2]. Gender-sensitive parameters become integral characteristics of a safe city. It is noted that discrimination against women may be caused by a lack of safe infrastructure [3]. The city should form such landscapes that make it impossible to manifest gender discrimination, gender violence [4]. Urban landscapes should not harm the health (physical, mental, social) of the inhabitants. Also, the city should ensure equality in the "right to the city" for all members of the urban community, regardless of age, sex, race, family, property status, etc. (gender+).

There is an urgent need to develop gender-sensitive approaches to the organization of safe public spaces, taking into account the diverse experience and needs of the inhabitants. And this, in turn, actualizes the expansion of the "factual basis", increasing the efficiency of the process of collecting the necessary data and disseminating information. GIS technologies are becoming an integral part of monitoring practices in which information and communication technologies (ICTs) are accessible to a wide range of users. Thanks to the open access of GIS applications for everyone, it is possible to create databases of various contextual data about the city.

The current theoretical and methodological situation is complicated because of the insufficient level of gender-sensitive approaches in the scientific discourse, as well as the relevant methodological grounds for security monitoring. Despite the recognition of the value of GIS technologies for creating mechanisms for monitoring and evaluation of urban areas, there are unresolved issues of their implementation for gender monitoring. In Ukraine, there is still a tendency for a fairly slow spread of GIS technologies, as evidenced by the increase in the "digital divide" in global development indices in comparison with the leading countries (UN E-Government Development Index) [5].

The relevance of the topic is also due to the need to improve the existing Ukrainian approaches to the development of a socially-oriented urban infrastructure, as well as to use the latest technologies for the registration of gender indicators in all urban life systems. It is especially important that the "security strategies" are in the "metropolises" (Kyiv, Kharkiv, Lviv, Odesa, Dnipro). Although in Ukraine,

GIS tools for gender monitoring and evaluation of the city's security measurement are not yet sufficiently used.

2. Literature review and problem statement

In studies of recent years, it is shown how the "security policy" concept is explicated on the "anthropogenic environment" of European cities. A three-component model of city security monitoring (SAP model): "perceived Security", "urban Attractiveness and spatial behavior", "Policy reactions" has been developed [6]. It is proposed to analyze the spatial attractiveness of the city sectorally (locations to live and work, mobility areas, public facilities, and others. It is shown that the phenomenon of mobility allows the better understanding of urban processes in general [7], as well as from the point of view of city safety for women [8].

The focus of space security leads to comprehension of vital and value meanings of the city, as well as to analysis of spatial frameworks in revealing the citizens' potentials and diverse experiences. The methodological basis of urban anthropological studies is the concept of city topos [9], including gender-based interpretations of urban locations [10]. New urban solutions are proposed for solving the problem of identifying urban spaces through the definition of a "generated city" with a multiplicity of ways of everyday life [11, 12]. The attempts are made to identify possible "coordinates" of gender-sensitive locations in the urbanized space [13], to determine the role of the gender factor in urban development [14], and to determine the parameters of gender audit [15].

The gender-oriented vision of the city allows urbanists to expand their own conceptual tools by mastering the gender mainstreaming approach in managing urban projects [16], developing architectural and spatial solutions for public spaces [19]. Comprehensive solutions for the implementation of gender approaches in planning a "hospitable city", with a special emphasis on women's safety (in particular, the Swedish city of Umeå) are proposed. In Ukraine, the gender discourses of cities are represented on the example of the Kharkiv city.

Also, researchers are actively using GIS technology to understand how cities function and change. Visualization becomes an integral part of the city-planning developments. For example, features of spatial accommodation of citizens in open urban spaces (parks, squares, and other recreation areas) are analyzed using GIS visualization of "behavior maps" [20]. New datasets are being formed, as well as ways to better plan a more sustainable urban environment. Researchers discuss the potential of GIS tools for participatory governance and development of society [21]. Also, GIS issues are developed in the context of feminist criticism [22]. Attention is drawn to the digital gap that generates exceptions of some groups of citizens (the poor, women, minorities, and the elderly) from full access to the digital information resources [23].

In Ukraine, geo-information definition of gender parameters of urban spaces is a new research task. The question of using web-cartography for the prevention and elimination of consequences of emergency situations is relevant [24]. Essential aspects of the safety concept, first of all, the cross-sectoral definition of dangerous locations using gender-based assessment systems, remain outside the field of view of researchers. The study of gender parameters of the urban area, which are connected with the possibilities of citizens to exercise their "right to the city", also did not find sufficient justification. However, it is the spatial focus of the city's gender perspective that makes it possible to expand the cognitive boundaries of urban studies.

3. The aim and objectives of the study

The aim of the research is the development of methodological solutions for the identification of gender components of the social-safe content of the safe city of Kharkiv (Ukraine) using GIS mapping on the platform "Secondary city" (USA).

To achieve this goal, it is proposed to solve the following tasks:

– to analyze the features of urban areas with the use of feminist optics for the concepts of a safe city;

– to identify the main methods of geo-investigation of the "safety component";

– to develop gender-sensitive geo-information maps of Kharkiv through explication of the problem of urban infrastructure security;

– to develop a solution for integrating GIS data of gender-sensitive maps into the processes of managing the content of urban infrastructure projects and programs.

4. The gender context of urban space security

Admittedly, security is vital for any segment of the city's social space. Identification of security factors occurs in a specific spatial context and is evaluated taking into account the diversity of everyday experience of citizens. It is noted that space is "occupied" by the body, and the perception of this space can be indicated by sensations of danger during a stay in urban locations. In particular, perceptual evaluation of "presence in urban spaces" by women can be manifested due to fear caused by a real or perceived threat to biological or social existence and human well-being. "Fear of space" can manifest itself in the perception of a street or a separate urban area, especially in the dark, as a threat to personal security. Feminist urbanistics notes that the female "fear of crime" is often experienced as the "fear of sexual violence". The "experience of women" in the city includes not only the likelihood of physical violence towards them but also psychological (for example, because of the existence of a symbolic space of sexist advertising) [2].

The initiative to design "safe cities without violence against women and girls" was established by the UN Women [3]. Safe focus issues of public spaces in the city in terms of the everyday experience of mobility of women and girls. Attention is drawn to the fact that streets, parks, public transport stops, sanitary buildings (toilets) that are not properly equipped, reduce the mobile freedom of women and girls in the city. "Road discourse" becomes important for residents who carry out reproductive roles. After all, it is important to identify the risks that they face when moving about the city with prams. Today, attention is focused on the issues of free movement by public transport or during the city's pedestrian traffic and the identification of spatial barriers for women. Also in feminist urbanistics attention is drawn to the peculiarities of women's spatial behavior – evasion from staying on the street after dark. They feel less safe than men during this period of the day. In this situation, it is a question of re-

stricting women's access to basic urban services, for example, cultural and recreational (women are often forced to refuse to attend various public institutions, have night work, etc.). This reduces their opportunities in social communications, as well as being attracted to education, work and social life. This also negatively affects their health and well-being.

Gender context of the safe city is indicated in the Sustainable Development Goals: ensure healthy lives and promote well-being for all at all ages (Goal 3: Good health and well-being); achieve gender equality and empower all women and girls (Goal 5: Gender equality); ensure availability and sustainable management of water and sanitation for all (Goal 6: Clean water and sanitation); make cities and human settlements inclusive, safe, resilient and sustainable (Goal 11: Sustainable cities and communities). In the content of the meaning of the Goals, the tasks related to the safety of women and girls in cities are highlighted:

– "...to combat water-borne diseases..." (3.3);

– halve the number of global deaths and injuries from road traffic accidents (3.6);

– "achieve universal health coverage ...access to quality essential health-care services ...for all" (3.8);

– end all forms of discrimination against all women and girls everywhere (5.1);

– eliminate all forms of violence against all women and girls in the public and private spheres (5.2);

– recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies (5.4);

– "...achieve access to adequate and equitable sanitation and hygiene for all ... paying special attention to the needs of women and girls and those in vulnerable situations" (6.2);

– "provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (11.2);

– "provide universal access to safe, inclusive and accessible public spaces, in particular for women and children, older persons and persons with disabilities" (11.7).

The outlined cross-sectoral context of gender monitoring of city security is presented in Fig. 1.

Gender-sensitive requirements for a safe city, presented in the system of Sustainable Development Goals, should be included in the context of projects for the design and development of public spaces of cities. Particular attention should be paid to the implementation of a comprehensive survey of urban facilities/locations and the measurement of gender-sensitive parameters of urban infrastructure. Creation of a safe space is possible due to the improvement of such infrastructure elements as transport, street lighting, sanitary facilities, playground equipment, etc.

It should be noted that the Sustainable Development Goals recommend using high-performance technologies, in particular, information and communication technologies, to address gender equality issues (5.b). Therefore, this requirement is actualized for all the target tasks presented by the structural and logical decomposition of the context of the phenomenon of "safe city for all" (Fig. 1).

Among the existing effective technological tools, attention is paid to electronic mapping. GIS mapping is a powerful tool for gender monitoring of cities. GIS can effectively collect, process and interpret various urban databases, and make informed decisions.

5. Creation of a geo-information map for gender monitoring of the security of Kharkiv city locations

It should be noted that in Ukraine, GIS tools for gender monitoring and evaluation of the city's safety measurement are not yet widely disseminated. Geo-information definition of urban spaces is a new research task for Ukrainian urban studies. In this study, the GIS practices of the city of Kharkiv (Ukraine) are comprehended. They were carried out as part of the international project of the American Association of Geographers "Secondary Cities", with the support of the US State Department [25]. The goal of the project is to develop local capacity through the use of geospatial technologies in the city's livelihoods.
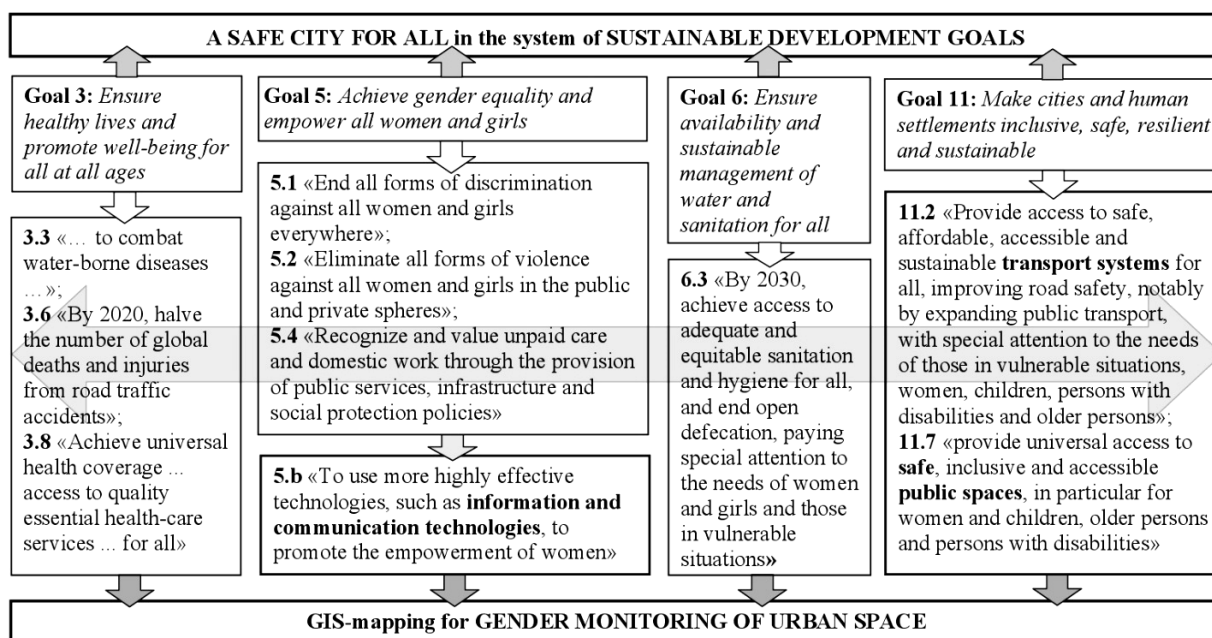

Fig. 1. Structural-logical decomposition of the gender phenomenon "safe city" in the context of Sustainable Development Goals

In the framework of project initiatives "Kharkiv, Ukraine: Secondary cities", "field studies" of urban areas were conducted. As a result, 2417 point objects of the "mobility features" block, 1496 points of the "social infrastructure" block and 18039 objects of the "public safety" block were recorded. Data collection was done using an application for mobile devices (smartphones) – Survey 123 for ArcGIS [26]. Within the framework of the project, the municipality of Kharkiv sorts cartographic material for information platforms: "Kharkiv: Transportation Network", "Kharkiv: Road Junctions", "Kharkiv: Power lines (points)", "Kharkiv: Tramway Lines", "Kharkiv: Building Use" [25].

The cartographic information, collected within the framework of the project initiatives "Kharkiv, Ukraine: Secondary cities", is laid out layer by layer, with the possibility of integrating thematic information from different layers. Working with map layers (selecting and displaying themes for visualization) makes it possible to combine the layers in such a way as to update the gender contexts. In particular, in this study, it is proposed to determine the number of gender-sensitive parameters of the city for creating the map "Kharkiv: safe for women – safe for everyone".

Firstly, "the mobility space is friendly to a woman and a child" (Fig. 2). The specialized map allows integrating information regarding the quality of the spatial environment of the city for street mobility. Low curbs, ramps, steps to improve the movement of pedestrians, particularly vulnerable gender groups (parents with small children, the elderly, and people with disabilities). Such locations as unequipped places to wait for public transport, unreliable routes make women vulnerable and unprotected. It is important that each point on the map is a representation of a set of attributive information collected by volunteers of the project directly on the site (Fig. 2, *a*). The data is confirmed by visualization (a photograph of the object, Fig. 2, *b*). Geo-spatial information of this map can be expanded due to the mobility characteristics of school-age children. After all, "parental fears" are often associated, for example, with the fact that children go to school through an unregulated transition (without a traffic light), or where there is no marking for a pedestrian crossing.
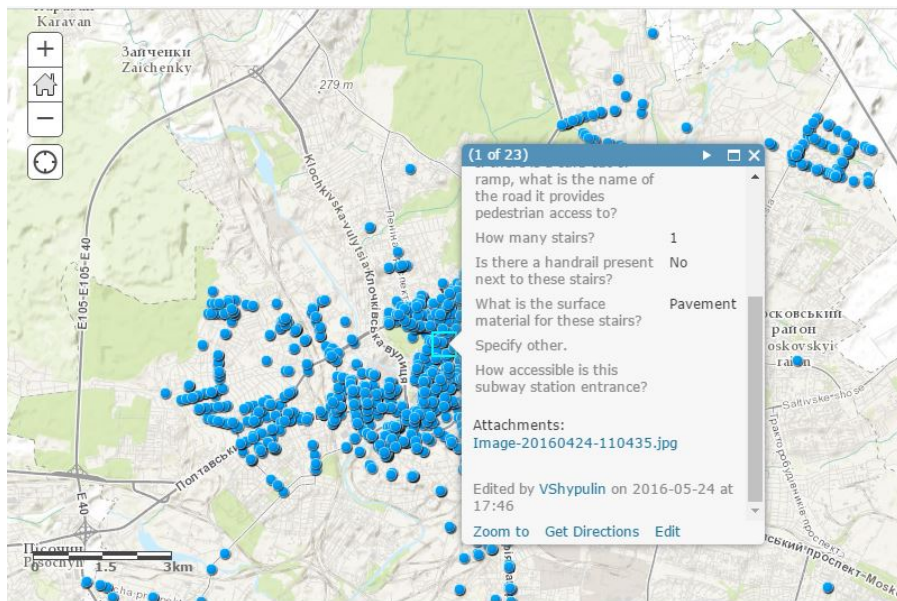
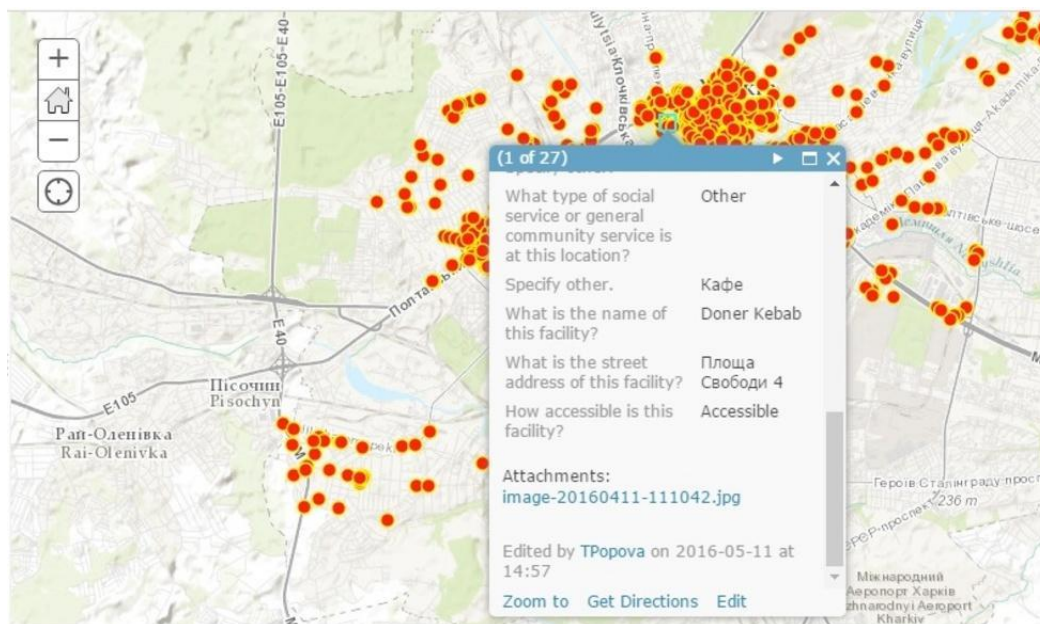

a
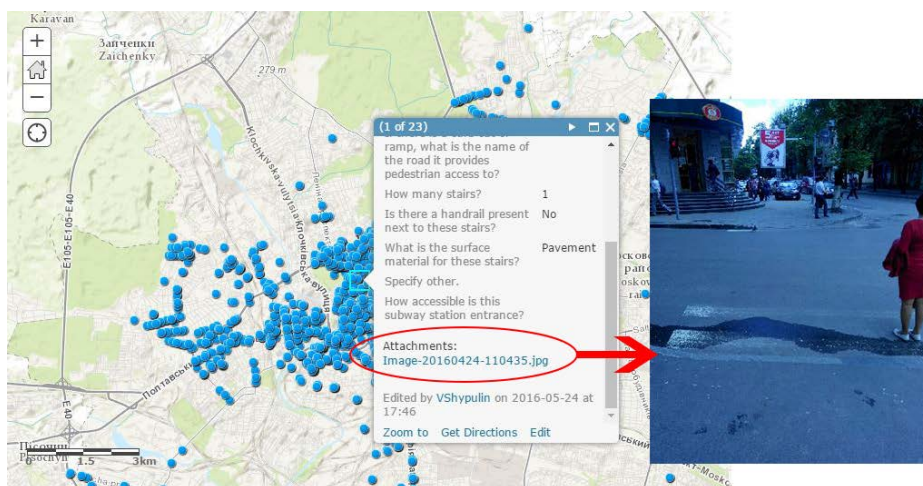
b

Fig. 2. Map "Kharkiv: mobility space — friendly to women and children (developed using ArcGISOnline [27])":
a — a window for placing information about the object; *b* — the output of the actual image of the object described
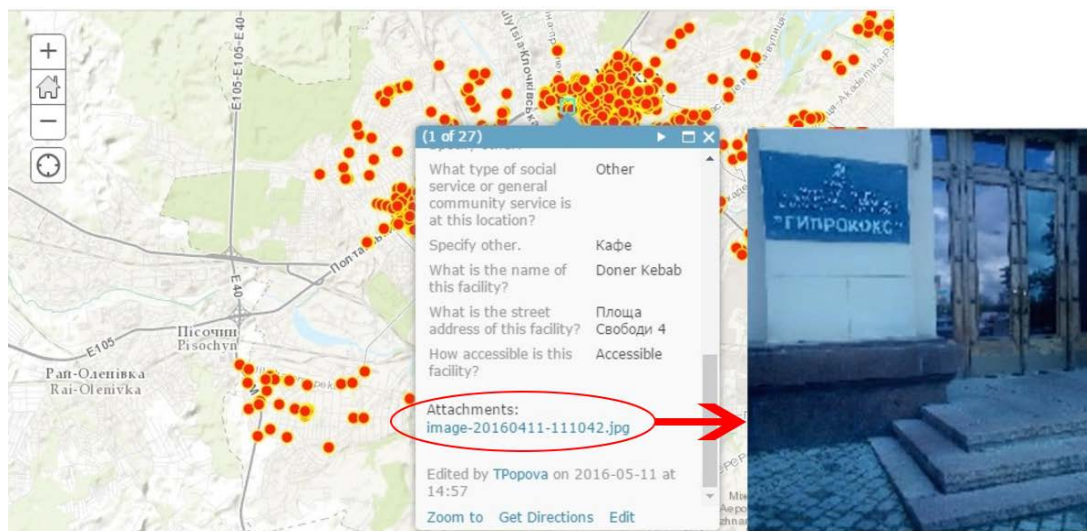
Secondly – "social infrastructure – friendly to the family". Attention is focused on the organization of specific urban spaces that help women to combine family and professional responsibilities. After all, it is women, irrespective of career employment, who demonstrate greater responsibility for most "internal" tasks: caring for children, elderly relatives, shopping for the family, etc.). Women, "caring about others", think of such urban locations as schools, hospitals, public services centers, shops, recreation facilities. In particular, an important indicator of a safe city is the existence of such a social facility as a refuge for women affected by domestic violence. It should be noted that in Kharkiv a similar object appeared in 2016, thanks to the support of UNDP. However, in the city of Vienna, there is a high indicator of gender equality, there are 6 such institutions. Such an infrastructure landscape of the city becomes part of the projects to create a safe city. Gender aspects of city security can be presented in the context of quality of living space, quantity and quality of social infrastructure objects in this map (Fig. 3, *a*). To confirm the relevance, photos of objects are attached to the map (Fig. 3, *b*).

Thirdly, "security of public spaces". A specialized map (Fig. 4) allows you to integrate information about the location of street lighting sources (lampposts). The availability of lighting sources along pedestrian paths, at entrances to buildings, near stops, in other public places (Fig. 4, *a*). A positive trend in the level of illumination of Kharkiv should be noted. According to the general urban technical parameters, it is 98.1 %, while 15 years ago this indicator was 36 %. It is known that women, as a rule, try not to go alone in the dark, fearing to become victims of gender-based violence. Illumination improves the visibility of paths for pedestrians and also prevents criminal acts. To confirm the relevance, photos of objects are also attached to the map (Fig. 4, *b*).
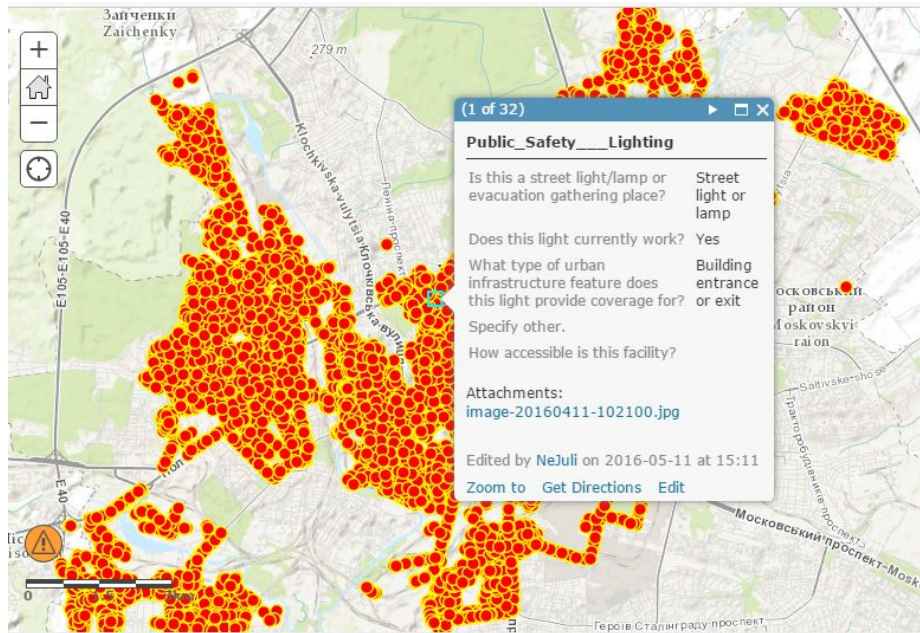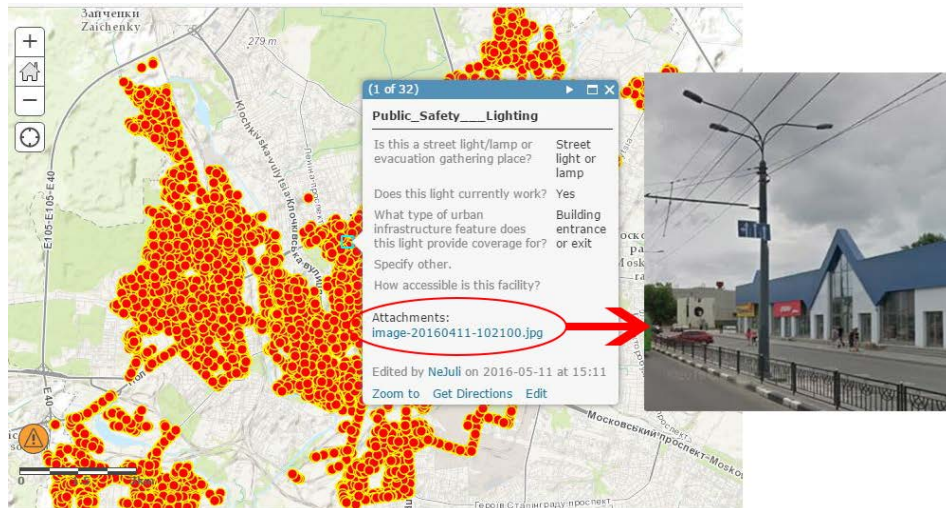

a

b

Fig. 3. The map "Kharkiv: social infrastructure — family friendly" (developed using ArcGISOnline [27]):
a — window for placing information about the object; *b* — output of the actual image of the object described

Fig. 4. The map "Kharkiv: Public Space Security" (developed using ArcGISOnline [27]):
a — window for placing information about the object; *b* — the actual image of the object described

The proposed gender-sensitive Kharkiv GIS maps contain wide functional possibilities. The developed gender maps form a powerful tool for integrating the efforts of city authorities and society to improve the urban space and comfortable living of all members of the community. Using an interactive map allows to get information about an object directly from the placement on the map, by calling the help window (Fig. 2–4). GIS map users have the opportunity to determine in real time the quantitative/qualitative gender sensitive characteristics of a city facility/location, and to minimize hazards in everyday urban practices.

6. The discussion of the results: a model for assessing the gender-sensitive content of urban infrastructure projects

Gender-sensitive GIS maps are a significant information source for the formation of the content of projects and programs focused on improvement, reconstruction of urban locations and infrastructure facilities. According to the PMBOK, "Project Scope Management (PSM)" should consist of the processes necessary for the successful implementation of the project [28]. The evaluation of the gender-sensitive content of urban projects should undoubtedly be presented in the information model "collection of requirements" [28]. Similarly, relevant gender information should be presented in the "requirements tracking matrix". It is proposed to develop a "gender tracking matrix" to manage the content of urban infrastructure projects and programs (Table 1). The matrix allows you to track the inclusion and development of the necessary gender components in the structural elements of the project content.

It is proposed to assess the level of safety of the infrastructure project through the prism of the inclusion of gender requirements in the content on a scale: "5" – high level;

"3" – average level; "1" – low level; "0" – does not affect; "–1...–5" – degree of negative influence.

Table 1

Matrix for tracking gender requirements for the content of infrastructure projects

Requirements for the content of the project [28]	Gender requirements for the content of the infrastructure project	"Checkpoints"		
		1	2	n
Project administration requirements	Support for up-to-date information on the state of gender-sensitive infrastructure of the city	AR_1	AR_2	AR_n
	Benchmarking of gender practices of GIS mapping			
Stakeholder Requirements	Gender competence of the team members (gender image, culture, level of mastery of gender-related GIS tools)	StR_1	StR_2	StR_n
	The ability of project team members to work (interpret, integrate) on IT for evaluation/monitoring of gender gaps indicators			
Requirements for the solution	The design solutions are presented by the GIS layers to visualize the gender-sensitive content of the design solutions	SR_1	SR_2	SR_n
	The solution integrates GIS content data in accordance with the gender groups of beneficiaries of the project (gender +)			
Requirements for transition	Readiness of the project team (administration) to implement gender-sensitive GIS mapping in the current project activity	TR_1	TR_2	TR_n
Quality requirements	GIS mapping is used to track the positive dynamics of gender security parameters	QR_1	QR_2	QR_n

Evaluation of the gender context of the infrastructure project as "a project that will improve the safety of urban locations" is presented in the following form:

$$GS_i = \alpha_1 AR_i + \alpha_2 StR_i + \alpha_3 SR_i + \alpha_4 TR_i + \alpha_5 QR, \qquad (1)$$

where AR_i – is the value of the i-th infrastructure project in its compliance with the gender requirements for project administration, $AR_i = \sum_{k=1}^{k'} AR_{ki} z_{ki}$, where k – gender requirements for the context of the infrastructure project concerning administration, z_{ki} – is the degree of importance the k-th gender requirement in the administration of the i-th infrastructure project;

StR_i – is the value of the i-th infrastructure project in its compliance with the gender requirements for stakeholders, $StR_i = \sum_{l=1}^{l'} StR_{li} z_{li}$, where l – gender requirements of stakeholders for the content of the infrastructure project, z_{li} – is the importance degree of the l-th gender requirement of stakeholders for the i-th infrastructure project;

SR_i – is the value of the i-th infrastructure project in its compliance with the gender requirements for decisions made, $SR_i = \sum_{h=1}^{h'} SR_{hi} z_{hi}$, where h – gender requirements of the content of the decisions adopted in the infrastructure project, z_{hi} – is the importance degree of the h-th gender requirement for the solution for the i-th infrastructure project;

TR_i – is the value of the i-th infrastructure project in its compliance with the gender requirements for transition, $TR_i = \sum_{t=1}^{t'} TR_{ti} z_{ti}$, where t – gender requirements of the context of transition of the infrastructure project, z_{ti} – is the importance degree of the t-th for transition for the i-th infrastructure project;

QR_i – is the value of the i-th infrastructure project in its compliance with the gender requirements for quality, $QR_i = \sum_{q=1}^{q'} QR_{qi} z_{qi}$, where q – gender requirements of quality, infrastructure project, z_{qi} – is the importance degree of the h-th gender requirement for quality for the i-th infrastructure project;

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ – are the weighting coefficients.

The model developed (1) refers to a task of multifactor mathematical programming. It needs solving by reducing one or a set of single-factor problems. In a situation where one individual makes the decision (individual decision making, IDM), it is necessary to take into account all the partial criteria, and the generalized quality functional takes the following form:

$$F(AR, StR, SR, TR, QR) =$$
$$= \alpha_1 AR + \alpha_2 StR + \alpha_3 SR + \alpha_4 TR + \alpha_5 QR;$$

$$\sum_{i=1}^{5} \alpha_i = 1, \quad 0 \le \alpha_i \le 1, \qquad (2)$$

where F – is an additive utility function, which is seen as a set of characteristics of the infrastructure project; α_i – stands for the weighting coefficients, $i = \overline{1;4}$.

The overall solution of the tasks (1) and (2) can be made in a sequence, with the primary necessity to determine the weighting coefficients a_i of the additive utility function (2). The numerical values of the weighting coefficients are found by an expert method, such as the hierarchy analysis method. The problem is further solved by integer linear programming methods.

7. Conclusions

1. The gender-urban analysis:

– showed the geolocation potential for identifying the safety/hazard coordinates of urban locations and assessing the quality of the urban environment as a whole;

– allowed visualizing the gender-segregated and gender-sensitive spatial data necessary for the implementation of gender monitoring of city security.

2. The developed GIS layers for the map of Kharkiv (using ArcGIS software products) are able to play an integrative role of the catalyst for the city's gender mainstreaming and allow local authorities to:

– effectively perform information and analytical processes to develop appropriate solutions (generation of gender-segregated data, data management and exchange, remote zoning), etc.;

– assess progress in the implementation of relevant activities by the municipality to improve the level of city security;

– identify problems, trends, new approaches to issues affecting the situation of girls and women, which require timely consideration.

3. GIS visualization of gender-sensitive identification of urban safety in an innovative way integrates open data, which allows:

– expanding the range of possible solutions to overcome discriminatory spatial practices;

– transforming dangerous locations into safe locations in the context of "safe for women – safe for everyone".

4. To improve the processes of "content management" of urban infrastructure projects and programs, a "model of multi-criteria evaluation of gender-sensitive content" was developed. The model is based on the structural and logical scheme requirements for the content of the project (PMBOK, p. 5.2.3.1 "Requirements documentation") and contains specially developed gender GIS requirements for the content of the infrastructure project. The application of the proposed model makes it possible to take effective design decisions by integrating gender parameters in the project database in a GIS mapping format.

PMBOK® Guide): Fifth Edition. (2013). USA: Project Management Institute, 589.

References

1. Wong, E. Gender Equality for Smarter Cities: Challenges and Progress [Text] / E. Wong. – Nairobi: UNON, Publishing Services Section, 2010. – 42 p.

2. Creating safe public spaces [Electronic resource]. – UN Women. – Available at: http://www.unwomen.org/ru/what-we-do/ending-violence-against-women/creating-safe-public-spaces

3. Safe cities free from violence against women and girls [Electronic resource]. – UN Women and ICRW, 2012. – 16 p. – Available at: http://www.icrw.org/wp-content/uploads/2016/10/Baseline-Research-of-Safe-Cities-programme-(1)[smallpdf.com].pdf

4. Sustainable Development Goals [Electronic resource]. – Available at: http://www.un.org/sustainabledevelopment/sustainable-development-goals/

5. Fesenko, T. E-readiness evaluation modelling for monitoring the national e-government programme (by the example of Ukraine) [Text] / T. Fesenko, G. Fesenko // Eastern-European Journal of Enterprise Technologies. – 2016. – Vol. 3, Issue 3 (81). – P. 28–35. doi: 10.15587/1729-4061.2016.71606

6. Van den Berg, L. The Safe City: Safety and Urban Development in European Cities [Text] / L. van den Berg, G. Mingardo, P. M. J. Pol. – Hants: Ashgate Pablishing Limited, 2006. – 31 p.

7. Lenormand, M. Towards a Better Understanding of Cities Using Mobility Data [Text] / M. Lenormand, J. J. Ramasco // Built Environment. – 2016. – Vol. 42, Issue 3. – P. 356–364. doi: 10.2148/benv.42.3.356

8. Building Inclusive Cities. Women's Safety and the Right to the City [Text] / C. Whitzman, C. Legacy, C. Andrew, F. Klodawsky, M. Shaw, K. Viswanath (Eds.). – London: Routledge, 2013. – 240 p.

9. Fesenko, G. Urban antropologichniy diskurs filosofii bezpeki [Text] / G. Fesenko // Gileya. – 2015. – Issue 92. – P. 166–170. – Available at: http://eprints.kname.edu.ua/39773/1/1-Fesenko%20G.pdf

10. Bibik, N. V. «Henderni okulyary» dlya urbanistiv [Text]: IV mizhnar. nauk.-prakt. konf. / N. V. Bibik, H. H. Fesenko, T. H. Fesenko // Hender. Ekolohiya. Zdorov'ya. – Kharkiv: KhNMU, 2015. – P. 41–42.

11. Fesenko, G. Filosofiya mista u henderniy interpretatsiyi prostoriv [Text] / G. Fesenko // Lyudynoznavchi studiyi. – 2014. – Issue 30. – P. 56–68. – Available at: http://ddpu.drohobych.net/filos_lud/wp-content/uploads/2016/04/2014_7.pdf

12. Fenster, T. The Right to the Gendered City: Different Formations of Belonging in Everyday Life [Text] / T. Fenster // Journal of Gender Studies. – 2005. – Vol. 15, Issue 3. – P. 217–231. doi: 10.1080/09589230500264109

13. Fesenko, G. Henderno-chutlyvi lokatsiyi v urbanizovanomu prostori [Text] / G. Fesenko // Hendernyy zhurnal «Ya». – 2015. – Issue 2 (38). – P. 4–6. – Available at: http://eprints.kname.edu.ua/43802/1/Fesenko%20G.G._4.pdf

14. Chant, S. Gender, Urban Development and the Politics of Space [Electronic resource] / S. Chant, C. Mcllwaine // E-International Relations (E-IR). – 2013. – Available at: http://www.e-ir.info/2013/06/04/gender-urban-development-and-the-politics-of-space/

15. Fesenko, G. Hendernyy audyt yak praktyka staloho rozvytku mist [Text]: mizhnar. nauk.-prakt. konf. / G. Fesenko // Henderna polityka mist: istoriya ta suchasnist'. – Kharkiv: KhNUMH im. O. M. Beketova, 2013. – Issue 4. – P. 234–237.

16. Fesenko, T. G. Gender mainstreaming as a knowledge component of urban project management [Text] / T. G. Fesenko // Strategic Management Department, NTU «KhPI». – 2017. – Issue 3 (1225). – P. 21–29. doi: 10.20998/2413-3000.2017.1225.4

17. Horelli, L. Gender mainstreaming urban planning and development – experiences of women s place based politics [Text] / L. Horelli. – Madrid: Escuela Tecnica Superior de Arquitectura, 2002. – 16 p.

18. Sandberg, L. Imagining the ideal city, planning the gender-equal city in Umea, Sweden [Text] / L. Sandberg, M. Ronnblom // Gender, Place & Culture. – 2016. – Vol. 23, Issue 12. – P. 1750–1762. doi: 10.1080/0966369x.2016.1249346

19. Fesenko, T. G. Implementatsiya hendernykh pidkhodiv u munitsypal'ni prohramy rozvytku zhytlovo-komunal'noho hospodarstva [Text]: III mizhnar. nauk.-prakt. konf. / T. G. Fesenko, D. M. Minayev, O. V. Belyats'kyy, I. S. Usachev // Henderna polityka mist: istoriya ta suchasnist'. – Kharkiv: KhNUMH im. O. M. Beketova, 2013. – Issue 4. – P. 238–240.

20. Marusic, B. G. Analysis of patterns of spatial occupancy in urban open space using behaviour maps and GIS [Text] / B. G. Marusic // URBAN DESIGN International. – 2010. – Vol. 13, Issue 1. – P. 36–50. doi: 10.1057/udi.2010.20

21. Wallin, S. Playing with the glocal through participatory e-planning [Electronic resource] / S. Wallin, L. Horelli // The Journal of Community Informatics. – 2012. – Vol. 8, Issue 3. – Available at: http://ci-journal.net/index.php/ciej/article/view/883/934

22. Kwan, M.-P. Is GIS for Women? Reflections on the critical discourse in the 1990s [Text] / M.-P. Kwan // Gender, Place & Culture. – 2002. – Vol. 9, Issue 3. – P. 271–279. doi: 10.1080/0966369022000003888

23. Pavlovskaya, M. Feminism and Geographic Information Systems: From a Missing Object to a Mapping Subject [Text] / M. Pavlovskaya, K. S. Martin // Geography Compass. – 2007. – Vol. 1, Issue 3. – P. 583–606. doi: 10.1111/j.1749-8198.2007.00028.x

24. Hnatyuk, S. Suchasna veb-kartohrafiya ta yiyi vykorystannya u poperedzhenni y likvidatsiyi naslidkiv nadzvychaynykh sytuatsiy (crisis mapping). Analitychna zapyska [Electronic resource] / S. Hnatyuk // Natsional'nyy instytut stratehichnykh doslidzhen'. – Available at: http://www.niss.gov.ua/articles/806/

25. Kharkiv, Ukraine: Secondary cities [Electronic resource]. – Available at: https://secondarycities.state.gov/kharkiv/#10/49.9804/36.2487

26. Survey123 for ArcGIS: Smarter Forms, Smarter Field Work [Electronic resource]. – Available at: https://survey123.arcgis.com/

27. ArcGISOnline [Electronic resource]. – Available at: https://www.arcgis.com/home/index.html

28. A Guide to the project management body of knowledge (PMBOK Guide) [Text]. – 5-th ed. – USA: Project Management Institute, 2013. – 589 p.

MODELING OF SOFTWARE DEVELOPMENT PROCESS WITH THE MARKOV PROCESSES

Запропоновано інформаційну модель процесу пошуку і використання асоціативних правил при розробці програмного забезпечення, яка може бути використана при створенні відповідної інформаційної технології. При цьому розглянуто формальні підходи для опису процесу розробки програмного забезпечення. Здійснено моделювання даного процесу на різних рівнях деталізації за допомогою Марковських ланцюгів

Ключові слова: Марковські процеси, Марковські ланцюги, розробка програмного забезпечення, пошук асоціативних правил

Предложена информационная модель процесса поиска и использования ассоциативных правил при разработке программного обеспечения, которая может быть использована при создании соответствующей информационной технологии. При этом рассмотрены формальные подходы для описания процесса разработки программного обеспечения. Осуществлено моделирование данного процесса на разных уровнях детализации с помощью Марковский цепей

Ключевые слова: Марковские процессы, Марковские цепи, разработка программного обеспечения, поиск ассоциативных правил

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1. Introduction

Software development is the process of computer programming, documenting, testing, and bug fixing involved in creating and maintaining a program [1]. A software development process is a sequence of stages, the transition between which has no clear boundaries. Usually, the next stage begins upon implementation of 80–90 % of the works of the previous stage. This is especially true of the requirements engineering stage when in some cases evaluation of indeterminate forms occurs only at the end of the project.

In the description of the process of creating software products (SP), the approaches based on data types such as functional, relational (Z, VDM) or axiomatic (OBJ) are preferable. These approaches facilitate software design while being insufficient to describe the system dynamics. Other formal approaches such as finite-state machines [2] or Petri nets [3] allow a detailed description of the system dynamics, but poorly describe changes in internal data during transitions between states. There are approaches that well describe both the system dynamics and processes in data, such as Statecharts [4]. However, they are insufficiently formalized.

The outlined approaches represent the overall software development process in dynamics, but don't represent it at different levels of detail that can be achieved using Markov processes and appropriate mathematical tools.

2. Literature review and problem statement

Formalization of software use cases with the Kripke model has been made [5]. This model is a variation of nondeterministic finite-state machine used in model checking to represent the behavior of a system.

The authors [5] propose to apply a template to transform the description of use cases into a Kripke structure [6]. This