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QUALITY MODEL OF MEDIA SYSTEMS WITH INFOGRAPHIC DATA

The study of the quality of media systems development, which incorporates a large volume of infographic data, is a highly relevant task, as the increasing amount of information demands new approaches to its presentation that ensure rapid and efficient perception. This paper is dedicated to analyzing the factors influencing the quality of media systems development and constructing a model of prioritized factor influence, which will serve as the foundation for further research into predictive quality evaluation.

The article employs graph theory tools and systems analysis methods, specifically the mathematical hierarchy modeling method. Based on expert evaluation, a set of factors influencing the quality of media systems development has been identified, including the target audience, content, interactivity, layout, prototype, typography, and data visualization. The influences and dependencies between these factors have been visualized using a directed graph. The priorities of the factors were determined through the method of mathematical hierarchy modeling, which involves the formation of a binary factor reachability matrix and the construction of iterative tables. These iterative tables contain information on the ordinal number of the factor in the set, the subset of reachable vertices, the subset of predecessor vertices, and the intersection of the subsets. It was found that the highest rank belongs to the factors "target audience" and "content", while the lowest rank was assigned to the "typography" factor. Based on the data obtained during the iteration process, a model of prioritized factor influence on the quality of media systems development with infographic data was synthesized.

The constructed model will assist in more effectively allocating resources, such as time and funds, across the key stages of media systems creation. Additionally, it will help minimize risks associated with the product's mismatch with the target audience's needs, thereby reducing additional costs in the development process.

Keywords: media system, infographic, factor, prioritized influence, model, quality.

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МОДЕЛЬ ЯКОСТІ МЕДІА СИСТЕМ З ІНФОГРАФІЧНИМИ ДАНИМИ

Дослідження якості розроблення медіа систем, що містять велику кількість інфографічних даних, є актуальною задачею, оскільки зростаючий обсяг інформації вимагає нових підходів до її подання, здатних забезпечити швидке та ефективне сприйняття. Дана робота присвячена аналізу факторів впливу на якість розроблення медіа систем та побудові моделі пріоритетного впливу факторів, яка стане основою подальших наукових розвідок щодо прогностичного оцінювання якості.

У статті використано засоби теорії графів та методи системного аналізу, зокрема метод математичного моделювання ієрархій.

На основі експертного оцінювання виокремлено множину факторів впливу на якість розроблення медіа систем: цільова аудиторія, контент, інтерактивність, верстка, прототип, шрифтове оформлення, візуалізація даних. Сформовано впливи та залежності між факторами, які візуалізовано за допомогою орієнтованого графа. Визначено пріоритетності факторів за допомогою методу математичного моделювання ієрархій, що передбачає формування бінарної матриці досяжності факторів та побудову ітераційних таблиць. При цьому ітераційні таблиці містять відомості про порядковий номер фактора у множині, підмножину сукупності досяжних вершин, підмножину сукупності вершин попередниць та перетин підмножин. Визначено, що найвищий ранг належить факторам «цільова аудиторія» та «контент», а найнижчий — фактору «шрифтове оформлення». На основі даних, отриманих під час ітерації, синтезовано модель пріоритетного впливу факторів на якість розроблення медіа систем з інфографічними даними.

Побудована модель допоможе ефективніше розподіляти ресурси, зокрема час і кошти, між ключовими етапами створення медіа систем. Крім того, вона сприятиме мінімізації ризиків, пов'язаних із невідповідністю продукту потребам цільової аудиторії, та, відповідно, зменшенню додаткових витрат у процесі розробки.

Ключові слова: медіа система, інфографіка, фактор, пріоритетний вплив, модель, якість.

Introduction

The primary function of media systems is the creation, transmission, and management of information flows, which facilitate communication between various social groups and institutions. Media systems play a pivotal role in shaping public opinion, political processes, and cultural values. With technological advancements, these systems have become more interactive, allowing citizens not only to passively consume content but also to actively engage with it, creating their own informational products. This, in turn, has transformed the structure of communication and contributed to the democratization of access to information.

It should be noted that users of media systems face the challenge of limited time, which significantly affects their informational needs. As a result, they prioritize quick responses to their queries, minimizing the effort required to sift through large amounts of textual information. This highlights the importance of providing content in an accessible and concise format, allowing for the perception of information with minimal cognitive effort. Moreover, the growing competition in the information services market compels media system developers to seek new approaches to user engagement.

One of the effective tools for addressing this challenge is the use of infographics in media systems. Infographics enhance the process of information perception by transforming complex data into visually appealing and easily understandable images. This is particularly relevant in the context of the rapid development of information technologies, which offer new opportunities for the interactive presentation of information. Infodesign, incorporating dynamic and interactive elements, enables the creation of infographic projects that are effectively integrated into the structure of modern media systems.

Media systems that employ infographics not only improve the processing and perception of information but also increase user interest and engagement. They become dynamic environments for visualizing large datasets, providing quick access to key information. Thus, the combination of media systems and infographic elements contributes to the enhancement of the quality of information services, optimizing the process of information transmission and facilitating its perception, which is a crucial factor in the competition for the attention of the target audience.

Research into the factors affecting the quality of media systems with infographic data is an important step in improving informational interaction. The quality of such systems is determined by a set of characteristics that ensure the effectiveness of information presentation and perception. One of the key factors is the target audience: understanding user needs allows for the adaptation of infographic content to their expectations and level of expertise. Relevance, accuracy, and accessibility of content ensure successful information delivery. System interactivity fosters deeper user engagement by allowing them to interact with the data and explore different aspects of the information independently. Layout is another important factor, as it must provide logical structure and intuitive navigation, facilitating the search for necessary information. Prototyping enables early evaluation of system capabilities and the incorporation of improvements to enhance the user experience. Appropriately chosen fonts improve readability and the overall impression of the content, while high-quality data visualization simplifies the understanding of complex information through graphical elements. Analyzing these factors aids in the creation of high-quality media systems that meet modern user and market demands.

The presented facts underscore the relevance of this study, which aims to develop a model for the priority impact of factors on the quality of media systems with infographic data. To achieve this goal, the following tasks were set: to analyze the factors influencing the quality of media system development; to determine the prioritization of factors using the analytic hierarchy process (AHP); and to develop a model for the priority impact of factors on the quality of media systems with infographic data.

Related works

An analysis of the literature on this topic [1–9] indicates that the issue of evaluating the factors influencing the quality of media systems with infographic data is relevant and widely discussed. In [1], the growing popularity of visual analytics is highlighted. Recommendations have been developed regarding the infographic representation of abstracts and the main text of publications. Problems and promising directions for data visualization have been identified. However, there is a lack of analysis of the criteria that determine the quality of the final result. In [2], it is recommended to use infographics not only in analytical but also in scientific journals as a form of presenting research findings. A multifactor linear regression analysis was conducted to determine the relationship between article type and social media attention, considering bibliometric characteristics. The results show a higher citation rate for articles that included data visualization. Moreover, infographics attracted significantly more attention on social media compared to original research articles on similar topics. Thus, by creating infographics, journals can increase the social media attention a particular study or topic receives.

The research [3] notes that the role of media institutions in the digital age is characterized by the transformation of media consumption models, which are becoming increasingly diverse and heterogeneous. Recommendations have been formulated to improve media quality in the context of social interaction. However, recommendations concerning media quality from a technological perspective are absent. In contrast, [4] presents the essence of an information-based approach to developing alternatives and identifying optimal options for high-quality websites. Specifically, the following influencing factors are highlighted: content, usability, information security, and performance. It was found that the quality of electronic web resources depends not only on the prioritization of identified factors but also on the chosen implementation modes (variants). Only Pareto-optimal factors were considered, which do not account for the resource development process.

In [5], it is stated that every content developer needs an audience and must possess knowledge about its characteristics. Key concepts such as "audience segmentation" and "audience engagement" are discussed. The modern trends in audience development under media convergence conditions are outlined. The problems and opportunities that these trends create for content producers are highlighted. Methods are proposed by which content developers can identify and effectively reach their target audience. Using datasets of social media posts from leading airlines and SUV brands, collected from Twitter and Instagram, [6] examines the impact of image content on social media engagement. A significant and reliable positive impact of graphic content on user engagement with both product categories on Twitter was identified. High-quality and professionally taken photographs also contribute to increased interest on both platforms for both product categories. The research [7] is aimed at studying the influence of brand interactivity in social media on customer behavior. The results indicate a positive impact of interactivity on

users' willingness to make purchases. Research [8] addresses the importance of data visualization in modern society and its role in effective communication and data interpretation across various sectors. Examples of data visualization applications in business management, scientific research, journalism, media, politics, and governance are provided. The utility in each of these contexts is emphasized. Tools and software commonly used for data visualization are analyzed. However, insufficient attention is given to identifying and systematizing the factors affecting media systems' quality. The prioritization of these factors remains unexplored. An effective method for determining the priority of influencing factors in the examined process is presented in the research [9]. However, this research is focused on evaluating factors affecting the quality of reference and encyclopedic book publications.

Method for determining the priority impact of factors

The key to solving the task at hand lies in selecting the criteria that influence the quality of media systems development and establishing, through expert assessment, a set of interrelationships between them. This initial data is represented by a directed graph. Factors are placed at the vertices of the graph, and arcs connect pairs of vertices for which a relationship has been identified. This relationship indicates a certain dependency of one parameter on another [9].

To establish the priority levels of the factors based on the constructed graph, the method of mathematical hierarchy modeling [10] was employed. A reachability matrix *A* was built, where the binary elements are determined by the following rule:

$$X_{ij} = \begin{cases} 1 \; if \;\; it \; is \;\; possible \; to \; reach \; vertex \;\; j \;\; from \; vertex \; i \\ 0 \; \text{otherwise.} \end{cases} \quad (1)$$

The reachability of vertex X_j *(j=1, 2, …, n)* with respect to vertex X_i *(i=1, 2, …, n)* is determined by the presence of a connection of a certain type (direct or indirect). Let us denote the subset of reachable vertices as $K(X_i)$. In this context, vertex X_i, for which reverse reachability from vertex X_j, is possible, will be termed its predecessor. The set of predecessor vertices forms the subset $L(X_i)$. The intersection of vertices formed by these subsets $H(X_i)=K(X_i)\cap L(X_i)$, under the condition that $L(X_i)=H(X_i)$, defines the dominance of the action of factors associated with these vertices and is established through the analysis of the so-called iterative tables. As a result of performing the aforementioned operations on the elements of the directed graph, a multi-level model is obtained, reflecting the dominance of the action of factors on the process of media system development.

For the further establishment of factor prioritization based on the reachability matrix, iterative tables are constructed containing four columns, where *i* denotes the ordinal number of the factor in the set. In this process, data from the rows of the reachability matrix are utilized to form column $K(X_i)$, while data from the columns of the same matrix are used to form column $L(X_i)$. The column $K(X_i)\cap L(X_i)$ presents the factors that are common to both $K(X_i)$ and $L(X_i)$.

Based on the obtained results, a model of the priority influence of factors on the quality of media system development with infographic data is synthesized.

Experiments

Based on the expert evaluation, a set of factors influencing the quality of media systems that contain a significant number of infographics has been identified $X = \{X_1, X_2, X_3, X_4, X_5, X_6, X_7\}$, where X_1 — target audience; X_2 — content; X_3 — interactivity; X_4 — layout; X_5 — prototype; X_6 — typography; X_7 — data visualization.

To establish the relationships among the identified factors, graph theory tools were employed [11]. Based on expert judgments, the influences and dependencies between the factors of the studied process were formulated:

X_1 (target audience) affects X_4 (layout), X_5 (prototype);

X_2 (content) affects X_3 (interactivity), X_4 (layout), X_6 (typography), X_7 (data visualization);

X_3 (interactivity) affects X_7 (data visualization) and depends on X_2 (content), X_4 (layout);

X_4 (layout) affects X_3 (interactivity), X_6 (typography), X_7 (data visualization) and depends on X_1 (target audience), X_2 (content), X_5 (prototype);

X_5 (prototype) affects X_4 (layout) and depends on X_1 (target audience);

X_6 (typography) depends on X_2 (content), X_4 (layout), X_7 (data visualization);

X_7 (data visualization) affects X_6 (typography) and depends on X_2 (content), X_3 (interactivity), X_4 (layout).

Based on the established statements, a graph of relationships among the identified factors has been constructed (Fig. 1), where the vertices of the graph represent the factors, and the edges connect them wherever a relationship exists.

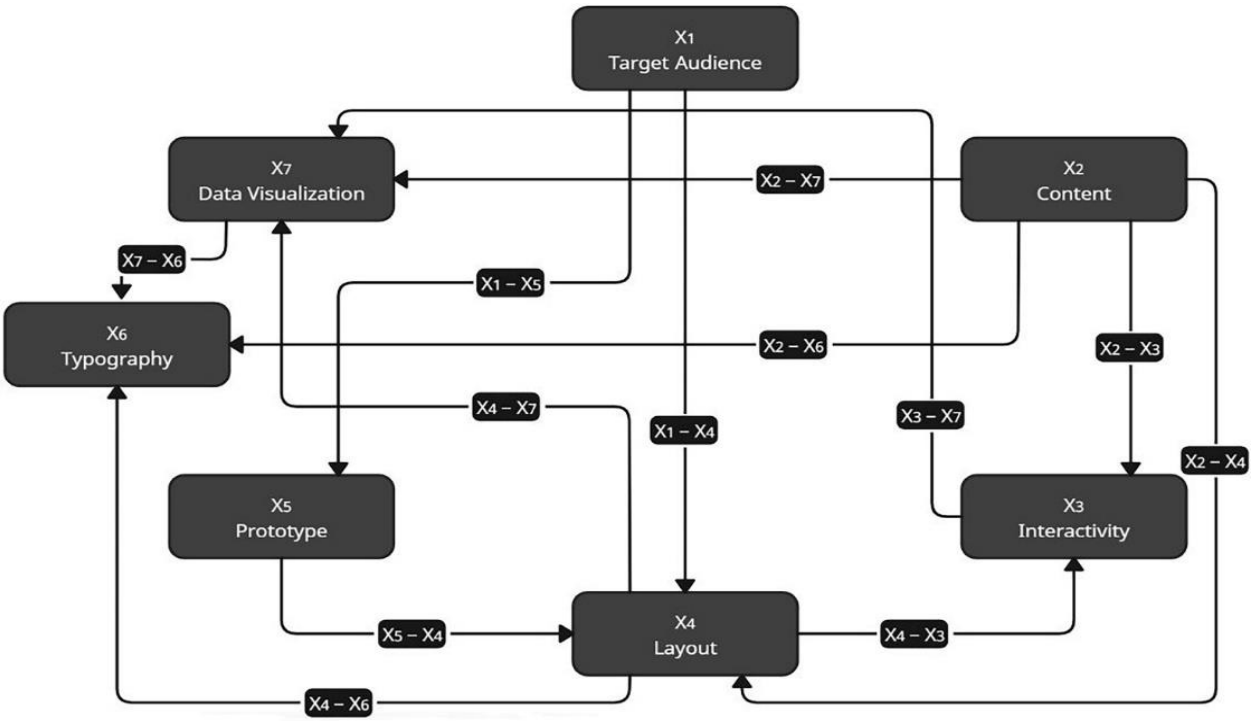

Fig. 1. Graph of relationships between factors in the development of media systems with infographics

Based on the created graph, an accessibility matrix has been synthesized (Table 1) according to the principle (1).

Table 1

Accessibility Matrix

Factor	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	1	0	1	1	1	1	1
X_2	0	1	1	1	0	1	1
X_3	0	0	1	0	0	1	1
X_4	0	0	1	1	0	1	1
X_5	0	0	1	1	1	1	1
X_6	0	0	0	0	0	1	0
X_7	0	0	0	0	0	1	1

Iterative tables have been developed to determine the priority of factors (Table 1 – Table 7). A table for the first iteration has been created, where $K(X_i)$ represents the subset of reachable vertices, $P(X_i)$ denotes the subset of predecessor vertices, and $K(X_i) \cap P(X_i)$ indicates the intersection of subsets [10]. Factors with an established priority level are highlighted in gray.

Table 2

Results of the first iteration

i	$K(X_i)$	$P(X_i)$	$K(X_i) \cap P(X_i)$
1	1, 3, 4, 5, 6, 7	1	1
2	2, 3, 4, 6, 7	2	2
3	3, 6, 7	1, 2, 3, 4, 5	3
4	3, 4, 6, 7	1, 2, 4, 5	4
5	3, 4, 5, 6, 7	1, 5	5
6	6	1, 2, 3, 4, 5, 6, 7	6
7	6, 7	1, 2, 3, 4, 5, 7	7

As a result, the factors X_1 (target audience) and X_2 (content) have the highest priority level. These factors are removed for the next iteration.

Table 3

Results of the second iteration

i	$K(X_i)$	$P(X_i)$	$K(X_i) \cap P(X_i)$
3	3, 6, 7	3, 4, 5	3
4	3, 4, 6, 7	4, 5	4
5	3, 4, 5, 6, 7	5	5
6	6	3, 4, 5, 6, 7	6
7	6, 7	3, 4, 5, 7	7

The second level of priority belongs to factor X_5 (prototype). After establishing the priority, this factor is removed from the table.

Table 4

Results of the third iteration

i	$K(X_i)$	$P(X_i)$	$K(X_i) \cap P(X_i)$
3	3, 6, 7	3, 4	3
4	3, 4, 6, 7	4	4
6	6	3, 4, 6, 7	6
7	6, 7	3, 4, 7	7

The third priority factor is X_4 (layout). It is removed for the next iteration.

Table 5

Results of the fourth iteration

i	$K(X_i)$	$P(X_i)$	$K(X_i) \cap P(X_i)$
3	3, 6, 7	3	3
6	6	3, 6, 7	6
7	6, 7	3, 7	7

The fourth level of priority is assigned to factor X_3 (interactivity). The iteration continues.

Table 6

Results of the fifth iteration

i	$K(X_i)$	$P(X_i)$	$K(X_i) \cap P(X_i)$
6	6	6, 7	6
7	6, 7	7	7

The fifth priority is assigned to factor X_7 (data visualization).

Table 7

Results of the sixth iteration

i	$K(X_i)$	$P(X_i)$	$K(X_i) \cap P(X_i)$
6	6	6	6

The last, sixth level of the hierarchy is occupied by factor X_6 (typography).

Based on the obtained values, a model of the prioritized influence of factors on the quality of media systems with infographic data has been constructed (Fig. 1).

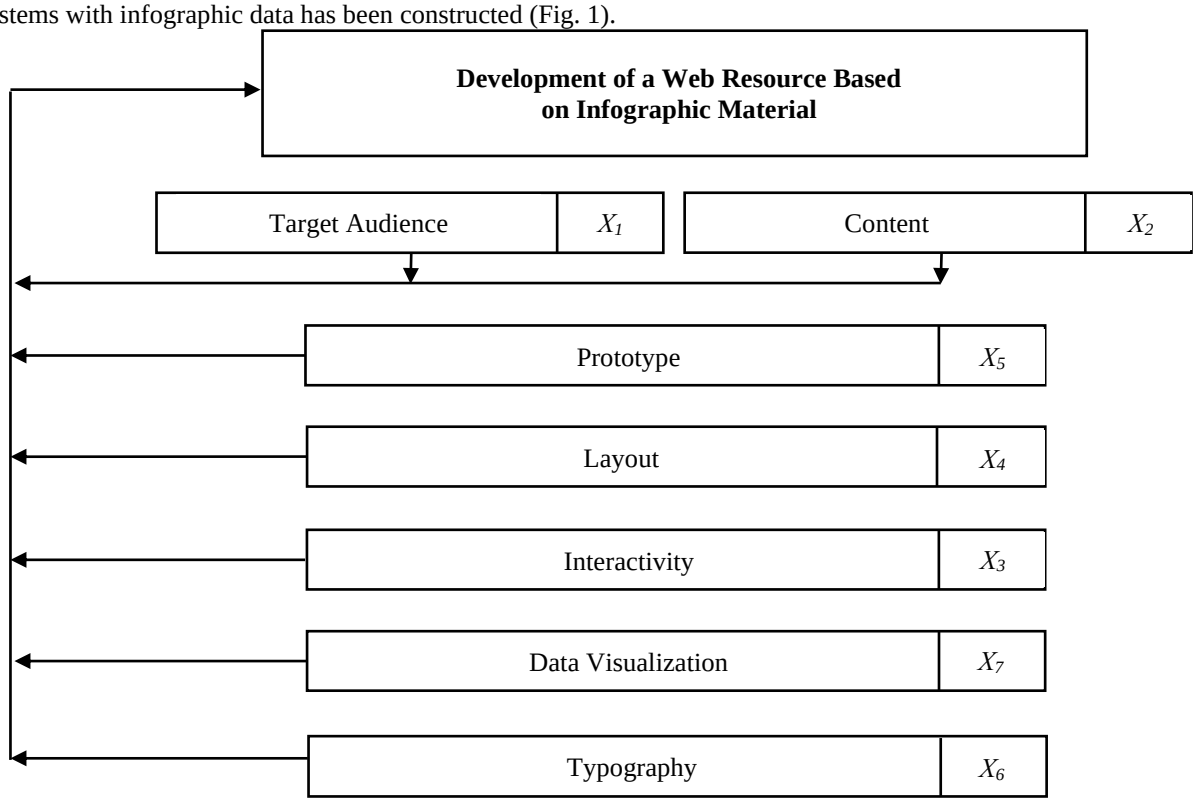

Fig. 2. Model of the priority influence of factors on the quality of developing media systems with infographic data

Conclusions

A model of the priority influence of factors on the quality of media systems with infographic data has been developed. The analysis of factors such as target audience, content, interactivity, layout, prototype, typography, and data visualization revealed that the highest influence on the quality of media systems is exerted by "target audience" and "content", while "typography" has the least impact.

Determining the priority of factors using the method of hierarchical mathematical modeling allowed for the clear identification of interdependencies among the factors and their influence on the quality of media systems. This enables developers to focus on key aspects of media system creation, optimizing resources, time, and costs at various stages of development.

Future development prospects in this area may be directed toward building predictive models for assessing the quality of media systems with infographic data, which will enhance their competitiveness and alignment with the needs of the target audience.

References

1. Zhu, S., Sun, G., Jiang, Q., Zha, M., Liang, R. A survey on automatic infographics and visualization recommendations. *Visual Informatics*. 2020. Vol. 4, Issue 3. Pp. 24–40. https://doi.org/10.1016/j.visinf.2020.07.002.

2. Kunze, K. N., Vadhera, A., Purbey, R., Singh, H., Kazarian, G. S., Chahla, J. Infographics are more effective at increasing social media attention in comparison with original research articles: an altmetrics-based analysis. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2021. Vol. 37, Issue. 8. 2591–2597. https://doi.org/10.1016/j.arthro.2021.03.056.

3. Syaputra, I., Sabri, Y. The role and function of media institutions in society in the digital age: a case study in indonesia. *Semantik: Journal of Social, Media, Communication, and Journalism*. 2023. Vol. 1, Issue. 1. Pp. 63–67. http://dx.doi.org/10.31958/semantik.v1i1.9237.

4. Senkivskyy, V., Pikh, I., Babichev, S., Kudriashova, A., Senkivska, N. Modeling of alternatives and defining the best options for websites design. *IntelITSIS*. 2021. Pp. 259–270. https://ceur-ws.org/Vol-2853/paper24.pdf.

5. Thompson, J. D., Weldon, J. Audiences and target audiences. In content production for digital media: an introduction. *Springer Singapore*. 2022. Pp. 11–20. https://doi.org/10.1007/978-981-16-9686-2_2.

6. LI, Yiyi; XIE, Ying. Is a picture worth a thousand words? An empirical study of image content and social media engagement. *Journal of marketing research.* 2020. Vol. 57, Issue. 1. Pp. 1–19. https://doi.org/10.1177/0022243719881113.

7. Bozkurt, S., Gligor, D. M., Babin, B. J. The role of perceived firm social media interactivity in facilitating customer engagement behaviors. *European Journal of Marketing*. 2021. Vol. 55, Issue. 4. Pp. 995–1022. https://doi.org/10.1108/EJM-07-2019-0613.

8. Inastrilla, C. R. A. Data visualization in the information society. *Seminars in Medical Writing and Education.* 2023. Vol. 2. Pp. 25–25. https://doi.org/10.56294/mw202325.

9. Senkivskyy, V., Babichev, S., Pikh, I., Kudriashova, A., Senkivska, N., Kalynii, I. Forecasting the reader's demand level based on factors of interest in the book. *CITRisk.* 2021. Pp. 158–175. https://ceur-ws.org/Vol-3101/Paper12.pdf.

10. Senkivskyy, V., Kudriashova, A. Models of information technology for designing post-press processes: Monograph. Lviv: UAD. 2022. 204 p.

11. Diestel, R. Graph theory: 6th edition. Springer. 2024. 445 p.

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