

The information technology for the formation of high-quality visual content of newspaper publications

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Abstract

The publication presents the results of a content analysis of four modern Ukrainian printed newspapers, with a specific focus on their visual elements. Following the analysis, the authors formulated a list of factors influencing the quality of photo illustration, shaping the visual content of printed media. They organized these factors systematically and constructed a factor-weighting model. Through iterative analysis, they synthesized a multi-level structured graphic model, depicting the position of each factor and illustrating their interconnections.

The resulting model, highlighting the priority influence of factors on the creation of visual content in newspaper editions, unveiled the individual importance of each factor. Notably, the compositional and graphic model of the publication, formed by the editorial team based on the publication's orientation, emerged as the most critical factor.

The authors correlated their content analysis of newspaper publications with the outcomes of mathematical modelling. Specifically, the branch publication "Highway" exhibited the poorest-formed visual content, aligning with the content analysis results. This deficiency was attributed to neglecting factors identified as high-priority in the information concept formation for quality photo illustration.

Based on the conducted experimental research and mathematical modelling, it is possible to recommend that publishers use the results obtained in this work when forming the visual content of publications, which will improve the quality of their polygraphic execution and expand the readership.

Keywords

Photo illustration, newspaper publications, content analysis, verbal-visual form, visual content of publications, compositional shortcomings of photo illustrations, genre, communication of photo illustration with text; functions of photo illustrations, information concept of forming the visual content

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1. Introduction

The average person has a constant need to receive information and, in particular, news about current events. Until recently, the main source of news was printed periodicals, but every day the emphasis is being shifted to the sphere of electronic media resources. According to Digital 2023 data [4], by the end of 2023 there will be more than 5 billion Internet users in the world, which is 64.4% of the entire population of the planet. At the same time, the number of users of social networks is constantly growing against the background of the constant growth of smartphone owners. Therefore, many specialists in the field of media communications predict the rapid disappearance of printed periodicals, as the modern media audience chooses free electronic sources of information.

However, not all experts are unanimous in expecting the rapid disappearance of print media. In particular, professor of journalism D. Kennedy from Northeastern University (Boston) [5] considers predictions about the inevitable death of printed periodicals to be premature, because they, as before, provide more income from advertising than the electronic version. Periodicals that are considered successful today, as a rule, have and harmoniously combine two viable components - print and electronic, such as the Wall Street Journal, The Atlantic, and many others [7].

Newspapers face many tasks, and the most important of them is to survive in the information market, attract new readers, offer them a high-quality information product, filling the content with new, interesting content. The formation of the content of the printed publication is an important factor affecting the promotion of this product in the market of periodicals. Since the human brain is arranged in such a way that we perceive visual information faster than verbal information, illustrations, especially photo illustrations due to their documentary nature, help to orient the reader among editions and in the search for information in a specific edition.

The photo illustration appeared in printed publications much later than the moment of its invention, because it was not immediately possible to print a photo next to the text. But today we can no longer imagine periodicals without photographic content. The level of visual material and the way it is presented, the compositional perfection of photo illustrations, and structure in combination with a verbal message play not the least role in attracting the readership and forming a certain information culture in it and the level of interest in printed products, ensuring the competitiveness of the publication in the modern printing market.

2. Related Works

Visual content is the first thing a reader sees when viewing a publication. Visual information is read at a subconscious level in the first seconds of getting acquainted with the publication, because the human brain perceives visual images many times faster than textual information, and then superimposes them on the verbal content of the material. According to research, 90% of visual images are immediately transformed into the human brain, and 80% of visual information is immediately remembered [6]. Therefore, you should be very careful with the selection of photo content to orient the consumer in the first moments of interaction with a verbal and non-verbal message and interest them in choosing your publication among many similar ones. That is why so much emphasis is placed on combining the text of the headline

complex and photo illustration on the front pages of newspapers and electronic news resources.

Illustration is one of the most important elements of a newspaper publication, to which the audience pays attention and which affects the demand for the publication among readers. Readers mostly respond to a page with a large number of materials, as evidenced by various analytics conducted by many researchers [2, 9, 11]. When the reader gets acquainted with the contents of the publication for the first time, he first pays attention to the photos, and later to the title of the material. Research by the Society for News Design (SND) has shown that the second most important factor in a successful newspaper after content (the content itself) is design. At the same time, the rating of factors influencing the reader is distributed as follows: 80% of readers first all perceive the general appearance (design) of the column, 75% consider the photo in the second place, then headlines - 56%, photo captions and takeaways - 29%. At the same time, attention to texts is 25% [12, 1]. These analytics demonstrate that poor design, low-quality photos, and weak illustrations will not allow the consumer to read even good texts, as his attention will switch to a new search for interesting images and, accordingly, journalistic messages. Also, the research carried out by the authors of this article [14] proves that it is no less important to comply with the requirements for polygraphic execution of publishing products (font design, typeface capacity, line and column length, margin sizes around the column), in particular newspaper publications, formulated in the relevant normative documents (for example, industry standard of Ukraine SOU 22.2-02477019-03:2005 "Newspapers. Technical conditions" dated November 28, 2005), as this will allow the reader to comfortably consume text information.

With a competent combination of the textual and visual parts of the message into a single picture, the image of the future material is formed in the reader, and this image should maximally attract the audience to the consumption of information. The amount of information in today's world is so large that the consumer simply does not have time to "absorb" it. Because of this, in modern media, there is a process of reduction of textual information, in parallel with which more and more meaningful load falls on other semiotic systems. Researchers note the total visualization of the media, which began at the end of the 20th century [13]. This becomes the determining trend of their development, and the non-verbal (iconic) element, in particular, "illustrating", increasingly becomes an element of informing about the content of the publication. Thus, to protect against information overload, our consciousness produces a new type of thinking - clip thinking. Its content is that the recipient selects only some fragments from the entire stream of messages, and "grabs" them, stopping at only some. When viewing publications, the reader composes the content consumed in the chain "image - title - text", and this is a reflection of the named type of thinking. The recipient first of all pays attention to the visual component because it arouses his interest with its documentariness, it emphasizes, details, intrigues, and therefore is so attractive to the audience.

Publications in modern mass media today cannot be imagined without images. Text and illustration interact so closely that they are perceived by the reader as something indivisible. These blocks of information form a verbal-visual form that is perceived as a single fragment and can carry more meaning, and be wider and more interesting than individual parts of this system. Surveys of modern media readers show that 2.5% of respondents prefer their favorite newspaper because it has many photos; 82% of respondents answered that the design of the

newspaper and the presence of photos in it are important to them; 66.25% of readers would like to see a caricature in the newspaper instead of a photo; 77.5% of respondents would like newspapers to publish extensive photo reports [15].

Thus, illustrations attract consumers (readers) and influence their choice of a particular periodical, so illustrations are a marketing tool. Taking into account a certain decline in interest in printed media products, newspaper editors need to take into account the demand of readers for the placement of high-quality illustrations, as well as operate with factors that affect the attention of consumers of content by competently placing it in the columns and combining it with text messages.

A newspaper publication, like any product of printing production, is not only a means of disseminating information but also an artistic work with its inherent artistic values and an object of design. The level of design and presentation of the material, its compositional structure, and font design are dominant factors in attracting the readership and forming the degree of interest in media products, ensuring the publication's competitiveness in the modern publishing market.

Because of the above, it is important to be able to predict the cumulative impact of many factors on the quality of publications even at the stage of pre-press preparation of publications. At the same time, the formation of the content of the photo-illustrative content of the newspaper is of particular importance. To do this, it is necessary to analyze expert assessments of the importance of the influence of each of the factors of newspaper photo illustration and their cumulative effect on the media product, to determine the interrelationships and mutual influence of the criteria and their constituent components on the degree of reader (consumer) involvement in the choice of certain newspaper publications.

In the technology of the modern publishing process, there are no methods of a priori modeling of the choice of illustration of the publication as a whole and photo illustration in particular. Separate publications are devoted to the study of the problems of compositional design of book publications [19]; analysis of quality indicators of book publications [13, 20]; criteria of demand for publishing products [2], and formation of an optimal assembly descent [1]. Many publications are devoted to the formation of visual content of social network pages [9], but the issue of choosing the optimal model for illustrating modern printed periodicals is practically not considered.

Since photo illustration is an active means of attracting the attention of the reader (consumer of visual content), to solve the task of ensuring the quality of the visual content of printed periodicals, it is necessary to single out and classify the factors influencing the quality assurance of the stage of integrating photo illustrations into the newspaper publication. Setting and solving the task of identifying the most complete set of compositional criteria for selecting photo illustrations and combining visual content with a verbal message is relevant. To form the most complete list of factors influencing the quality of the formation of visual content of periodicals, it is necessary to conduct a content analysis of Ukrainian print media.

Given the above, the purpose of the research is to consider the peculiarities of the placement of photographs in newspapers, and the visual concepts of photo illustration, to analyze the peculiarities of the use of photo illustrations in specific modern newspaper publications of Ukraine. Based on the analysis, formulate a list of factors that most actively influence the perception of visual information in print media, and rank the factors of visual

content formation, which will allow publishers to optimize the model of graphic design of newspaper print editions.

As a result of the study of the selected criteria, their essence, and methods of application, it seems appropriate to develop a graphic model of the hierarchy of criteria, which would ensure their ordering according to the importance of the impact on the quality of the publication's photo illustration. In connection with the increasingly dynamic development of publishing and media processes, to attract a wider range of consumers of printed publications, qualified specialists must implement modern technologies and new methods in their professional activities. Precisely in order to create a high-level product, during artistic design and design, it is necessary to use the methods and methods of data and information management as much as possible.

Several editions of Ukrainian newspapers were selected for the study: socio-political newspapers "Express", "Vysoky Zamok", "Den" and the all-Ukrainian transport periodical "Magistral". All editions are all-Ukrainian and have different publication frequencies, formats, and volumes of pages. Since each edition has its peculiarities in layout, including the placement of photos, it was decided to focus on publications of different orientations, designed for the widest audience. Also, an important characteristic that unites these editions is that all these newspapers are distributed throughout the territory of Ukraine. The analyzed newspaper editions differ in frequency of publication ("Magistral" - 2 times a week, "Express" - 3 times a week, "Vysoky Zamok" - 4 times a week, "Den" - 5 times a week), volume and format.

The set goal will be realized through the following tasks:

- analyze the genres of newspaper photographs;
- conduct a typological analysis of photo illustrations;
- investigate the peculiarities of using photographs on the front page and inside the newspaper;
- analyze the sources for obtaining photographs;
- investigate the relationship between photo illustrations and textual materials;
- study the role of photography as an informational message;
- analyze typical technical and compositional shortcomings of photo illustrations;
- conclude the task of photo illustrations in newspapers.

In particular, the study analyzed the placement of photographic materials in selected publications, other types of illustrations (drawings, collages) were not taken into account. Also, photos in advertising areas were not considered, since the advertisement is created by the advertiser and he chooses the ratio of text and visual material and not directly by the photo editor and photo correspondents of the editorial office.

To analyze the illustrative content of newspaper publications, we will analyze the following indicators:

- volume of individual issues of newspaper publications in pages;
- the number of illustrations in the numbers;
- ratio of illustrative and textual information in issues;
- average illustrativeness of the pages;

- methods of creating illustrations and their role in the compositional and graphic model of the publication;
- source of origin of illustrative material;
- genre classification of photo illustrations presented in the publication;
- classification of illustrations according to the method of their communication with the text;
- compositional features of photo illustrations.

First, let's analyze how many rooms are filled with photo-illustrative content. In fig. 1 presents a diagram of the content of illustrations in certain issues of newspaper publications (a total of six issues of each newspaper published over some time were selected). From the presented dependence on the amount of illustrative material, a certain stability is observed from issue to issue: the number of photo illustrations varied within a somewhat narrow range for each edition in particular. It can be clearly distinguished that the graphic model of some publications, such as the "Magistral" newspaper, is significantly saturated with visual content, and some of them have quite a few photographs. The social and political newspapers "Express" and "Vysoky Zamok" are characterized by approximately the same percentage of illustrative material. If we analyze the ratio of textual and illustrative contents of newspaper issues of these editions, the textual information occupies 70-80% of the total volume of the edition. At the same time, from 10 to 50% of the area of newspaper columns is allocated to illustrative material.

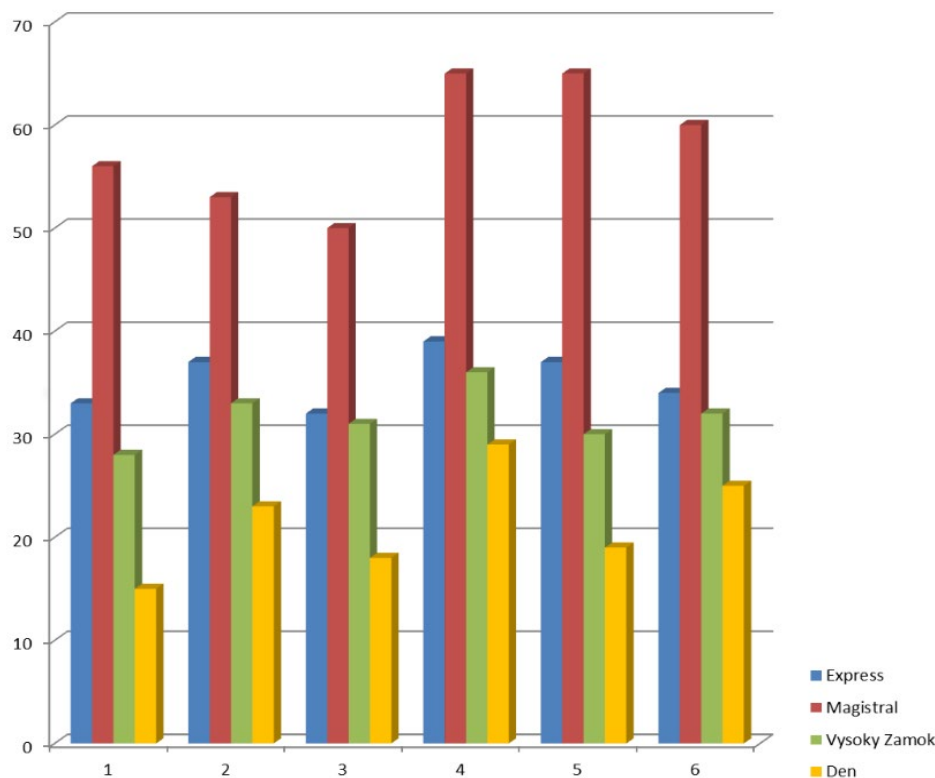


Figure 1: Content of photo illustrations in analyzed issues of newspaper publications.

Special attention is drawn to the fact that the compositional and graphic model of the "Magistral" publication is completely different from that of the "Express" newspaper. This, of course, makes this publication in its way unique in its market segment and for its circle of readers. Its illustrative quality is very high (practically all considered issues of the newspaper contain photo illustrations on all their pages). This edition is excessively saturated with visual information, the ratio of the illustrative and textual parts of the content of newspaper issues is about 30/70 percent, and in some issues - up to 50/50. At the same time, a large part of the column area is devoted to illustrations (in some cases, this figure is 60%). That is, it can be argued that the illustration communicates with the reader almost at the same level as the text. A significant content of illustrative material does not always have a positive effect on the compositional model and appearance of the periodical. Such a high percentage of photo-illustrated content is believed to be typical of publications of a lower rank and quality, such as a tabloid press or district-level subordination. For an all-Ukrainian newspaper, such a graphic compositional model and distribution of content components is inappropriate. The reader gets the impression that the journalists lacked information and the strip was occupied by a large number of pictures.

Many researchers of newspaper content classify the genre variety of newspaper photos in different ways. News photography, photo reportage, photo message - such a classification is offered in the field of photojournalism by specialists in social communication. The most diverse genres of photography are found on the pages of newspapers, which are grouped into two groups - informational and analytical. Informational ones include photo information, photo sketches, photo reportage, photo series, and analytical ones - photo correspondence, photo interviews, photo essays, and collages.

In the above classification of genres, the degree of communication of the photo illustration with the reader is taken into account, so the illustration is considered as a separate message. Within the scope of this study, a more generalized classification is proposed, which takes into account both the genre features of individual photo illustrations and the technical and compositional features of their production. Therefore, we classify photo illustrations as follows:

- • photo portrait (as the most common genre of newspaper periodicals);
 - • photo reportage (recording and telling the reader about an event in its development);
 - • photo information.
- Fig. 2 presents diagrams demonstrating the genre representation of photo illustrations in the analyzed newspaper publications. And in each newspaper, a separate genre prevails. Among the photo illustrations in the Den newspaper, the genre of photo reportage prevails, which, according to studies [20, 21, 23], is the most popular among consumers of visual information. On the other hand, in the issues of the newspaper "Express", the vast majority of photos belong to the genre of photo information (36-60%) or photo portrait (38-52%). Photo reports in the columns of this edition appear quite rarely and occupy a small part of their volume: 6-15%. Mostly reporting messages are accompanied by selections with 2-4 photos. Each issue of the newspaper "Magistral" contains a photo report, the volume of which in the total number of photo illustrations is quite significant:

from 10 to 45% of the total volume of photo illustrations in the publication. Such a genre presentation is interesting for the reader, but often the photo reports of this publication are composed of photos with an unsuccessful compositional structure.

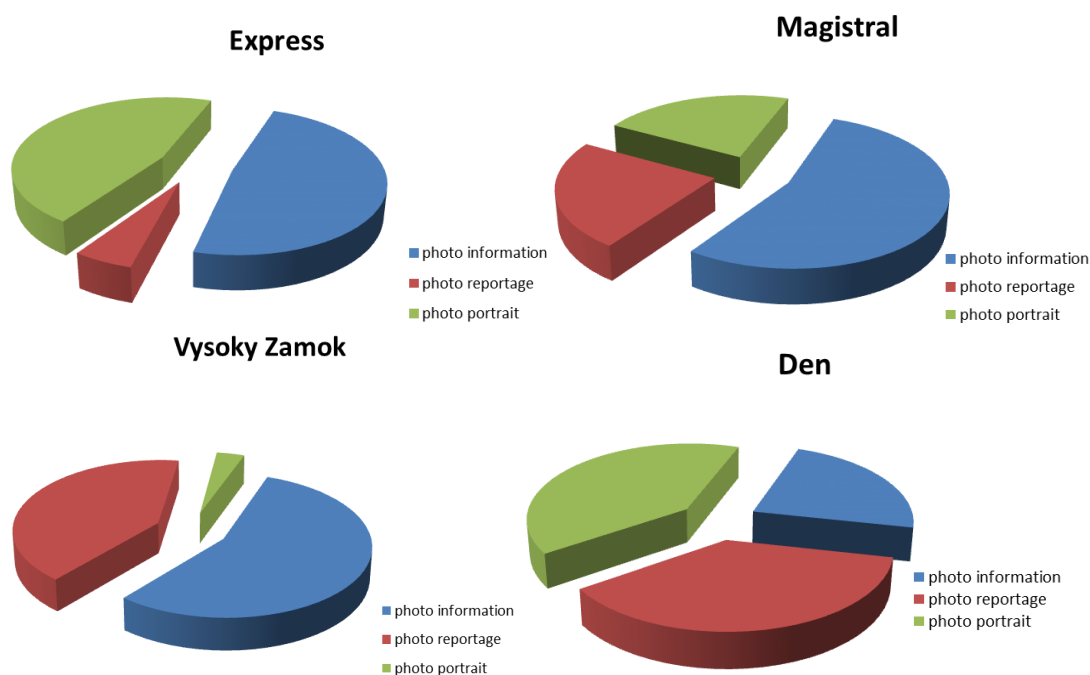


Figure 2: Distribution of photo illustrations in the analyzed newspapers by genre.

After analyzing the genre distribution of photographs, it is possible to recommend publications to diversify image genres. It is not easy to make a portrait interesting for the reader, besides, they are often repeated, while reportage photos are most often original, interesting, and full of events.

The level of illustration of a newspaper cannot depend on the number of illustrations printed in it – their quality, impact on the reader, degree, and method of communication are important. One, but expressive illustration, competently drawn up on a newspaper page, will have a stronger impact on the reader than 3-to 4 small, indistinct pictures.

When illustrating the text of a media message, the image editor sets completely different tasks for the image. Depending on this, different types of illustrations are distinguished in terms of their relationship with the text: direct, associative, and free.

Direct illustration has a direct connection with the text of the publication, text and image complement and reinforce each other. When the reader perceives such material, a certain effect of resonance occurs. The free type of illustration has no direct associative connection with the text; the image diversifies and artistically complements the text only when necessary. The associative illustration adjoins the text thematically. It does not duplicate the content of the text but complements it, and creates a pictorial series, using the background knowledge of the audience about the subject of the story. Sometimes the understanding of associative illustration requires knowledge in areas directly or indirectly related to the subject of the publication or even unrelated to it.

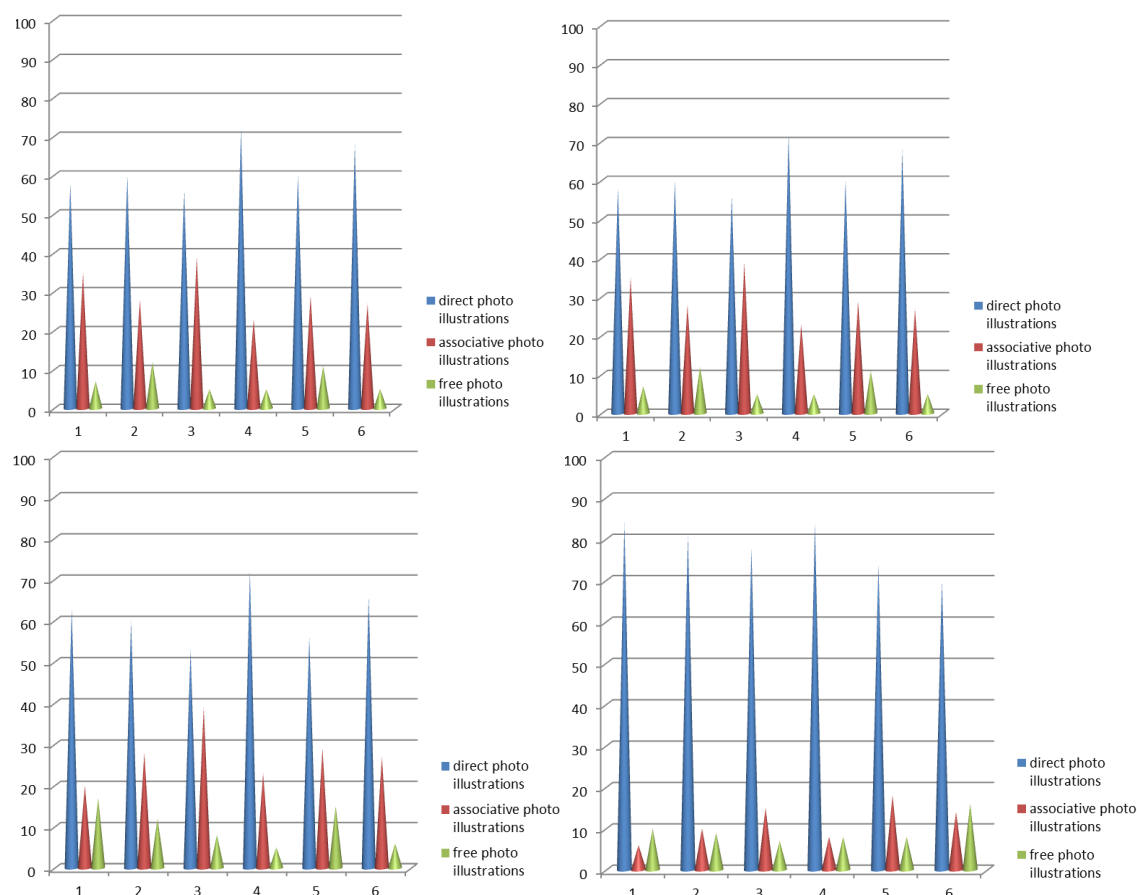


Figure 3: Distribution of photo illustrations in the analyzed newspapers according to the type of connection with the text (a - "Express"; b - "Magistral"; c - "Vysoky Zamok"; d - "Den").

The distribution of photo illustrations by the type of connection with the text in the considered newspapers demonstrates the predominance of direct photo illustration (at the level of 60-90% of the total volume), which is quite logical since this is one of its main functions - to documentally describe an event or an object. On the other hand, associative photo illustration is not present in all issues of the analyzed newspaper publications: in some issues of "Magistral" and "Den" newspapers, this type of photo illustration is not found at all or is represented at the level of 5-10% of the total volume. This selection of photo-illustrative content does not demonstrate originality and does not give the reader space for a broader understanding of the printed material.

In the design of "Express" and "Vysoky Zamok" newspapers, the associative photo illustration occupies approximately 20-35% of the total volume of photo content. Such an indirect presentation of information enriches the compositional and graphic model of the publication and makes the perception of publications more interesting and versatile.

Let's analyze another important aspect - the fact of observing copyright on photo illustrations. The conducted studies show that in the considered newspapers there are generally several sources of origin of photo-illustrative content: works of own photo correspondents, and various photo banks. Also, a certain percentage of photo illustrations come from the personal archives of the heroes of the publications. However, unfortunately,

some of the photo illustrations are published in the columns and without indicating the authorship and source of their origin. In particular, in the newspaper "Express", about half of the photo illustrations of each issue are taken from well-known photo banks (43-53%), while the source of origin is indicated next to each photo. About a third of the photo illustrations are the work of our photojournalists: 16-36%, and 11-29% - from the heroes' archives. This distribution in the origin of photo illustrations explains the fact that the photographic content of the "Express" newspaper is at a high level. The photoillustrations are competently selected, they successfully complement the text part of the publication, they have a good compositional solution, and a significant part of the photos is accompanied by a signature about their origin. Only a small percentage of the photo illustrations in this edition are not accompanied by the indicated authorship or source of origin. These are mostly portraits of famous people, which accompany small interviews.

Analysis of the illustrative content of issues of the newspaper "Magistral" revealed completely different trends in the origin of the photo. The works of own photojournalists make up only 32-71%, and photos from photobanks make up a very small share - 7-21%. Photographs from the personal archives of the heroes of publications in issues of the newspaper "Magistral" - up to 32%, that is, much more than in the rest of the analyzed newspapers. It is the photos from personal archives that are characterized by an unsuccessful compositional solution and a large number of photo stamps. It is necessary to diversify and qualitatively improve the content of the publication itself due to the photo illustration of photos with a better compositional structure, which will allow publications to better communicate with the reader.

The peculiarities of illustration in general, and photo illustrations in particular, are that they participate both in the formation of the graphic appearance of the printed publication and in its content. Without the relationship between the two mentioned points, it is impossible to achieve the proper effect from the publication of the illustration. As an element of the design, the photo illustration highlights the publication on the side of the publication, attracting the reader's attention to it, and its meaningful content satisfies the need for knowledge and evaluation of the displayed fact or phenomenon. Therefore, the correct placement of illustrative material on the pages of the periodical is another important factor that determines the relevance of the publication for the consumer.

In the practice of using photo illustrations, some stable, basically similar methods of compositional arrangement of photographs on strips and spreads have developed. The following composite constructions are distinguished: block layering, diagonal layering, circular layering, strip arrangement, and cross and center arrangement. Block, diagonal, and strip arrangement of illustrations are most often used.

We will analyze what techniques of column design were used in the studied newspapers. In particular, we will consider the peculiarities of the posting of photo illustrations in the newspaper "Magistral", which, as the above studies show, is more illustrated and the columns of its issues contain a large percentage of photos. However, the decisions of the picture editor of this publication regarding the placement of photo illustrations are not always successful. Individual spreads are decorated with photo illustrations in a somewhat chaotic manner: some columns are overloaded with photos that are placed without a system, without observing any compositional and graphic model. There are columns so overloaded with photo illustrations that there is very little space left for the text, although some of these photos can be completely

removed due to their inappropriateness without losing the content of the photo report. The compositional solution of many photos is unsuccessful, some are frank photostamps and similar to amateur photos mass-produced in private photo albums, but for a photo reportage, their composition and content are uninformative.

Let's consider for comparison the methods of stacking and arrangement of photo illustrations on newspaper columns in the "Express" edition. From the above analysis, we can already conclude that the photo illustration of this edition is at a high level. Most of the photos are taken by professional photographers (our photojournalists or obtained from well-known photobanks) and are succinctly and competently combined with text information on the columns. A typical graphic and compositional model of the arrangement of photo illustrations on the newspaper columns of this publication is their placement at the vertices of a triangle. Such a graphic model is very stable and guides the reader's eye through text blocks and illustrative messages. This holds the reader's attention, the gaze moves from one illustration to the next, while emphasizing verbal messages.

Of course, flaws in the presentation of photo material in the columns of the compositional and graphic model of the newspaper are found in each of the analyzed publications: a spread excessively saturated with graphic material, violation of the rules for posting portrait photos, etc. But among the four considered newspaper editions, it is "Magistral" that has the most shortcomings in the graphic model and appearance of newspaper spreads.

Issues of validity, reliability, and validity are very important in any research. Content analysis differs favorably from other types of document study precisely because of its high reliability. In general, reliability is understood by most researchers as validity (compliance with the laws and concepts of research) and stability or rigor (reproducibility of results). Content analysis provides many opportunities for researching both the existing and the hidden content of information. Of course, in the latter case, special procedures are needed to increase the reliability and validity of the research findings. Content analysis requires the researcher to have a good knowledge of the subject of analysis in order to correctly choose the units of research, and also to clearly distinguish and count the units of analysis. The ratio of qualitative and quantitative principles in content analysis allows to achieve a high degree of reliability and validity. The validity of the research findings also depends on the representativeness of the sample. To achieve high validity, the correct selection of analytics indicators is of great importance. They should be chosen so that as a result of the procedures, the conclusions represent a complete section of the content on this topic.

As a result of the content analysis of several newspaper editions, some influencing factors on the formation of their visual content were revealed. Therefore, it is appropriate to determine the priority of influencing factors by building an information model followed by its analysis, which will allow the most accurate approach to photo illustration of newspaper periodicals.

3. An information model for determining the priority of factors of the formation (creation) of the visual content of newspaper publications

To realize the formulated goal of the research, we will single out a clear list of factors influencing the formation of high-quality visual content of newspaper publications and, based

on an expert analysis of the importance of each of the factors, we will build a graph of relationships between them. This will make it possible to develop an informational concept of forming the visual content of newspaper publications and give appropriate recommendations for optimizing the process itself.

Based on the analysis of literary sources [15, 16], which give an understanding of what types of information a newspaper edition is formed from and its filling with photo illustrations, the main factors that influence the quality of the formation of the visual content of newspaper editions are determined. These include compositional and graphic models, fullness of the publication with photo illustrations; place of uploading photo illustrations; method of communication of photo illustration with text; functions of photo illustrations; source of origin of photo illustrations, composition of photo illustrations, and genre of photo illustrations.

The list of factors presented above, which significantly influence the process of forming the visual content of newspaper publications, can be described by a set of linguistic variables, which is a vague analog of the factors influencing an arbitrary technological process. We will consider the procedure of forming newspaper editions as some function, the arguments of which will be the above factors.

$$P = F(f_1, f_2, f_3, f_4, f_5, f_6, f_7, f_8), \quad (1)$$

where f_1 – compositional and graphic model (CGM); f_2 – fullness of the publication with photo illustrations (FPP); f_3 – place of uploading photo illustrations (PUP); f_4 – a way of communicating photo illustration with text (CPT); f_5 – functions of photo illustrations (FPH); f_6 – source of origin of photo illustrations (SOP); f_7 – composition of photo illustrations (CPH); f_8 – genre of photo illustrations (GPH).

In terms of terminology and essence, the identified factors are classified as linguistic variables, which in the tasks of the pre-press process can be parameters that influence the formation of visual content and further determine the degree of interest of the consumer (reader) in the publication as a whole and its publications. To do this, we will build an initial graphic model (orientated graph), taking into account expert judgments regarding the pairwise influence (connections) between the factors (Fig. 4).

The output graph of Fig. 4 will be used to arrange the factors according to the importance of influence on the researched process, the result of which will be a multi-level model of factors for creating visual content of modern newspaper media. For the synthesis of the linguistic model, we will use the tools of matrix theory and system analysis [8, 18, 22].

Using the formed graphic model – an analog of the semantic network, we build a binary reachability matrix (Table 1), which simulates the possible options for hitting other vertices from each vertex of the graph.

We construct the matrix by filling in the table, the binary elements of which are determined according to the following logical rule:

$$b_{ij} = \begin{cases} 1, & \text{if } b_i \text{ you can get into } b_j \\ 0, & \text{if } b_i \text{ you can not get into } b_j \end{cases} \quad (2)$$

Practically the top f_j ($j=1,2,...,8$) of the original graph of Fig. 4 is considered achievable relative to the top f_i ($i=1,2,...,8$), if it is possible to get from f_j the last one arbitrarily, taking into account transitions through other vertices. The result of the analysis of all vertices leads to obtaining a subset of reachable $D(f_i)$ vertices.

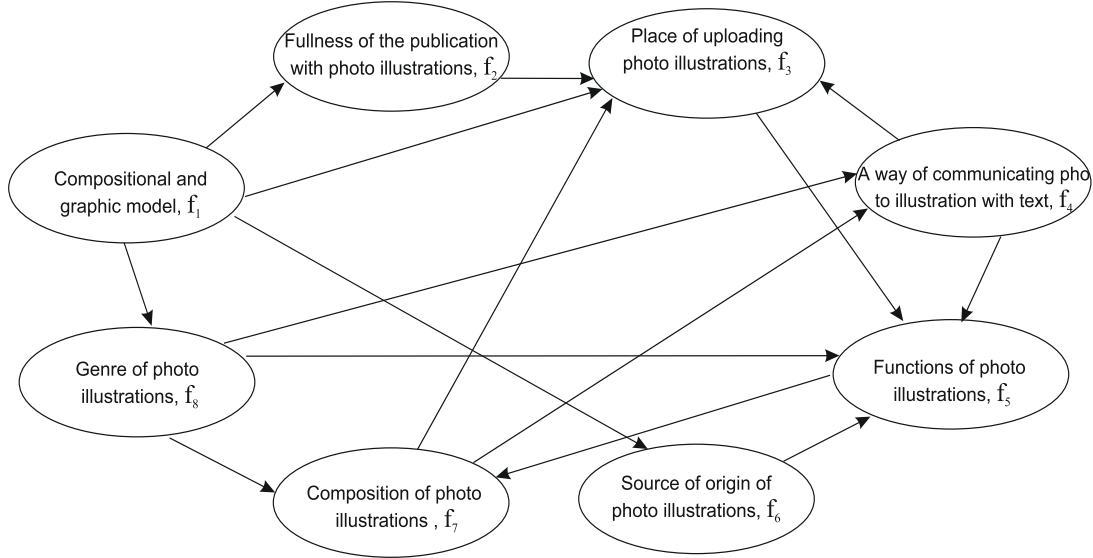


Figure 4: Initial graph of priority of factors of formation (creation) of visual content of newspaper publications

Table 1
Reachability matrix

	CGM	FPP	PUP	CPT	FPH	SOP	CPH	GPH
CGM	1	1	1	0	1	1	1	1
FPP	0	1	1	0	0	0	0	0
PUP	0	0	1	1	1	0	1	0
CPT	0	0	1	1	1	0	1	0
FPH	0	0	1	1	1	0	1	0
SOP	0	0	0	0	1	1	0	0
CPH	0	0	1	1	1	1	1	0
GPH	0	0	0	1	1	1	1	1

At the same time, the top f_i we will consider the predecessor of the vertex f_j , if it is reached vertices and predecessors will form a separate subset

$$Z(f_i) = D(f_i) \cap P(f_i), \quad (3)$$

which determines a certain level of priority of the action of the factors assigned to these vertices. An additional condition is the provision of equality

$$P(f_i) = Z(f_i), \quad (1)$$

The implementation of dependencies (3) and (4) using iterative tables leads to the formation of the corresponding levels, the initial of which is the highest in priority of influence on the researched process. To determine the specified level, we use the reachability matrix and mathematical dependencies (3) and (4), based on which we build Table 2.

Table 2

i	$D(f_i)$	$P(f_i)$	$D(f_i) \cap P(f_i)$
1	1,2,3,5,6,7,8	1	1
2	2,3	1,2	2
3	3,4,5,7	1,2,3,4,5,7	3,4,5,7
4	3,4,5,7	3,4,5,7,8	3,4,5,7
5	3,4,5,7	1,3,4,5,6,7,8	3,4,5,7
6	5,6	1,6,7,8	6
7	3,4,5,6,7	1,3,4,5,7,8	3,4,5,7
8	4,5,6,7,8	1,8	8

A subset $D(f_i)$ – numbers of reachable vertices or numbers of single elements of the corresponding rows of the reachability matrix are entered in the second column of the table; the third column specifies the subset of predecessor vertices $P(f_i)$ – numbers of the single elements of the columns of this matrix. In this case, dependency (4) will mean the fulfillment of the condition of equality of factor numbers specified in the second and third columns of the table, resulting in a certain level of factor hierarchy in the resulting graphic model.

As can be seen from the table. 2, the coincidence of numbers is recorded for factor 1 - the compositional-graphic model. We consider this factor to be the highest in terms of priority level of influence on the process of forming the visual content of newspaper publications.

According to the methods of system analysis and mathematical modeling of hierarchies [18], remove from Table 2, the first line (which corresponds to the number of the singled out factor), and in the second and third columns of this table, we cross out the number 1, respectively. Let's get a table that is the basis for calculating the next iteration - the basis of the next most important level of the hierarchy of factors.

Table 3

i	$D(f_i)$	$P(f_i)$	$D(f_i) \cap P(f_i)$
2	2,3	1,2	2
3	3,4,5,7	1,2,3,4,5,7	3,4,5,7
4	3,4,5,7	3,4,5,7,8	3,4,5,7
5	3,4,5,7	1,3,4,5,6,7,8	3,4,5,7
6	5,6	1,6,7,8	6
7	3,4,5,6,7	1,3,4,5,7,8	3,4,5,7
8	4,5,6,7,8	1,8	8

Analysis of the table. 3 is carried out according to the above algorithm. It is easy to notice that the coincidence of numbers is recorded for factor 2 - the publication's abundance of photo illustrations, which forms the next level of the hierarchy.

Actions similar to those described above lead to the table. 4, in which the line with the number 2 is deleted, and this number is missing in the third column of the table.

Table 4

i	$D(f_i)$	$P(f_i)$	$D(f_i) \cap P(f_i)$
3	3,4,5,7	1,2,3,4,5,7	3,4,5,7
4	3,4,5,7	3,4,5,7,8	3,4,5,7
5	3,4,5,7	1,3,4,5,6,7,8	3,4,5,7
6	5,6	1,6,7,8	6
7	3,4,5,6,7	1,3,4,5,7,8	3,4,5,7
8	4,5,6,7,8	1,8	8

From Table 4 we get factor 8 – the genre of photo illustrations. We removed it and this number is missing in the fourth column of the table. As a result of repeating the procedures, we get:

Table 5

i	$D(f_i)$	$P(f_i)$	$D(f_i) \cap P(f_i)$
3	3,4,5,7	1,2,3,4,5,7	3,4,5,7
4	3,4,5,7	3,4,5,7,8	3,4,5,7
5	3,4,5,7	1,3,4,5,6,7,8	3,4,5,7
6	5,6	1,6,7,8	6
7	3,4,5,6,7	1,3,4,5,7,8	3,4,5,7

From Table 5 we get factor 6 – the source of origin of photo illustrations. As a result of repeating the procedures, we get:

Table 6

i	$D(f_i)$	$P(f_i)$	$D(f_i) \cap P(f_i)$
3	3,4,5,7	1,2,3,4,5,7	3,4,5,7
4	3,4,5,7	3,4,5,7,8	3,4,5,7
5	3,4,5,7	1,3,4,5,6,7,8	3,4,5,7
7	3,4,5,6,7	1,3,4,5,7,8	3,4,5,7

Table 6 leads to the exclusion of four factors at once: 3 – the place of posting the photo illustrations, 4 – the method of communication of the photo illustration with the text, 5 – the functions of the photo illustrations, and 7 – the composition of the photo illustrations.

Using the data of the iterative analysis and taking into account [8, 24], we synthesize a multi-level structured graphic model (Fig. 5), in which the place of each of the factors is displayed and the connections between them, specified in the original model (Fig. 4), are reproduced.

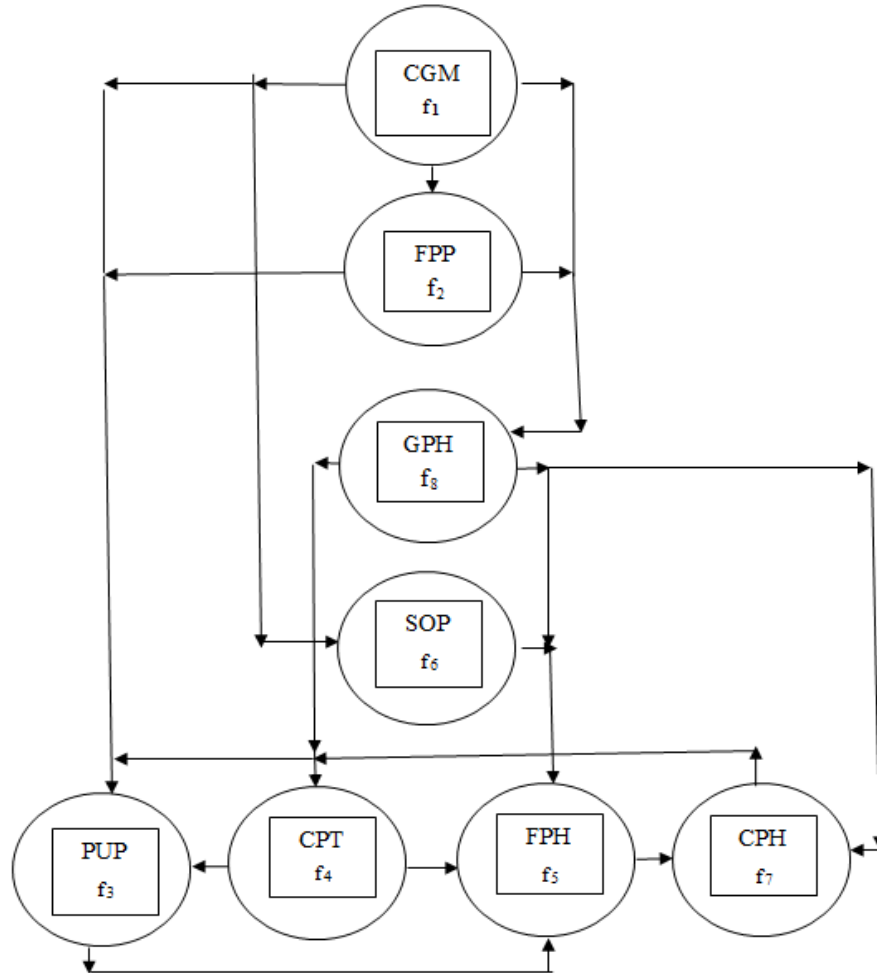


Figure 5: A multilevel model of factors for creating the visual content of a newspaper publication.

In the model of Fig. 5, the priority of the effect of the factor on the process of photo illustration (creation of visual content of the newspaper) is determined by the level of its placement, which is reflected in the following model.

The synthesized models abstractly reflect the subjective judgments of experts regarding the factors that influence the main procedures of the stage of the photo illustration of the newspaper publication.

As can be seen from the figures, the compositional and graphic model of the publication has the greatest weight, depending on which a hierarchical "pyramid" of factors or ascertaining criteria is built.

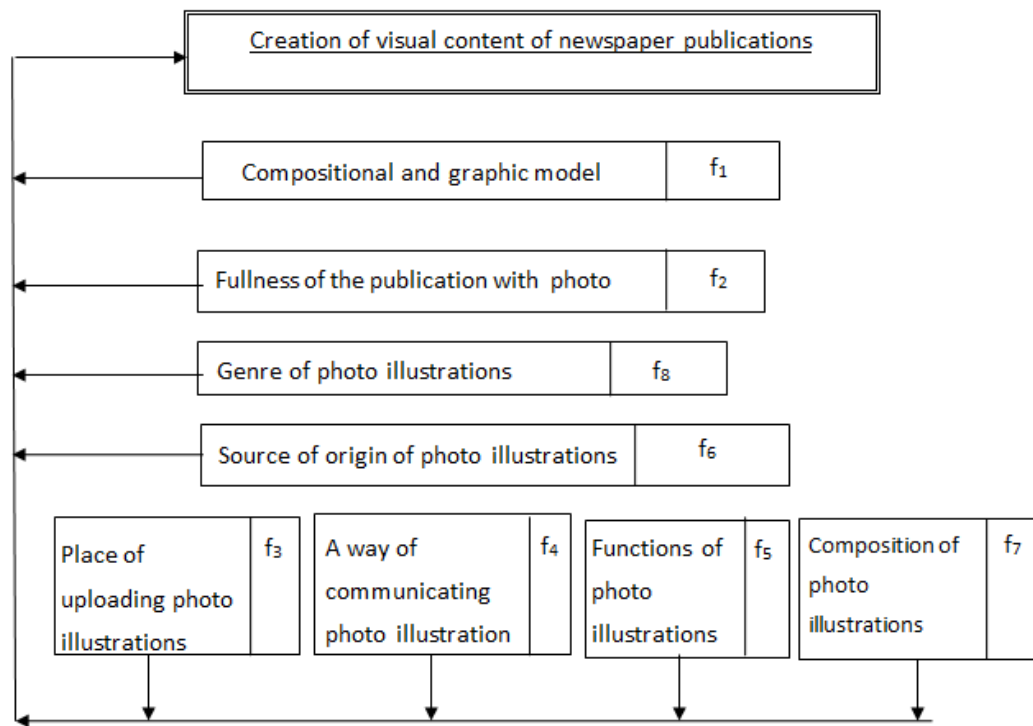


Figure 6: Model of the priority influence of factors on the process of creating visual content of newspaper publications.

Results and Discussion

Thus, the built priority model makes it possible to understand what is most important when choosing specific photo illustrations for forming the visual content of newspaper publications. First of all, the choice of photo illustrations is influenced by the compositional and graphic model of the publication, which in turn is formed by the editorial team depending on the direction of the publication itself (social and political, etc.), the intended audience and the content of the publications. The organization of verbal and illustrative messages in newspaper columns determines the type and compositional solution of photo-illustrative material for publications. The publication's abundance of photo illustrations determines the number of necessary photos, but this indicator must be consistent with the compositional and graphic model of the publication and the content of the publications, so as not to overload the visual series. Regarding the genre solution of photo illustrations, the most interesting for the consumer (reader) is the genre of photoreportage; therefore the main emphasis of the photo editor should be on this type of photo illustration. The source of origin of photo illustrations is the next most important factor that determines the success of the formation of photo-illustrative content. This is explained by the high level of professionalism of works obtained from photo banks or their editorial photographers, which in turn has a positive effect on their compositional solution. The remaining four factors have the same level of priority: the location of the photo illustrations, their functions, and the way of communication with the text, as well as the composition of the photo illustration.

A practically conducted content analysis of four Ukrainian newspaper editions confirms the results of the obtained mathematical modeling. It is the factors taken into account in the model that determine the success of the formation of the photo-illustrative content of the periodical. Thus, according to the results of the content analysis, the branch publication "Magistral" is characterized by the worst-formed visual content. The factors for which the highest degree of priority for the formation of high-quality photo illustration was determined based on the developed information concept were not taken into account by the editors of the specified media.

The results obtained in this work can be taken into account when forming the visual content of publications, which will improve the quality of their printing and expand the readership by attracting new consumers.

Conclusion

1. The study of visual and communicative features of photo illustration indicates that successful compositional solutions, in particular, the compositional and graphic model of the newspaper publication itself, have the greatest influence on the successful use of the photo image.
2. As a result of the content analysis of modern Ukrainian newspaper publications, the main influencing factors on the formation of the photo-illustrative content of the periodical publication were determined: the compositional and graphic model of the publication; fullness of the publication with photo illustrations; place of uploading photo illustrations; method of communication of photo illustration with text; functions of photo illustrations; source of origin of photo illustrations; composition of photo illustrations; genre of photo illustrations.
3. The information concept of forming the visual content of periodicals based on the priority model, developed by the authors, made it possible to identify the following sequence regarding the importance of influencing factors. The most significant factor when choosing specific photo illustrations is the compositional and graphic model of the publication, which depends on the type of newspaper publication and the planned audience and content of publications.
4. A successful compositional solution allows you to influence the attention of the consumer of visual content as quickly as possible. The abundance of photo illustrations, the subsequent factor in the priority model, should align with the publication's compositional and graphic model and content to avoid overwhelming the visual series.
5. After the editorial department has decided on the number of photo illustrations, the genre of photo illustrations should be taken into account. Studies indicate that the most informative and engaging genre for readers is the photo reportage genre, fostering a sense of presence in the illustrated event.
6. The source of origin of photo illustrations ranks fourth in importance, determining success in the formation of photo-illustrative content, as selecting photos from photo banks or employing in-house photojournalists ensures compositional excellence and high-quality standards due to professional expertise. The remaining four factors have the same level of priority: the location of the photo illustrations, their functions and the way of communication with the text, as well as the composition of the photo illustration.

7. Adopting the information concept developed by the authors for forming the visual content of periodicals will enable publishers to enhance the content of printed newspaper publications. This, in turn, will provide the mentioned editions with the opportunity to compete effectively for readership in the era of constant growth in the popularity of digital media products.

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