Synthesis and Research of a Model of Factors of Infographics Compositional Design with Elements of Visual Communication

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Abstract

Visualization is a method of presenting information in the form of an optical image, such as graphs, flowcharts, charts, tables, maps, etc. Visual information is better comprehended, as it effectively communicates to the viewer thoughts and ideas. Visualization is a tool for presenting data, which encourages the reader to think about the essence, rather than methodology, to avoid distortion of what the data should convey. One of the essential advantages is displaying many numbers in a compact space to show an array of data as a whole. Visualization performs the functions of motivating the viewer to compare fragments of data, description, research, organization of large data sets. The paper considers the visualization selection method, namely the combination of data with text and visual images, basic charts for data presentation, and data coding methods in different types of charts. Synthesis and research of a model of factors of the infographics compositional design with visual communication elements are provided based on the selection of infographics components (elements). The optimization of the hierarchical model of priority of impact factors using a method of pairwise comparisons is created and carried out. This allowed obtaining the weights of the influence factors on the infographics design with visual communication elements.

Keywords

Visualization, infographics, data encoding, hierarchical models, method of pairwise comparisons, factors, graph, matrix.

1. Introduction

Visualization is particularly effective in displaying naturally invisible information (for example, population density distribution, the spatial distribution of electromagnetic field, temperature, etc.). The study of images allows exploring the spatial structures of objects. A writing system is based on visualization; it is inextricably linked with the development of symbolic and figurative thinking. Visualization problems are studied in the studies of philosophers, psychologists, developers of software and computer graphics systems [1-9].

Basic principles of the visual means organization of information presentation:

- conciseness;
- generalization and unification;
- emphasis on the main content elements;
- autonomy;
- structure;

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- stages;
- use of common associations and stereotypes.

The principle of conciseness is the most universal. The central idea is that the graphical means of presenting information should contain only those elements necessary to communicate only essential information, precise understanding, or perception. The desired visual emphasis on the main compositional elements is achieved by eliminating unnecessary distracting details. From the principle of generalization and unification, it follows that within the whole set of graphical means of information presentation, the symbols representing the same objects or phenomena must be unified – to have a one-piece graphic solution. The principle of emphasizing the main content elements intends that the means of information visualization must highlight the size, shape, and color of the most crucial elements first [1, 2].

Thus, by researching the literature, we found that the study of visualization can be divided into the following areas - some are devoted directly to the process of information perception through infographics [3, 4], and others are dedicated to comparing algorithms [5-7] and methods of reproduction and presentation of visualization [8-10]. Much of the research focuses on the data presented by the visualization [11-13]. These studies help to analyze how people understand, create, and percept infographics.

2. Visualization selection algorithm

Infographics combine data with text and visual images. However, it is impossible to provide numbers and expect readers to receive explicit information. Therefore, it should be considered visualizing the data to create high-quality and readable content [2, 14].

The first task to solve this problem is to choose the right chart or graph for numerical data, which will provide:

- deepening the understanding of complex concepts;
- strengthening the persuasiveness of visualization in infographics;
- key visualization data that is easy to perceive.

2.1. Method of choosing a chart for data

Stage 1. Defining the purpose of visualization (Fig.1)

Figure 1: Defining the purpose of visualization

Inform: convey an important message or data point that does not require context for perceiving information;

Compare: show similarities or differences among values or parts of a whole of numerical data;

Change: visualize trends over time or space;

Organize: show groups, patterns, trends in their purpose;

Relationships: show relationships like correlation or distribution [15, 16].

Stage 2. Select a chart to achieve the desired goal

Charts for information purpose

The easiest way is to use large informative blocks of textual information (Fig. 2).

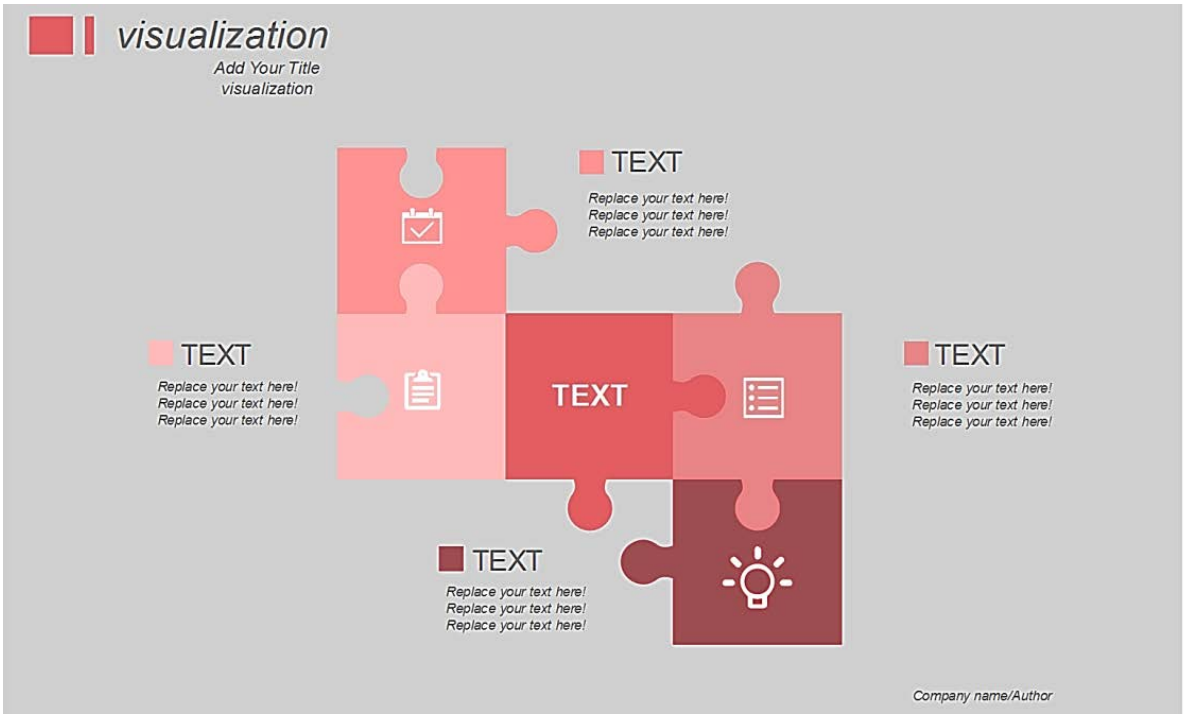


Figure 2: An example of a visualization layout for information purposes

The advantage of this type of visualization: conveys the essence - there is no room for misinterpretation. Disadvantage – sometimes one number, without any context, may not seem very meaningful and understandable. This problem in infographics is easy to solve using simple symbols or icons. For example, an arrow showing the decline, the direction of movement for reading information (Fig. 3).

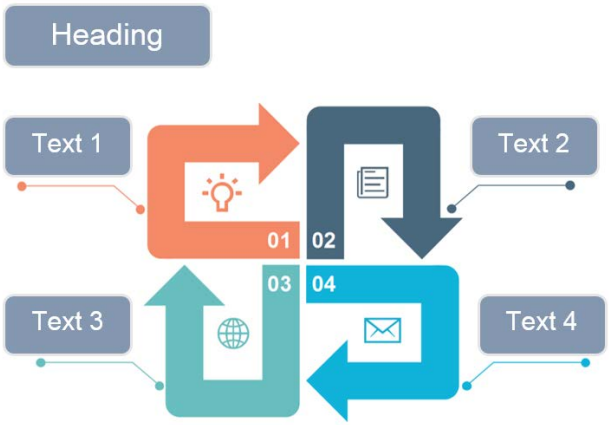


Figure 3: An example of a visualization layout for information purposes with icons

It is also advisable to use an icon chart (icons, which are represented by two colors) for the purpose of informing (Fig. 4) [15, 16].

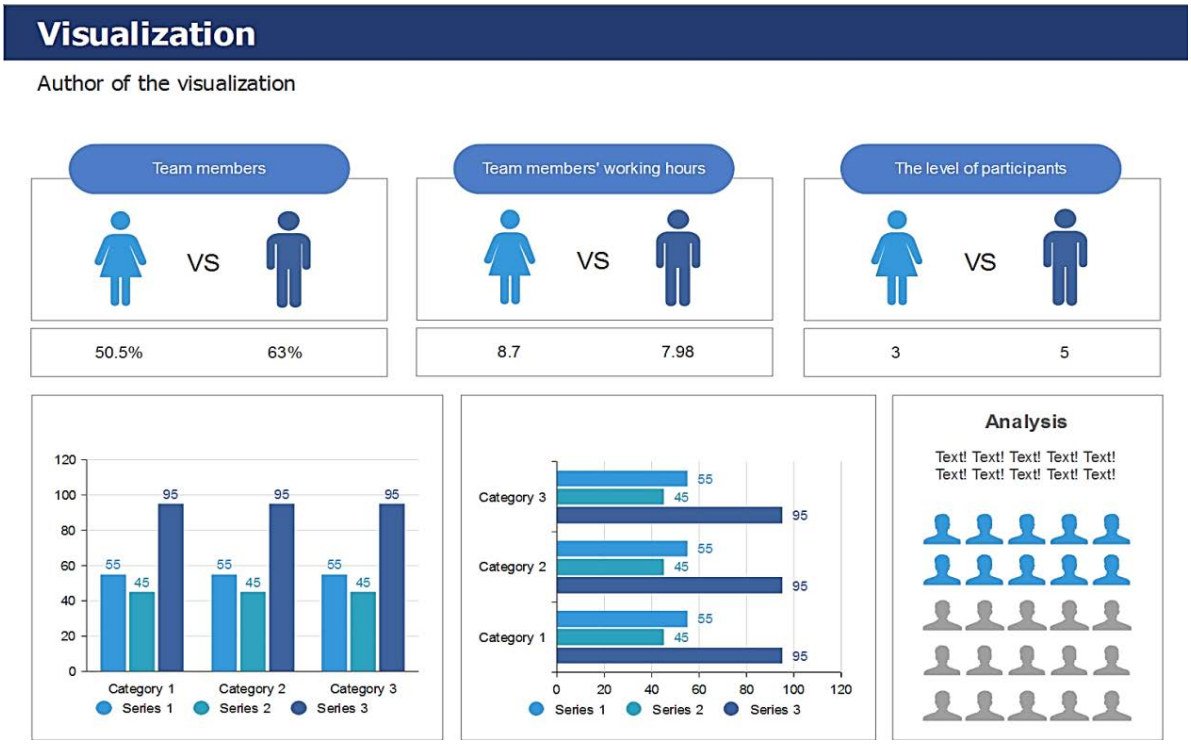


Figure 4: An example of a visualization layout for information purposes

List of charts for comparison purpose

If the infographics' primary purpose is to show the similarities or differences among the values, parts of the whole, it is best to use a bar or column chart. In these types of visualization, the data are arranged in columns or rows. Column charts are useful for showing changes in data over time or for visual comparison of elements. The categories are located along the horizontal axis in column charts, and the values along the vertical axis (Fig. 5) [17].

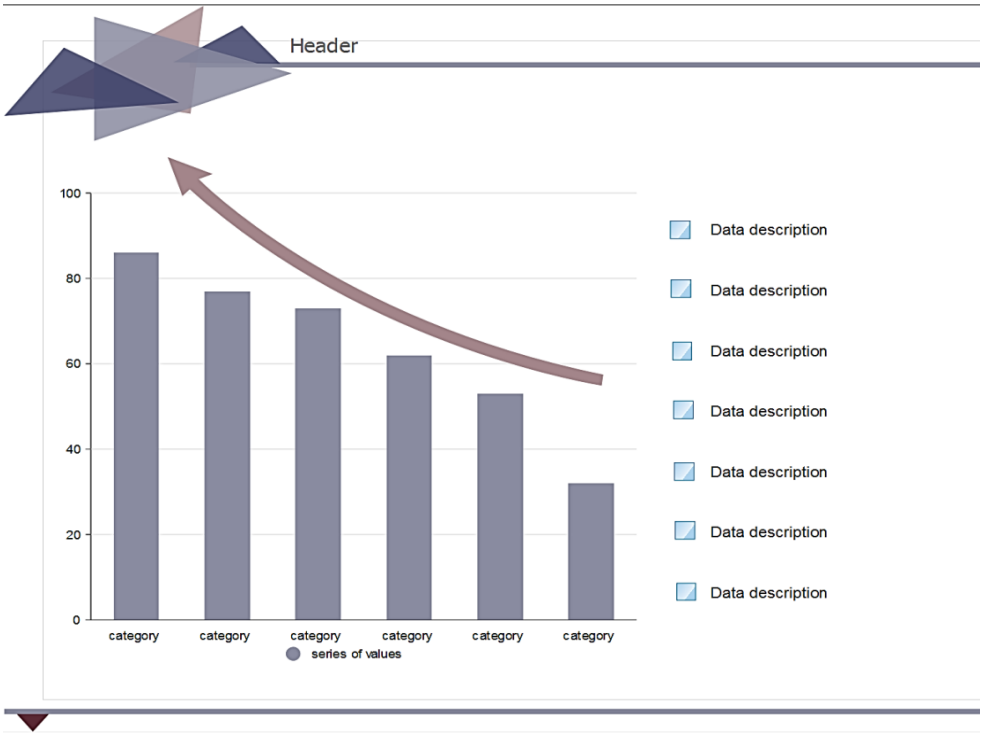


Figure 5: An example of visualization layout for comparison purposes

In turn, line charts distribute category data evenly along the horizontal axis (categories) and all numerical values along the vertical axis (values). It is worth paying attention to the order because the data list does not have regular order; sorting the items from largest to smallest adds an extra dimension of information. These types of charts are the best choice in terms of the readability of numerical data. However, infographics sometimes require a more unique and attractive solution [14].

A more authentic way to visualize is to use a bubble chart to compare independent values with clear differences. This type makes it very convenient to display a lot of related data in one chart. In scatter charts, one numerical field is displayed on the x-axis and another on the y-axis. Therefore the relationship between the two values for all chart elements is easily observable (Fig. 6).

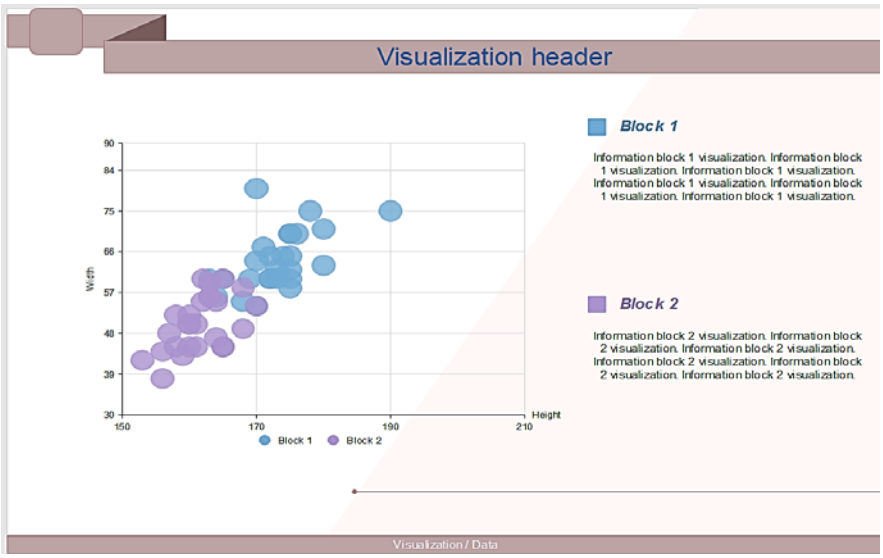


Figure 6: An example of visualization layout for comparison purposes

In the bubble chart, the third numeric field determines the size of the data points. The play axis can be added to a scatter or bubble chart, which allows viewing data that changes over time [16].

The easiest way to visualize simple relationships is a pie chart (Fig. 7). It is worth using a pie chart to compare parts of a whole. The main requirements for constructing such type of charts:

- ordering segments from largest to smallest;
- start the first segment at 12:00 and continue clockwise;
- limit the chart to a maximum of 7 segments.

Figure 7: An example of visualization layout for comparison purposes

Pie charts are clear and easy to use, but they have their limitations (when comparing several values). Instead, it is preferable to use a composite column graph.

Charts for change purpose

There is more flexibility when it comes to visualizing trends in time or space. The line chart or area chart should be used to show constant changes over time (Fig. 8). Line charts are the most efficient chart for displaying time-series data. They can handle multiple data points and multiple data series, and they are understandable for everyone.

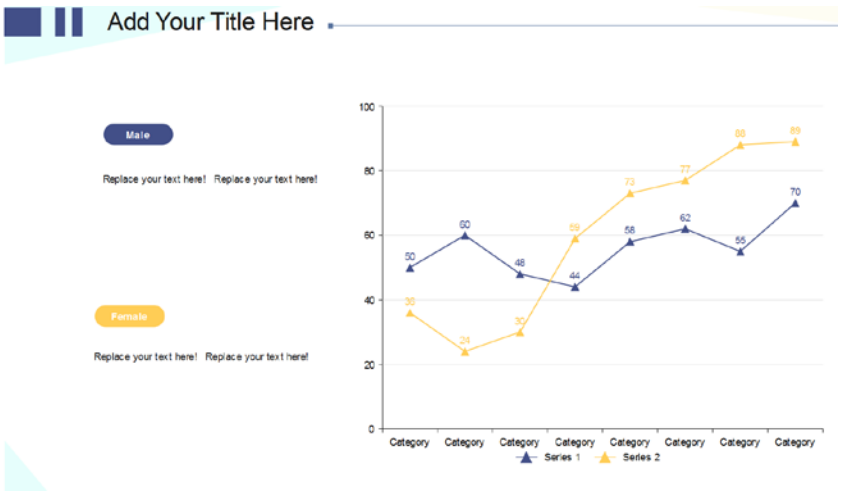


Figure 8: An example of visualization layout for change purposes

Area diagrams can be more aesthetic but require a little more subtlety in their construction. They should practically be used with only four types of data categories and color transparency to ensure each area's readability (Fig. 9).

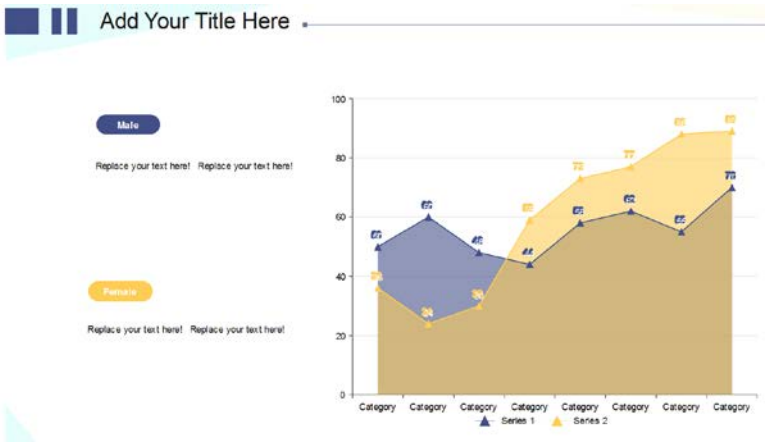


Figure 9: An example of visualization layout for change purposes

Charts for organization purpose

Charts for organizing data or information in infographics can take many forms, depending on whether you want to show groups, templates, ranks, or order. The simplest form of organizing infographics is a list.

When it is necessary to provide textual information about each element (for example, when describing a linear process), a numbered list should be used to show the rank or order [17-20].

The table can be used to organize data so that readers can search for specific values. Tables are the most suitable when exact values are needed when viewers require access to individual numbers or a data set containing several different units [16, 17].

However, tables can contain many details. They do not give a sense of the data form, so it is often useful to include tables as a supplement to a more visual chart. Simple fields, borders, arrows, and lines should be used to visually organize groups (Venn diagram, mind map, and flowcharts). Visualizations that use these principles are a Venn diagram (Fig. 10) and a mind map (Fig. 11).

Figure 10: An example of a Venn diagram visualization layout

Figure 2: An example of a mental map visualization layout

Charts for the purpose of the relationships

The two fundamental types of relationships that can be found in a data set are correlation and distribution. A scatter plot should be used to identify the relationship and distribution of a two-variable data set. Scatter charts are the easiest way to study the potential correlation between two variables. They allow detecting the distribution and clustering. Scatter charts are useful because they do not require data aggregation or pre-processing to detect the data set's distribution. A histogram is a common way to display age-related demographics and is excellent for all distribution types [17, 18].

2.2. Methods of data encoding in different types of charts

1. Data encoding in column charts

Method 1: When the data shows a specific range of values, which will focus the user's attention on extreme values.

Figure 12 shows the sales volume of cosmetics ranked by category to show which month sales are highest.

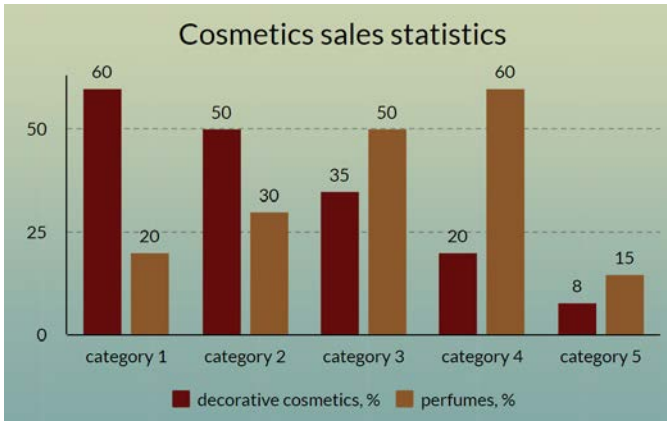


Figure 3: An example of data encoding in a column chart

Method 2: When the elements in the chart have a short category label.

It is essential to add category labels for each column to make it clear. Usually, the user gets confused and starts to lose useful information in the visualization (Fig. 13).

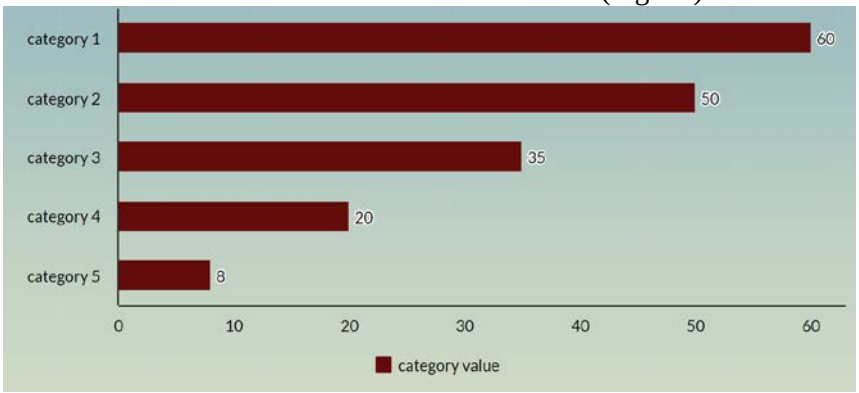


Figure 4: A visual form of data encoding in a bar chart

Method 3: When the chart requires the visualization of tendency.

A tendency bar is a row associated with a row of data on a chart that indicates a statistical tendency. The tendency line does not represent data from this data series but instead reflects the tendency in available data or future data forecasts (Fig. 14).

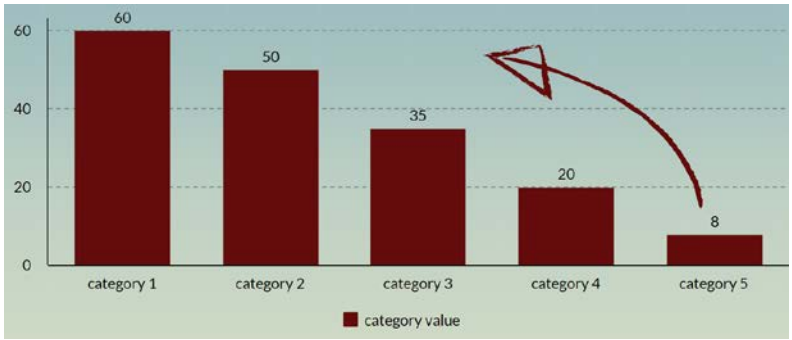


Figure 5: An example of tendency visualization encoding

Method 4: When the chart contains negative values.

Negative values show opposites and are often used to display the size of a loss or deficit. In this case, bar chart visualizations work much better than other types (Fig. 15).

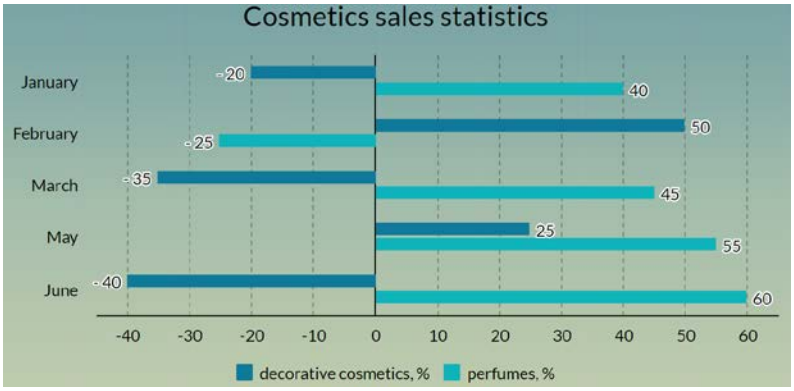


Figure 6: An example of visualization with negative values

It can be concluded that column charts should be used when the data displays rank values to focus on extreme values, the elements on the chart have short category labels, the tendency line is required, or the chart contains negative values [15-17].

2. Data encoding in line graphs

Method 1: When the data is a series of linear numerical points.

A line graph is a chart used to display a series of data points connected by straight solid segments [14]. In a line graph, solid points are called "markers," and line segments are often drawn chronologically. The x-axis lists the categories equally, and the y-axis represents the measurement values. For example, if there is a requirement to analyze how revenue or sales develop over the year, then visualizing the type of line chart will be the most effective solution (Fig. 16).

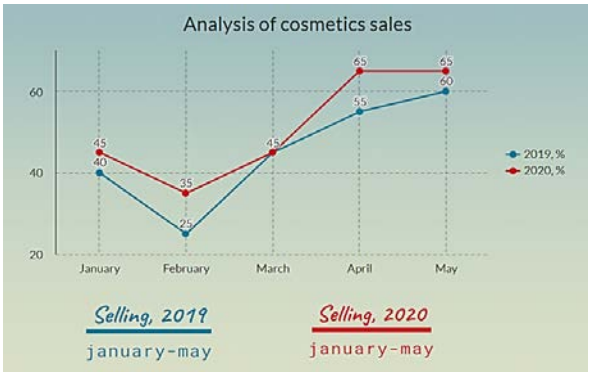


Figure 7: An example of data encoding in a line graph

Method 2: When the data contain experimental statistics.

Experimental data and conclusions received from repeated experiments and analysis, calculations of assumptions, additional experiments, and data verification to confirm the hypotheses — performing all these operations, researchers write detailed results in a table, rather than displaying a linear graph. However, the table is not intuitive enough to show such a tendency (Fig. 17).

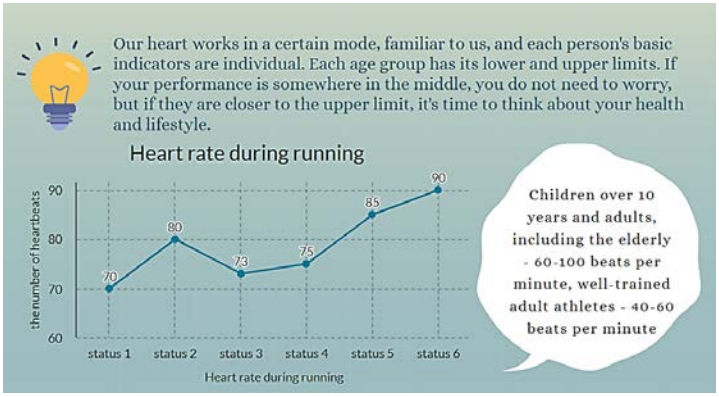


Figure 17: An example of statistical visualization

Method 3: When the data change over time.

As mentioned above, the line graph shows a tendency, namely data that change over time. It is easily observable that all graphs of product sales, valuations, and different data that change over time are presented using line graphs. Nevertheless, line graphs can also be used to indicate tendency based on other constant periodic values, such as speed, temperature, distance, etc. [16-18].

Let`s suppose the visualization shows a tendency rather than the specific values of each category. In that case, the grid should be hidden because it compresses the lines, dots, and text in the frame, making the line graph messy and crowded.

Highlight the category that is most important in the visualization. In this case, a different color or thick line should be used to highlight the data of the primary data line and paint the other lines gray (Fig. 18).

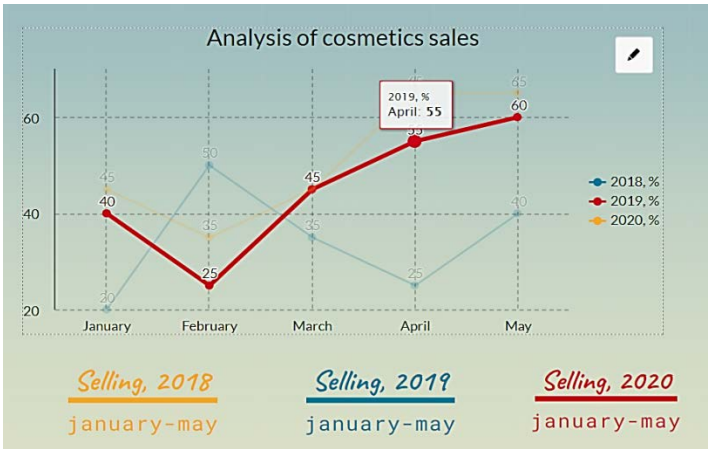
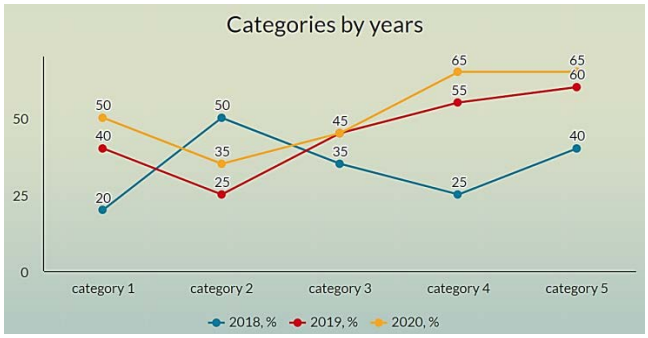


Figure 8: An example of visualization with a change in time

3. Data encoding in the area chart

Method 1: When the data correspond to the relationship of time series.

This type of chart is used to represent data that corresponds to the relationship of time series. The difference between line graphs and area charts is that the space below the drawn line is filled with color. The area diagram displays information about the x-axis and data values on the y-axis, connecting data points with continuous segments of lines (Fig. 19).



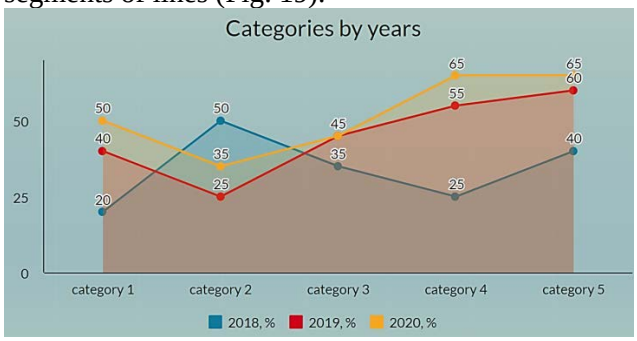


Figure 9: An example of time series visualizations comparison

Method 2: When the data correspond to the distribution of categories.

The area chart is best used to display the distribution of categories as parts of a whole where the aggregate result does not matter. We can call such a chart "Overlapping chart" (Fig. 20).

Filling between line segments and an axis helps to understand a quantity that cannot be achieved with a line chart. Line charts help to show trends and changes in the category. However, line charts are not able to visually determine the scale of change. In the area diagram, the fill between the line segments and the axis indicates the change.

4. Encoding data using histogram

This type of chart shows the meaning of each category intuitively and visually to compare different categories (Fig. 21). Most histograms are designed horizontally, which show the difference

with column charts. Typically, histograms visualize categories along the y-axis (vertical axis) and values along the x-axis (horizontal axis).

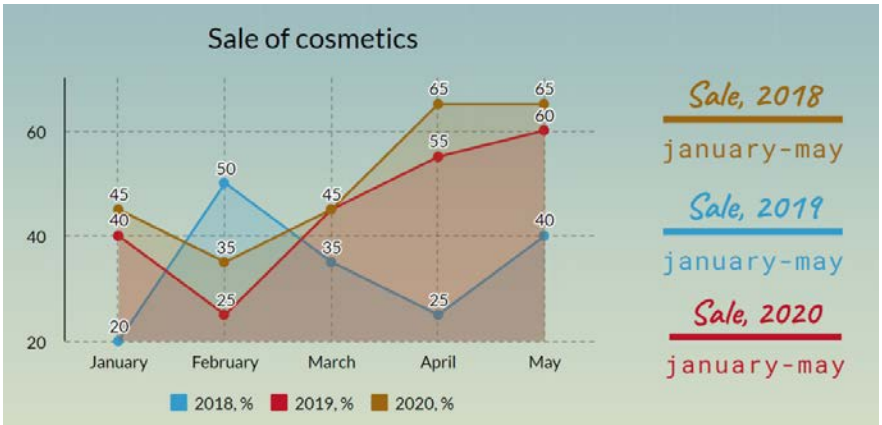


Figure 20: An example of categories distribution visualization

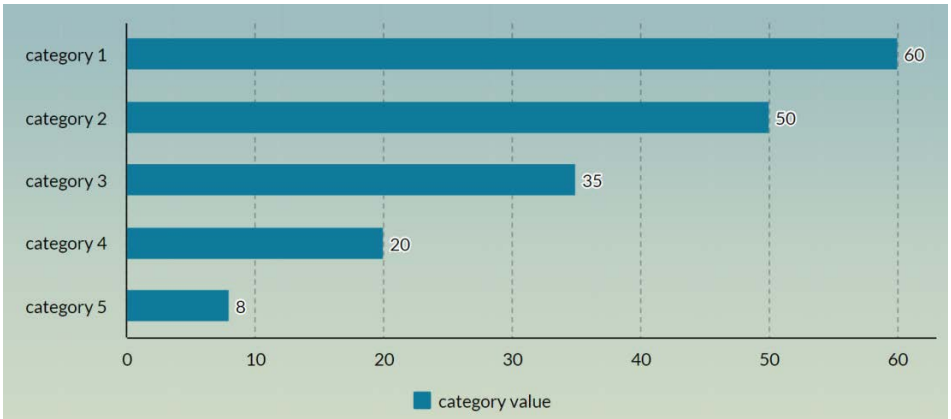


Figure 21: An example of data encoding using histogram

Method 1: When the meaning of each category needs to be considered intuitively.

If it is essential to know each category's number, ratio, and frequency in the chart, a one-piece chart should be chosen. It allows observing the elements' values with each line's length on one bar of the histogram.

Method 2: When chart elements have more than 5 categories.

If there are more than five categories, it might be difficult to view category labels in the vertical columns. Therefore, horizontal charts help to view a large number of categories.

Method 3: When it is necessary to visualize data comparisons on a graph.

It is known that a one-piece chart is intuitive to view values. However, if there is a need to visualize data by groups of categories, a cluster bar chart is the best tool. Cluster bar charts are used to compare each element of a category and by category. For example, the clustered histogram shows the comparison of three companies' monthly sales (Fig. 22).

Method 4: When it is necessary to depict the relationship of the category.

The bar chart indicates the ratio of parts of the whole between each category. Because the clustered bar chart makes it difficult to represent the differences among each group's total number, composite charts are used to address these inconveniences [16-18].

Therefore, histograms are used to view each category's values, when there are more than five categories, and compare data and parts of the whole category relationship.

[d] encoding data with a pie chart

Pie charts are one of the statistical graphs in the form of a circle, divided into segments that illustrate the numerical relationship. In a pie chart, the length of each segment's curve (and consequently its central angle and area) corresponds to the number it represents (Fig. 23).

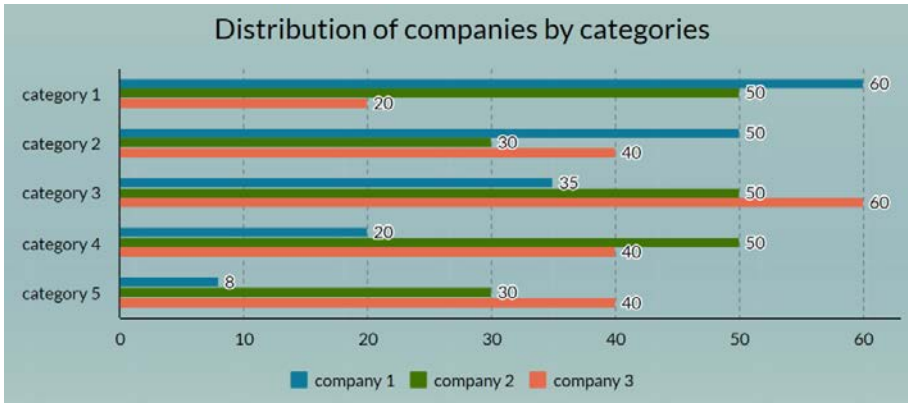


Figure 22: An example of data comparison visualization

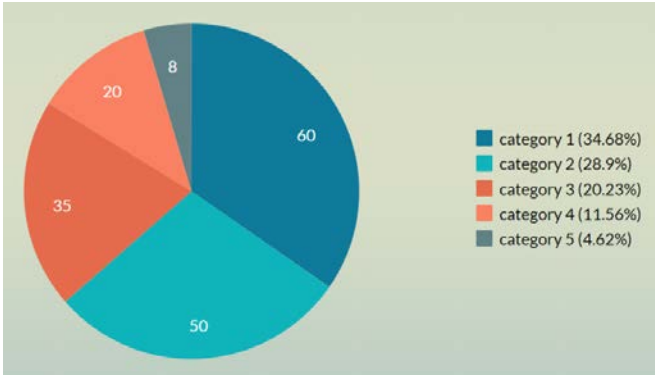


Figure 10: Encoding data with a pie chart

- encoding data using a radar chart

The radar chart is also called a web chart, spider chart, and polar chart, known for its unique shape. This chart uses a two-dimensional graph to display a multidimensional data structure. However, it has a limit and can compare no more than six subjects. Otherwise, the data is not visible.

In a radar chart, each element can cover a fixed area based on its data (Fig. 24). If there is a need to visualize each element's coverage by different indicators, a spider chart is the best choice. For example, if a coach wants to examine his players' performances in a match, he can observe each player's general situation, analyze and prepare a specific training plan [17, 18].

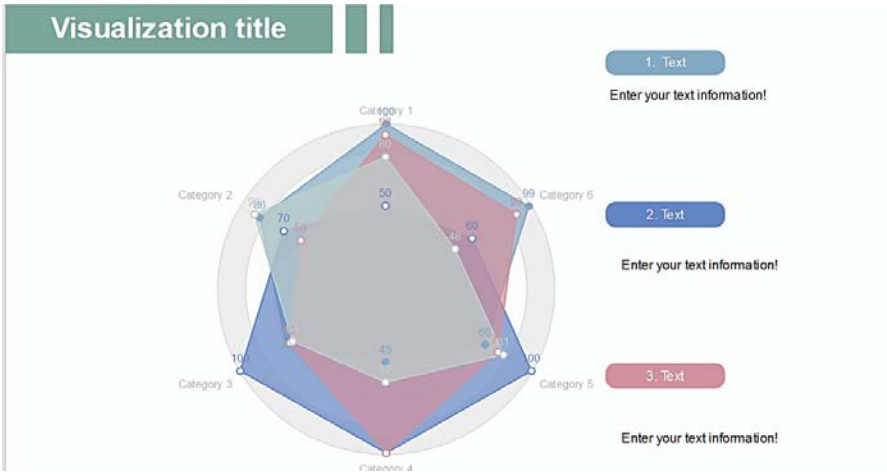


Figure 11: An example of radar chart visualization

3. Solving the issue of factors of infographics compositional design with elements of visual communication

At the stage of development of infographics visual content, it is necessary to carry out several actions to optimize the efficiency of the visualization process. Most visual coding components are represented by spatial elements, labels, connections, shells, link properties, etc. Each of them can be used in its own way to represent the relationship between different types of data. It is proposed to use the analytic hierarchy method to determine and prioritize the factors used in the compositional design of infographics with visual communication elements. This method is widely used in solving problems of this profile. Spatial mapping is the most effective way to present numerical data that helps readers perceive this type of content quickly and easily [19, 20].

It is also worth analyzing three main components of communication that need to be assessed in the process of infographics development – appeal, understanding, and retention.

The *appeal* is the idea that visual communication should perform the function of attracting the audience.

Understanding enables a reader to understand the presented information easily. In its turn, *retention* means that a reader must perceive and remember the data presented in the infographics. The order of performance of functions will depend on the purpose of the infographics itself. For example, if the infographics are used for commercial purposes, the appeal becomes the most important function, followed by retention and understanding [19].

The functions of appeal and retention in practice can be assembled with a clear layout. Data visualization is often used in infographics and can be the foundation of the entire infographic layout. Many types of visualization can be used to represent the same data set. Therefore, it is essential to determine the appropriate visualization for the data set and infographics, taking into account graphical functions such as position, size, shape, and color.

High-quality infographics allow to display of vast amounts of information and analyze data and draw visual conclusions.

3.1. Components (elements) of infographics

Text. Usually, the text is used for explanations, names of separate elements, information blocks.

Numerical data are used to indicate values, order individual elements, information blocks.

Graphs and charts illustrate the relationship between different objects.

Flowcharts demonstrate the connection of elements, objects, blocks of infographics.

Images are used for thematic illustration of infographics, adding art.

*Icons/*pictograms will help with the identification and unification of information blocks, drawings, charts.

As infographics' primary purpose is to supplement the main material with data visualization and icons, which are the report's principal components, infographics perform a crucial function of persuasion [1]. Considering the fact that visualization is most appropriate for presenting research results, it should be used in infographics to present numerical data.

3.2. Development of a hierarchical model of priority impact of factors on the process of infographics designing

The analysis of infographics design factors with elements of visual communication shows the importance of developing a hierarchical model of the priority impact of these factors on the process of infographics designing.

Let us assume that the aggregate of these factors forms the set $i = \{1, 2, 3\ldots\}$, and choose from this aggregate a subset of the most significant factors of impact on designing of the infographics with elements of visual communication.

For better accuracy, each factor denoted as follows:

- h_1 – text (T);
- h_2 – numerical data (ND);
- h_3 – graphs and charts (GC);
- h_4 – flowcharts (FC);

- h_5 – image (IM);
- h_6 – icons (IC).

The subset of factors and relationships between them are presented in the form of an oriented graph (Fig. 25). In its vertices, let us place subset elements; arcs will connect the adjacent pairs of vertices for which a connection is defined. It shows a certain interdependence of factors. Then a binary dependency matrix *B* for the set of vertices *H* is built by the following way [19]:

$$b_{ij} = \begin{cases} 0, if\ i\ does\ not\ depend\ on\ j, \\ 1, if\ i\ depend\ on\ j. \end{cases} \quad (1)$$

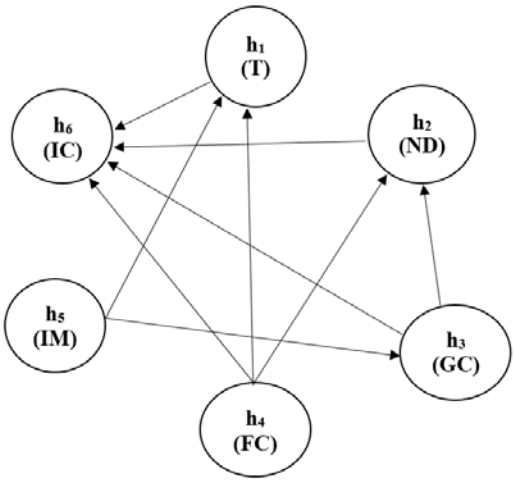


Figure 12: The initial graph of the relationship among the factors of infographic design and elements of visual communication

Practically its construction is in Table 1.

Table 1

Binary matrix B

		1 T	2 ND	3 GC	4 FC	5 IM	6 IC
1	T	0	0	0	0	0	1
2	ND	0	0	0	0	0	1
3	GC	0	1	0	0	0	1
4	FC	1	1	0	0	0	1
5	IM	1	0	1	0	0	0
6	IC	0	0	0	0	0	0

Based on the binary matrix *B*, we form a reachability matrix according to the following rule (*I*+*B*) (where *I* is a unit matrix), which we raise to the power of *n* to satisfy the condition [20]:

$$(I + B)^{n-1} \leq (I + B)^n = (I + B)^{n+1} \quad (2)$$

Filling the matrix with binary elements is performed by the rule:

$$d_{ij} = \begin{cases} 1, if\ the\ vertex\ j\ is\ accessed\ from\ the\ vertex\ i, \\ 0, in\ other\ cases. \end{cases} \quad (3)$$

Practically its construction is in Table 2.

The vertex *j* is accessed from the vertex *i*, if the graph (Fig. 25) contains a path that leads from the vertex i to the vertex j. Such vertex is called an accessed vertex. Let's mark the subset of such vertices with the letter $R(h_i)$.

Similarly, the vertex *i* is a predecessor of the vertex *j*, if it is accessed from this vertex. Let's mark this subset of preceding vertices with the letter $B(h_i)$. The intersection of these subsets is the subset:

$$B(h_i) = R(h_i) \cap B(h_i). \quad (4)$$

The set of those vertices $B(h_i)=R(h_i) \cap B(h_i)$ that meets the condition of inaccessibility from any of the remaining vertices of the set H can be defined as a certain level of the hierarchy of the priority impact of factors [19, 20].

Table 2

Reachability matrix D

		1 T	2 ND	3 GC	4 FC	5 IM	6 IC
1	T	1	0	0	0	0	1
2	ND	0	1	0	0	0	1
3	GC	0	1	1	0	0	1
4	FC	1	1	0	1	0	1
5	IM	1	1	1	0	1	1
6	IC	0	0	0	0	0	1

The subset $R(h_i)$ contains elements of the i^{th} row of the accessibility matrix with units. The subset $B(h_i)$ includes elements of the i^{th} column of the accessibility matrix with units. The subset $R(h_i) \cap B(h_i)$ is formed as the logical intersection of elements of the subsets $R(h_i)$ and $B(h_i)$ (Table 3) [21, 22].

Table 3

Priority levels of factors of the first iteration

k_i	$R(h_i)$	$B(h_i)$	$R(h_i) \cap B(h_i)$	
1	1, 6	1, 4, 5	1	
2	2, 6	2, 3, 4, 5	2	
3	2, 3, 6	3, 5	3	
4	1, 2, 4, 6	4	4	←
5	1, 2, 3, 5, 6	5	5	←
6	6	1, 2, 3, 4, 5, 6	6	

It should be noted that the equality $B(h_i)=R(h_i) \cap B(h_i)$ is true for elements 4 and 5. They correspond to factors of the block diagram and the image. These factors have the lowest priority level of impact of infographics design with elements of visual communication.

Let's delete rows with numbers 4 and 5 from table 3 and cross out numbers 4 and 5 in the second column. As a result, we will obtain Table 4.

Table 4

Priority levels of factors of the second iteration

k_i	$R(h_i)$	$B(h_i)$	$R(h_i) \cap B(h_i)$	
1	1, 6	1	1	←
2	2, 6	2, 3	2	
3	2, 3, 6	3	3	←
6	6	1, 2, 3, 6	6	

In table 4, the equality $B(h_i)=R(h_i) \cap B(h_i)$ is true for factors numbered 1 and 3, which correspond to the text, graphs, and charts. They determine the second level of the hierarchy of the priority impact of factors. Similarly to table 4, let us determine the third level of the hierarchy (Table 5).

Table 5

Priority levels of third iteration factors

k_i	$R(h_i)$	$B(h_i)$	$R(h_i) \cap B(h_i)$	
2	2, 6	2	2	←
6	6	2, 6	6	

In table 5, the equality $B(h_i)=R(h_i) \cap B(h_i)$ is true for element 2. This numerical data factor determines the third level of the hierarchy in the model of the priority impact of factors. Therefore, icons are at the highest factor level.

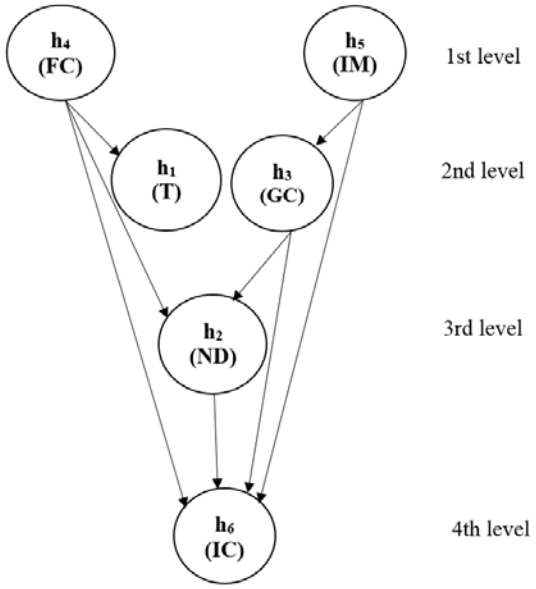


Figure 13: The hierarchical model of priority impact of factors on the infographics design with visual communication elements

The obtained model of the priority impact of factors proves that icons and numerical data are the most significant factors. The quality of visualization directly depends on the accuracy of its application, namely on the choice of a type of graph, its use, and design. It allows expressing the fundamental idea of the numerical data the most accurate and to the fullest extent possible, so it is essential to choose the appropriate type of charts.

The principal advantage of infographics is to turn uninteresting, complex information into a graphical structural model. Even a non-professional audience will understand the content, topics, and the central idea of infographics.

It is essential to consider the artistic aspect of infographics. The use of matching colors, a uniform font style and lettering, layout — all these, and many other aesthetic points are also important. Using familiar learning images, it is possible to enhance the effect of memorization and motivation to learn specific information on a particular topic, presented in infographics.

Therefore, these key factors should be considered at the initial stage of infographics design planning. The obtained results make it possible to optimize the model and establish the factors' numerical weight to obtain expert judgment consistency.

4. Optimization of a model of factors of infographics compositional design with elements of visual communication

Continuing to study a hierarchical model of priority impact of factors on the infographics design with visual communication elements is to establish their numerical weight. The method of pairwise comparisons is used to solve this problem. This technique consists of constructing a matrix of values based on the results of expert comparisons of factors. Its main advantage is that each expert determines how much one factor prevails over another [19, 23]. To establish such benefits, scientists use the scales of relative importance according to Saaty (Table 6).

Based on the obtained model of priorities of factors impacting the process the infographics design with elements of visual communication, the numerical weights of the studied factors are set: T (h_1) – 30; ND (h_2) – 50; GC (h_3) – 30; FC (h_4) – 10; IM (h_5) – 10; IC (h_6) – 70, which determine the initial estimates of factor levels in the hierarchical model V_{in} (30; 50; 30; 10; 10; 70).

Table 6

Saati scale of relative importance of objects

Intensity of importance	Comparison factors
1	Equal importance
3	Weak importance
5	Essential or strong importance
7	Demonstrated importance
9	Absolute importance
2,4,6,8	Intermediate compromise values

To determine the numerical weight of the relevant factors, it is necessary to construct a matrix of pairwise comparisons $A = (a_{ij})$, which is inversely symmetric and corresponds to the relation $a_{ij} = 1/a_{ji}$. When performing expert evaluation determines how one criterion dominates another. To do this, experts use the scale of the relative importance according to Saaty (Table 6) [22].

According to the methods of constructing hierarchies, the matrix of pairwise comparisons provides an opportunity to make a pairwise comparison of elements at each hierarchical structure level. This method allows the assessment of the importance of factors at different levels of the hierarchy.

The matrix of pairwise comparisons is presented in Table 7.

The components of the main eigenvector are calculated as the geometric mean value in the matrix row:

$$V = (0{,}818;\ 2{,}053;\ 1{,}030;\ 0{,}430;\ 0{,}341;\ 3{,}926).$$

In turn, the component of the priority vector is calculated [21]:

$$V_n = {V_i}\Big/{\sum_{i=1}^{n} V_i}\,. \tag{5}$$

V_n = (0,095; 0,238; 0,119; 0,050; 0,039; 0,456). The obtained vector determines the priorities of factors impacting the infographics design with elements of visual communication. For a better representation, the resulting components of the vector should be multiplied by a factor k=1000.

Table 7

The matrix A of pairwise comparisons

		1 T	2 ND	3 GC	4 FC	5 IM	6 IC
1	T	1	1/3	1/2	3	3	1/5
2	ND	3	1	3	5	5	1/3
3	GC	2	1/3	1	3	3	1/5
4	FC	1/3	1/5	1/3	1	2	1/7
5	IM	1/3	1/5	1/3	1/2	1	1/7
6	IC	5	3	5	7	7	1

The obtained vector: V_n x k = (95; 238; 119; 50; 39; 456).

The consistency of the factors' weight values is calculated by multiplying the priority vector (V_n) by the matrix of pairwise comparisons.

The obtained vector V_{n1}: V_{n1}= (0,595; 1,484; 0,750; 0,314; 0,249; 2,875).

The approximate value of λ_{max} for estimating expert judgments' consistency is calculated as the vector's arithmetic mean component [23].

The obtained vector V_{n2}: V_{n2}= (6,256; 6,218; 6,259; 6,278; 6,280; 6,297).

The next step is to determine the assessment of the consistency of expert judgments λ_{max}:

$$\lambda_{max} = \sum_{j=1}^{n} M_j V_{j,} \tag{6}$$

The calculations show λ_{max} = 6,26, which is the main characteristic for establishing the consistency of expert judgments on pairwise comparisons of factors in problems with linguistically indeterminate factors. The theory of fuzzy sets is used to solve them. The consistency index determines the evaluation of the obtained decision:

$$IU = \frac{\lambda_{max} - n}{n - 1}. \quad (7)$$

The received result is IU = 0,05. Comparing the value of the consistency index and the table for 6 objects (Table 8) [19, 23]

Table 8

Consistency index scale

Number of objects	3	4	5	6	7	8	9	10	11	12	13	14	15
Index standard value	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,54	1,56	1,57	1,59

We receive the inequality 0.05 <0.1x1.24. This inequality indicates the proper consistency of expert judgments.

The level of convergence is confirmed by the histogram (Fig. 27).

All components of the normalized vector are optimized weights of factors influencing the design of infographics with visual communication elements, which are used to build an optimized model in Fig. 28.

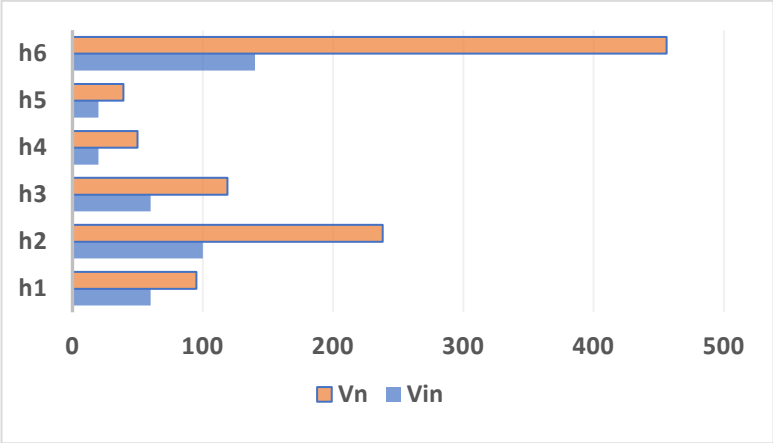


Figure 14: Comparative histogram of weight values of components of initial (V_{in}) and normalized (V_n) vectors

5. Conclusions

Advantages of data visualization: the information presented in the form of visualization is perceived better and allows conveying thoughts and ideas to a viewer quickly and effectively. Physiologically, the perception of visual information is fundamental for humans.

For each design purpose, it is recommended to use the appropriate data visualization layouts. They can be very heterogeneous in type and structure, but in the simplest case, they present continuous numerical and temporal data, discrete data, geographical and logical data. This research shows that depending on the purpose and type of data, it is expedient to choose the most appropriate method of choosing the visualization, i.e., the combination of data with text and visual images, basic diagrams for presenting data, methods of encoding data in different types of diagrams.

We carried out the synthesis and research of the model of factors of infographics compositional design with elements of visual communication on the basis of separation of components (elements) of the infographics.

Optimization of the hierarchical model of the priority impact of factors using the pairwise comparison method allowed obtaining the weight values of the factors impacting the process of designing the infographics with elements of visual communication.

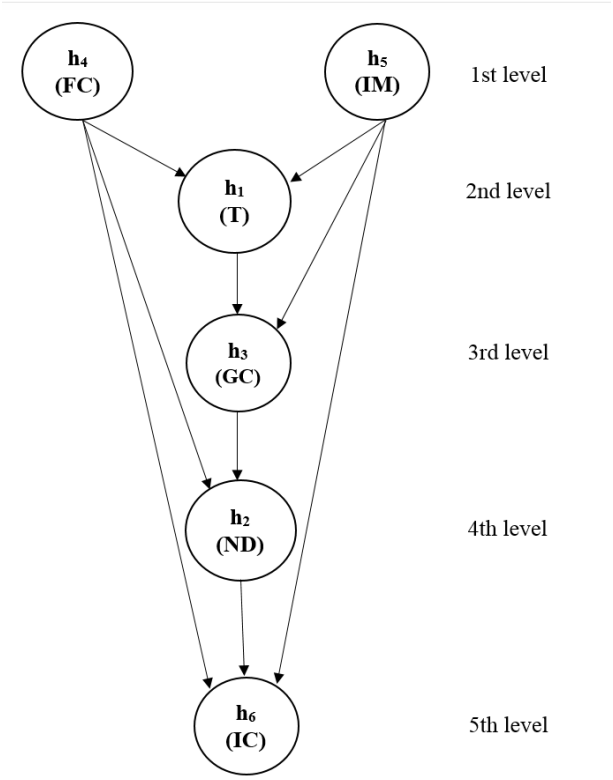


Figure 15: An optimized model of factors of infographics compositional design with elements of visual communication

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