personified multifunctional network device that has a wide range of applications, video cameras, cameras, allows you to connect with all devices on the Internet, with other people.

The higher the economic growth rate, the faster the number of smartphones increases. Currently, China's economy has reached the first place in the world in terms of growth rates, accordingly, China ranks first in the world in terms of the number of smartphone owners. In second place is the US economy – the US ranks second in the number of smartphone owners.

Cloud technologies allow processing large arrays of unsystematized information, systematizing it. It certainly makes marketing decisions easier. Therefore, the costs of implementing cloud services are increasing in the world. Currently, 60 % of the information collected in the world is stored in the cloud. National programs for the development of cloud services have been adopted in the USA and EU countries: in the USA – "Federal Strategy for Cloud Computing"; in the EU – "Unlocking the potential of cloud computing in Europe" (2,5 million additional jobs, 160 billion euros in annual additional income).

Business analytics on the basis of digital technologies changes the traditional, time-stretched scheme of analytical work: information was collected for a certain time, and then analyzed. Nowadays, automatic network analysis of the flow of undocumented data, directly or indirectly related to the enterprise, is important. Business analytics tools are: business analytics platforms (business intelligence, BI), performance management tools (corporate performance management, CPM), advanced analytical applications. The largest specialized manufacturers are SAP and Microsoft.

Social media harmonize the cross-functional coordination of business units and communication with consumers and partners. The recent growth of social networks is due to two factors: the increase in the number of people who connect to the Internet through mobile phones, and the growth of the audience of social networks at the expense of people of older age groups.

Techniques have already been developed that allow you to influence the target audience even in an offline environment (phone applications, SMS/MMS, advertising displays on the streets). This is the latest type of marketing, which is based on the use of data in digital form and devices that process them (computers, phones, smartphones).

Digital marketing is broader than Internet marketing by:

1) new possibilities of mobile communication:

– text messages (SMS);

– automatic voice menu (IVR);

– multimedia messages (MMS);

– local radio communication between communication devices (Bluetooth);

– wireless data transfer protocol (WAP);

– mobicod – a combination of numbers that makes it possible to make payments or receive discounts;

– QR-code – a picture on printed products, which allows a quick transition to the virtual environment;

– technologies Click To, Flash SMS, Location Based Services (LBS) – technologies for convenient downloading of software products;

2) new possibilities of television:

– technology of augmented reality in mobile devices (AR) – technology of reproduction of virtual elements in reality;

3) new possibilities of interactive mobile screens:

– 3D-projections (3D-mapping) – the technology of projecting an image onto an object in the environment;

4) new possibilities of POS terminals, video cameras:

– biometric technologies – the technology of automated identification of consumers based on physiological (fingerprints, facial recognition, DNA, iris pattern, palm or ear shape, smell) or behavioral (handwriting or keyboard handwriting, voice) characteristics.

5) new e-mail features:

– sending electronic advertising messages in the form of SMS to mobile devices, i.e. telephone marketing is combined with postal mailing.

Advantages of digital marketing using mobile technologies:

– interactivity – active involvement of the consumer in interaction with the brand;

– absence of territorial restrictions during the implementation of marketing ideas;

– ease of access to the resource (web and wap resources);

– significant spread of the Internet and mobile communication ensures active involvement of the target audience;

– the ability to quickly evaluate campaign activities and manage events in real time.

Mobile marketing is divided into:

1. ***Pull-form:*** the consumer independently selects the information he needs, the platform (content) and turns to the brand himself. In this case, the audience uses what is offered to them.

2. ***Push-form (pushing):*** the consumer, regardless of his desire, receives information (SMS, SPAM, etc.). This form has a significant drawback – the information obtained in this way is often not paid enough attention, and therefore such efforts are sometimes useless. Sometimes the consumer is forced to download a mobile application to receive the offline services he needs, such as a taxi quote.

In order to develop a reliable and effective digital strategy in modern conditions, it is necessary to understand the new, more complex path of the buyer, which includes a wide range of forms of online presence, accordingly, three main types of media channels should be distinguished: paid (paid), owned (owned) and earned / purchased (earned) media channels. Let's consider the key differences between media channels and the impact of each of them on the development of

mobile applications.

Paid media channels are communication with the user, in which funds are purposefully invested. The channel expands the reach of the advertising campaign and increases brand recognition with the help of media advertising, advertising through bloggers, affiliate marketing, conversions as a result of search marketing optimization or other tools: video advertising, display advertising, native advertising, special. projects, promotions The Paid Media audience is Internet users who have not heard of the company before, but are potentially interested in the product. Paid media channels are designed for large-scale Internet campaigns aimed at increasing brand awareness and conversion. In this case, corporate mobile technologies are used, which help to form the principles of flexible project management within the team. In addition, Paid Media clients can be members of a closed user club of one of the companies. A significant advantage is the ability to measure key performance indicators and marketing metrics that reflect the ratio of spent funds and efforts. These are catalysts that react with the company's resources and lead to the formation of Earned Media.

Earned Media – earned media channels that form a recognizable, honest and reliable brand image. This is the result of planned and implemented activities in Paid Media and Owned Media. The audience is attracted through the complex actions of users and media towards the brand, including editorials, comments and publications on the Internet, discussions on Internet platforms, likes and comments. This is advertising generated by the brand's audience: online reviews, content distribution, and word of mouth. Earned Media audiences are users targeted by an advertising campaign and those already engaged through paid and organic online channels. It also includes fans of the brand, their friends and followers. Now, earned media also includes discussion that can be driven through viral and social media marketing.

Owned Media – own media channels that are created and controlled directly by the business owner. There are the following platforms for posting brand

content: product website, social media pages, company blog, YouTube channel, email, mobile apps, retail stores, print ads. The audience of Owned Media is regular, new and potential customers. The conversion of users into customers through paid media depends on the quality and relevance of the company's content. Owned Media is a push to encourage customers to use mobile software in their daily activities. US scientists found that in developed countries more than 80 % of the population uses the mobile interface for almost 8 hours a day.

In some situations, the own channels of some companies become paid media for others – for example, when an online or virtual store implements advertising spaces in its mobile application. The expansion of the spectrum of media formats reflects fundamental changes in the perception and understanding of advertising messages by consumers. In this regard, there is a need for thorough research and expansion of the "paid, owned, earned" media mix model, since in modern conditions the concept of paid, owned and earned channels is not sufficiently developed and comprehensive. How, for example, should a marketer respond to offers to purchase advertising spaces on sites dedicated to other companies' products? What measures should be taken to mitigate the consequences caused by the actions of web agitators spreading a negative opinion about a product or an advertising campaign? Obviously,

Thus, sold media channels mean own resources, the traffic of which is large enough for other organizations to be interested in posting information and using e-commerce mechanisms. This trend, which is still only developing, has already proven its effectiveness on the example of retail trade and tourist services (airlines and hotels), so it will undoubtedly continue to gain momentum in the future. Johnson & Johnson, for example, offered a completely independent media project, BabyCenter, which advertises not only ancillary products, but also competitors' products. In addition to income, third-party companies bring elements of objectivity to the site, help increase traffic for the benefit of all interested parties. In this case, mobile applications for choosing and ordering children's cosmetics

from several companies will be a very effective marketing campaign.

On the one hand, mobile innovations have opened up additional (and more diverse) communication opportunities for marketers. On the other hand, they increased the risk that the reaction of dissatisfied consumers could be immediate and public. So, a stolen media channel is the exact opposite of an earned one, as the results of an advertising campaign are controlled by consumers, shareholders or activists who speak negatively about a brand or product. Participants of social networks have already mastered the hijacking of media channels in order to put pressure on the owners of advertising materials. Among the loudest examples are Domino Pizza with a humorous video posted on YouTube where two employees dirty sandwiches, Red Bull (drift on Sofiivska Square).

In each case, active consumers tried to convince others to boycott certain products, putting the company's reputation at risk. In such situations, the reaction of the brand owner is often not quick or thoughtful enough. Since different types of advertising are interconnected and interdependent, marketing plans and resources must be adapted to new realities and take into account all five types of media resources. This approach has a synergistic effect and comprehensively solves the client's media tasks.

Questions for self-control:

1. What are biometric technologies?
2. What types of cloud technologies exist?
3. What is the process of digitization in the interaction of different groups of respondents?
4. What is remarketing?
5. What is mobile marketing?
6. Name the principles of branding when creating mobile applications.

6.2. Strategy and audit of the use of mobile applications

The mobile application development strategy is inextricably linked with the overall business strategy, as it is a set of planned actions to achieve the company's business goals. Implement the strategy according to the established schedule using the most appropriate online channels to increase revenue, increase company awareness and improve relations with the audience. The company cannot limit itself only to the use of mobile applications and must activate social networks and website operation.

The mobile application development strategy is a content plan for achieving the company's goals with the help of mobile technologies. The purpose of the strategy is the process of identifying, formulating and implementing digital opportunities that will give the organization competitive advantages.

Digital marketing includes the main areas: content marketing, email marketing, search engine marketing (SEM), search engine optimization (SEO), contextual advertising, marketing in social networks, partner marketing. The goal of a mobile application development strategy is to combine all these elements into one plan, allowing you to save time, money and effort.

The need to develop a strategy for the development of mobile applications is:

– in the opportunity to receive more information;

– in establishing direct contact with the audience;

– increasing sales and customer loyalty while simultaneously reducing costs thanks to the acquisition and analysis of new insights;

– obtaining real data and increasing flexibility in decision-making;

– structuring actions to achieve the company's overall strategy;

– increased ROI, increased return on investment;

– improving the customer experience and increasing the value of the product with the help of digital capabilities;

– creation of new easy-to-use sales channels with effective and inexpensive service at the same time.

Stages of creating mobile application development:

1. Determination of goals, taking into account the business goals of the company.

2. Defining the target audience.

3. Formation of a unique sales offer, mobile product ideas.

4. Analysis of technologies and tools, identification of external and internal digital tools and channels.

5. Creation of mobile application functionality and block chains.

6. Setting the general KPIs of the mobile application.

7. Monitoring and management.

8. Performance analysis, determination of performance indicators of each stage and overall strategy.

9. Control and adjustment.

The development of a content marketing strategy involves the use of the POST method (People, Objectives, Strategy, Technology). Individual elements of the method are listed in Table 6.1.

***Table 6.1* – Characteristics of POST method elements**

POST method	*Analysis of the target audience*
1	*2*
People	This stage determines which types of online activities consumers prefer, which functions of mobile applications are clear to them.
Objectives	Definition of clear goals. The company must have clearly defined goals for its future campaign for introducing a new mobile product to the market.
Strategy	Development of relations with consumers. To implement this stage of strategy development, first of all, you need to answer the following question: "How do you want to change your relationship with the client?". Define three main strategies that most modern companies tend to use in the field of customer relations: – listening: researching what customers are saying about the company's products or services. In this case, when creating mobile applications, it is necessary to provide for a feedback system; – expression: using social media to spread announcements, ideas and opinions to customers. Companies actively use chat groups and interactive platforms; – attracting customers to the business to achieve goals. This strategy allows consumers to be involved in the creation of ideas for new products, such as choosing the color of a laptop or designing clothes for a doll.

Continuation of Table 6.1

1	*2*
Technology	Selection of functional capabilities of mobile applications that will be understandable for ordinary consumers. It is necessary to conduct a thorough analysis of consumers regarding their literacy in the use of software. An example can be a social service mobile application for calculating pensions and social benefits. Not everyone over 60 has skills in using mobile smart devices. You should also pay attention to consumer preferences in using certain operating systems (Android, iOS).

When using mobile marketing, it is important to constantly monitor the main indicators characterizing the effectiveness of the actions performed. KRI (Key performance indicators) – a system of indicators of key performance metrics of mobile applications – which includes:

1. *Traffic:* the number of visitors, returns and hours of operation in the mobile application.

2. *Conversions:* the ratio of the number of unique views to the total number of actions performed (page views, clicks, link conversions, viewing time, viewing depth).

3. *Backlinks* (incoming links from other sites).

4. *Mention* (textual reference to the domain).

In addition, ROI (return on investment) indicator is used to determine profitability, which makes it possible to assess the return on costs of creating and distributing content valuable to the target audience (the ratio of the profit obtained as a result of certain actions to the costs of implementing actions is determined).

ROI is determined for profitability management, forecasting, and competitor analysis. To evaluate the effectiveness of investments in mobile marketing, several variations of the ROI formula are used: evaluation of sales according to individual conversion, evaluation of sales in terms of one-time leads, evaluation of advertising for traffic from social networks of the campaign. Also, the ROI calculation can include indicators reflecting the degree of interconnectedness of the company's social networks with involvement in the use of the mobile application.

In addition to measuring KPIs and ROI, software such as SAP can be used to determine the effectiveness of mobile marketing. Instead of tracking indicators for individual content units, within SAP, you can calculate the payback index of customer engagement in a mobile application. It shows the level of consumer engagement generated by a company's content in a specific category or market.

So, the key differences of mobile marketing from other elements of communications are the different marketing impact on consumers and the CRI of each element, i.e. indicators of determining the effectiveness of each tool of the mobile application. The obtained results deepen the applied aspects of digital marketing. Their practical use will make it possible to purposefully choose the most effective marketing measures in a specific market situation using the capabilities of the Internet.

A properly configured digital marketing system of the company is the main factor in the efficiency of business processes in companies and allows for comprehensive analysis of external and internal information and effective management decisions aimed at optimizing business processes and obtaining maximum profit.

Changes in consumer preferences and behavior, the intensity of competition in the markets, the development of new technologies and other factors force modern companies to make more prompt, aggressive and effective decisions. A marketing audit is an effective way of evaluating the effectiveness of marketing activities.

A marketing audit is a study of the micro- and macro- environment of the enterprise, its marketing goals and strategies, covering all the main areas of marketing activity. The company conducts an audit in the event that sales begin to fall and companies go through periods of crisis (P. Kotler, 2012). At the expense of the effectiveness of mobile applications, a marketing audit is conducted based on the comparison of sales results through an offline network, through its own website, social networks, and a mobile application.

Philip Kotler identified six areas of marketing audit:

1. Audit of the marketing environment: macro and micro environment.

2. Marketing strategy audit – business, marketing goals and objectives, strategy.

3. Audit of the marketing organization – organizational structure, functional efficiency, effectiveness of interaction.

4. Audit of marketing systems – marketing information system, marketing planning system, marketing control system, new product development system.

5. Audit of marketing products – analysis of profitability, analysis of cost effectiveness.

6. Audit of marketing functions – products, prices, distribution, advertising, sales promotion, product promotion, sales staff.

In modern marketing, a separate digital sphere is added, which includes the audit of social networks, marketplaces, the company's own sites and mobile applications. In this case, the analysis of the operation of mobile applications is carried out alongside the analysis of the operation of the entire digital marketing of the enterprise.

Reasons for conducting a marketing audit when working with mobile applications:

– changes in the company's product policy;

– the need to increase the volume of sales of goods through digital networks;

– price fluctuations on the market, the possibility of price comparison in mobile applications;

– formation of a basket of purchases and negative reviews of consumers;

– insufficient information about the behavior of consumers who downloaded the mobile application;

– insufficient information about the market, competitors;

– procurement planning and forecasting of financial results due to the introduction of a mobile application.

As a result of conducting a marketing audit, the company can receive answers to relevant pricing issues that will allow management to adjust pricing goals, develop or improve pricing strategies and methods of pricing based on customer requests and formed values, develop mechanisms for providing discounts, which will contribute to increasing the competitiveness of products.

Principles of marketing audit of mobile applications:

– *comprehensiveness* – coverage of all areas of marketing;

– *systematicity* – taking into account the factors of the external and internal environment, goals and strategy of the company;

– *regularity* – identifying problems and solving them in marketing activities at the stages of implementing the company's strategy;

– *periodicity* – development of plans for the implementation of the company's marketing strategy;

– *uniformity* – comparing the performance of mobile applications at the same time of the same product.

The digital marketing audit mechanism includes the following stages:

1. Determination of marketing goals and tasks of mobile applications: entering a new market, reaching a larger number of customers, informing society about the company's work, attracting a new market segment, increasing competitiveness, increasing the use of products among existing customers, improving the level of service, etc.

2. Digital understanding of the consumer, personalization of the consumer according to the main characteristics: geographical, demographic, behavioral, etc. Creation of a portrait of consumer behavior and a map of the consumer's journey, which will allow to specify the object of the marketing audit and make informed decisions regarding the achievement of the company's marketing goals.

3. Analysis of the competitive environment: identification of the company's main competitors (3–5 significant competitors in the industry), especially in the digital space, and research of the competitive environment using methods and

tools of Web analytics, which will allow assessing the company's weaknesses compared to competitors and opportunities for development.

4. Drawing up a road map of work during a marketing audit, i.e. conducting an inventory of all available intangible and tangible marketing assets.

5. Analysis of data obtained as part of a marketing audit.

6. Development of a work plan based on the results of a marketing audit and identification of responsible persons.

Therefore, the marketing audit, as a systematic, independent and periodic check of the external and internal marketing environments, goals, strategies and individual types of marketing activity, allows timely identification of "critical points" of such activity and weak points in the implementation of management decisions.

When conducting a company audit, it is very important to establish the level of customer satisfaction with goods and services. On this occasion, a portrait of the consumer is drawn up. A consumer portrait is a marketing tool that allows you to fully satisfy the needs of the target audience, which will contribute to effective communication with customers and business profitability.

Digital understanding of the audience is advisable:

– when developing an updated version of the mobile application;

– planning new company projects;

– simultaneous creation of groups in social networks, blogging, development of a YouTube channel;

– during media planning and targeting settings (determining the most effective communication channels and choosing the format of advertising campaigns);

– during the development of product design and packaging design;

– for conducting effective PR actions;

– to develop new markets and expand the client base.

A consumer portrait is a collective image of a buyer, consisting of certain

characteristics: demographic, social, behavioral, personal, and others. The more detailed and accurate this portrait is made, the more accurately the company's digital marketing will work. For him, they will form a list of desired products, current promotions, new products of the company, as well as offer additional services. Google, Facebook, etc. ads will be targeted at him.

Key characteristics of the consumer for the formation of a portrait (required information):

1. Credo (basic rules of life).

2. Demographics (gender, age, marital status, family size).

3. Geography (place of residence).

4. Lifestyle (education, language, status in society, level of income, average check).

5. Psychotype (type of thinking, tasks, goals, problems, pains, interests).

6. Behavior during purchase (motives, key selection criteria, objections, impulsivity, decision-making methods, product expectations, product fears and apprehensions, product knowledge).

7. Information consumption (groups, audience of social networks, desired type of content, etc.).

Sources of obtaining information about customers:

1. Web analytics systems (Google Analytics). Google Analytics in the "audience" tab provides insight into the following data of visitors to your own site and the mobile version:

– gender and age;

– interests;

– geography;

– devices and browser;

– keywords (not all information);

– the most visited pages, goods and services.

2. Statistical data of social network pages – Facebook, YouTube, Instagram

regarding the direct transition of customers to the mobile application. Facebook page statistics provide an understanding of how content is consumed by day and time of day (statistics / publications). Understanding audience interests can be taken from the Facebook Social Graph. The statistics of Instagram pages are very similar to those provided by Facebook and other social networks: gender, age, geography. YouTube statistics, in addition to standard things, provide an interesting opportunity to analyze the socio-demographic characteristics of individual videos.

3. Google Display Planner and Facebook Audience Insights advertising planners. Google Display Planner (or KMS Planner) is a tool that can be found in your Google AdWords advertising account. Data on the audience of any site can be obtained in a few clicks and receive the following information: gender, age, interests, devices.

Facebook Audience Insights (or Audience Statistics) – a tool for evaluating the audience on Facebook, which allows you to get information: gender, age, interests, marital status, level of education, position.

4. Polling the audience through a direct link in the mobile application: some things that can reveal the fears and expectations of the audience can be discovered with the help of a survey in the mobile version. At the same time, it is advisable to offer some kind of bonus for completing the survey.

To form a consumer portrait, it is advisable to take into account the theory of generations developed by the Nile Hove and William Strauss, which describes the cycles of generations:

1. The baby boomer generation is people born between 1943 and 1960, who pay much attention to spiritual values and choose traditional ways of communication. When choosing a product or service, baby boomers prefer rational consumption. Baby boomers are the first generation to grow up watching television, so television advertising will continue to appeal to these people, unlike future generations.

2. Generation X – people born from 1961 to 1981. They try to maintain a work-life balance and are willing to spend a lot more money on vacations. Generation X uses computers intensively, which has greatly influenced the way they buy goods, they are interested in digitalization of processes.

3. Millennials or Generation Y is a group of people born between 1982 and 2004. This is a generation of tech-savvy people who have been using cell phones and other devices from an early age. Mobile applications are an integral part of their lives.

4. Generation Z was born between 1997 and 2010–2012. Given that Gen Z grew up in an age of advanced technology, the marketing approach to them should be even more digital than to Gen Y. Marketing to Gen Z should focus on quality. When selling products through mobile versions, companies decided to influence the behavior of consumers of generation Z with the help of photos and videos.

5. Generation Alpha – born after 2010. The definition of the Alpha generation was given by the Australian sociologist Mark McCrindel. The Alpha generation will be the most technological and educated. The researcher also calls them the Glass Generation, emphasizing the fact that Instagram and the iPad appeared simultaneously with their birth in 2010. McCrindel also says that after 2025 it will be time for a new generation, and that will likely be the beta generation.

Applying a generational cycle approach to digital marketing is more difficult than it might seem at first glance. For example, choosing a millennial as a marketing audience solves several problems at once. You already have the age range and characteristics that determine consumer behavior. However, it is necessary to think over many more nuances – from transformations and archetypes to locations. This is a fairly basic overview of generational theory, but it can be a solid foundation for building a company's overall target audience, improving marketing strategies and seasonal campaigns for different age groups.

In order to personalize the consumer's profile, it is necessary to give him a

name. To visualize the portrait, give it a face that would be associated with the image, create a history of the relationship between the collective image of the client and the company, and allow him to feel, experience, experience difficulties.

For a more detailed analysis of audiences, create consumer mapping and an empathy map.

The Customer Journey Map is a marketing tool that visualizes the experience of interaction between the client and the company at all stages of the product sales funnel. CJM helps clarify such important questions as:

– where exactly do customers find information about products;

– in which places they find products: on the website, mobile application, store;

– how the audience reacts to the product;

– what is the age of the consumer segment;

– what objections arise on the way to making a purchase decision;

– how buyers react to the sales method;

– in which cases clients are maximally satisfied;

– when they feel frustrated.

All these points are entered in a table or graphs, then this information is analyzed, decisions are made about improvement and exclusion of negative points.

The empathy map is a marketing tool that allows you to put yourself in the customer's place and look at yourself and your product through his eyes. They help to collect and visualize detailed characteristics of the target audience: problems, pain points, values, achievements, motives, and so on. The empathy map complements the client portrait. A typical empathy map includes six elements: who is the customer; why the company is researching the client; what the client sees; what the client says; what the customer is doing; what the client feels. However, the main thing in modern marketing is the client's pain and expectations. In this regard, the mobile application provides a more thorough

response to the client's feelings. It is advisable to conduct a customer satisfaction analysis after all steps of the customer journey. So the information is the main one for the audit of the mobile application.

Questions for self-control:

1. What does a mobile app development strategy include?
2. Name the characteristics of the elements of the POST method.
3. What should a KPI scorecard for mobile applications include?
4. List the six areas of marketing audit according to Philip Kotler.
5. Name the principles of marketing audit of mobile applications.
6. What stages does the Digital Marketing Audit Mechanism include?
7. Name the main characteristics of the consumer to form a portrait.

6.3. Mobile versions of social platforms and the development of SMM

Mobile app marketing is the easiest way to reach a large audience. Currently, half of the world's population, 3,8 billion people, use social networks, and the use of mobile applications is growing every month. In June 2011, there were 250 thousand applications in the Google Play Store, and already in June 2021, there were 2,9 million of them. Social platforms are essential for increasing company brand awareness. According to data from Hootsuite, 52 % of online companies use social media. That's where most people recognize new brands.

According to Statista, in the first quarter of 2018, the population spent an average of 295,4 billion hours on social media and communication using mobile applications. In the fourth quarter of 2021, this indicator reached 411 billion hours. During this period, the population also spent 243,7 billion hours viewing photos and videos in mobile applications. Therefore, mobile applications open up great opportunities for attracting the target audience and building long-term

relationships. Statista made a forecast until 2026 regarding the use of mobile applications through the App Store and Google Play. In fact, in 2021, consumers spent $ 85 billion on mobile apps through the App Store and $ 45 billion on mobile apps through Google Play. It is predicted that in 2026, consumers will spend $ 161 billion on mobile apps through the App Store and $ 72 billion on mobile apps through Google Play. In total, consumers will spend more than $ 230 billion annually. This shows the relevance of using mobile applications in the company's marketing campaign in the coming years.

Marketing media and communications in mobile applications is a set of specific online marketing activities that influence the target audience through downloaded digital programs and are aimed at achieving the company's marketing goals.

The role of social media marketing in the development of mobile applications is significant:

– increase in sales;
– reduction of marketing costs;
– promotion of business partnership;
– increase in ranking in search engines;
– promotion of business development;
– promotion of traffic;
– attraction of potential customers;
– customer support and feedback;
– targeting capabilities;
– forming the loyalty of the target audience.

Most people cannot imagine their life without communication through mobile applications that speed up the time to receive feedback. Therefore, social networks and mobile applications are inextricably linked. The most popular social networks in the world have millions of users.

A social network is a network of people who meet in a digital space to

communicate by posting information and images, leaving comments or sending messages. Members can expand their personal and business contacts by contacting others at mobile versions of social networks.

Classification of social networks:

A. **By audience:**

1. Broad social networks accept all users, regardless of their origin. Facebook started as a network for students, but now it is the main network for friendship. Moreover, Facebook has communities and groups formed around brands and interests.

2. Niche social networks aim to connect people who come from a specific niche and have a common goal. For example, The-Dots is a community for creators who want to collaborate and share their skills.

Б. **By appointment:**

1. Informational social networks inform communities about news and events and solve everyday problems. These include discussion forums and consumer review social networks such as Yelp, Zomato, TripAdvisor and Reddit.

2. Educational social networks allow students to communicate. Some popular examples are Pinterest (to some extent) and ResearchGate.

3. Social dating networks are suitable for people who want to build relationships. Examples include Badoo, How About We and Tinder.

4. Multimedia and social content sharing networks allow users to share their unique content (articles, photos, etc.) through blogs and publications.

5. Social networks allow people to keep in touch with each other. Networks like Twitter and Facebook bring people together.

6. Work-based platforms include e-commerce platforms (TaskRabbit, Airbnb) and consumer review platforms (Zomato, Foursquare). People can search for information about brands, products and services and make purchases.

7. Shopping networks allow users to shop online.

B. By platform:

1. Web networks can only be accessed from desktop computers. Facebook, YouTube and Twitter – some of the most popular social networks today – started as web social networks.

2. Hybrid networks combine Internet and mobile capabilities and can be accessed from any device. They are optimized for mobile devices and have mobile apps for iOS and Android. Take Facebook and LinkedIn as examples. You can access these platforms from your laptop, PC, tablet and mobile phone.

3. Pure mobile networks are applications designed to run on mobile devices such as smartphones, tablets and smartwatches. Some popular examples include Telegram and Snapchat.

Building a marketing policy in social networks with the help of mobile applications is created at the expense of storytelling. Storytelling in digital marketing creates a new format for conveying information to the end customer. First, it delves deeply into the problem of society and reveals issues that are relevant for consumers. For example, the need to look at a problem from the other side, to discover new criteria and requirements for a product or service. Second. Convey timely and relevant information in a language understandable to the consumer. Thirdly, high-quality storytelling personalizes the appeal, and the consumer understands that the brand solves exactly his need (a story about safe headlights on bicycles for those who ride at night, big wheels on a baby carriage when off-road on city streets). Fourth, storytelling inspires new ideas and innovation for other businesses.

The main factors of the influence of storytelling on the brand [40]:

1. Storytelling creates neural connections. The received information affects the work of the brain in such a way that it creates an opportunity for a person to make parallel connections with his own life and experience, that is, to apply the idea of storytelling to a personal situation.

2. Mirroring. The receiver of information not only perceives and processes such information, but also distributes and reflects it as a speaker.

3. Creates the production of dopamine – a substance that causes positive emotions, sensations and euphoria. With the help of this substance, the listener remembers information better and can reproduce it clearly.

4. Activity of the cerebral cortex. A good story that is memorable and evokes extraordinary feelings can touch the parts of the cortex responsible for emotions, mobility, and sensuality. A person can reproduce information with movements and gestures.

Due to the fact that different parts of the human brain are activated, effective storytelling should be accompanied by visual content. In the case of a story about the success of a brand or the implementation of a new idea in business life, graphs, diagrams and tables are widely used. Thus, an interesting business story should captivate and constantly attract attention, "be on the ear", as well as "transfer" the consumer into the reality of the hero of the story [41].

There are three rules for the effective use of graphs, drawings and diagrams in the creation of storytelling [42]:

1. Who. It is necessary to clearly identify and justify who is the main audience to whom the information will be presented. It is necessary to reveal the main key questions: what is the relationship of the audience to the brand? What motivates them to buy products? What can excite and disturb? The answers to these questions substantiate the special characteristics and behavior of the consumer. If the answers are given correctly, the story will help not only attract attention to itself, but also provide a solution to the problem that exists in the potential consumer.

2. What. The information must be clear, distinct and unambiguous. After reading or listening to a story, the consumer must understand what is relevant and necessary today. If in the case of cases, the solutions can be different, then storytelling should have a bright finale. This finale should directly correspond to the obligations and slogan that the author tried to convey. For example, if the story is about the dangers of plastic toys, the story should have an ending about what

could possibly happen when using or disposing of such a toy.

3. How. Visualization should be insightful. Information should confirm the story, not divert from reality. Block diagrams, drawings with stages will be useful for visualizing logical decision-making. To attract the attention of the audience, photos of situations, visualization of trends with the selection of individual elements will be relevant. Different colors and fonts are used to emphasize a separate important idea.

The usual storytelling mechanism is based on eight stages [43]:

1. Understand the importance of context.
2. Determine the appropriate graph type.
3. Recognize and eliminate clutter.
4. Direct the attention of the audience.
5. Think like a designer when visualizing data.
6. Use the power of storytelling to make your message resonate with your audience.
7. Practice storytelling at home and at work.
8. Make the closing content.

When creating a business history, there are well-known principles and approaches [44].

Classic storytelling. The reader or listener needs to be presented with the general rules that send him on the "customer journey". There are several models of story scenarios (heroes' journeys, the search for a guru, personal victory, etc.). The story has three main components: beginning, plot, ending. In such a story, it is clear who to love and who to hate. From the point of view of branding, the consumer receives frank "true" information. However, the story should not be boring, because the consumer must go his "way" to the end together with the main character of the story.

An authentic story. It is necessary to make the story truthful through belonging to a part of the community. Every woman pays attention to information

when it comes to diet products. Such a story highlights the problem of an individual woman, her life, her problems related to diet. This story model is favorable to the majority because most consumers see their relevance to the events being covered. They consider themselves part of such history.

Storytelling is not about sales. A story is not meant to sell a product, a story represents a brand. It conveys the most important information about ways to satisfy consumer needs. In the story, the consumer must find himself and a way to solve his problem.

Visualization. Each person perceives information differently: someone pays attention to colors, while someone, on the contrary, needs audio support. It is necessary to specifically imagine for yourself what the potential consumer reacts to (numbers, emotions, sounds, smells, etc.).

Conflict in history. The conflict in the story must be open and understandable to the consumer in order to arouse him to events and reactions (caring for children, protecting animals and plants, lack of resources). When the average person tells a story, they usually tell about themselves, mostly guided by experience, and not based on numbers. Information is better perceived not by dry numbers, but by empathy.

Accident. Despite all the existing rules of creating a story, an unexpected situation can not only attract attention, but also get ahead of competitors.

Time to create. One and the same story will be transmitted through social networks, channels, websites, etc. Therefore, it takes time to agree on the structure and form of information submission. When creating a story, it is necessary to plan time not only for creation, but also for the editing and design of the story.

The language of storytelling. It is necessary to use the “natural” language of consumers, that is, to communicate in the “language” of the consumer, to use phrases and quotations of consumers for a better perception of information.

Advantages of storytelling:

1. Consumer confidence. Consumers determine important criteria for

themselves according to the information provided in the story. Thanks to the advice, the consumer feels like an expert when choosing a specific product or service.

2. Transfer of personality. Social networks are an ideal place for bringing people together. Telling stories about your own brand brings the consumer closer to the brand, if they find their participation in the characters of the story or in the events covered in the story.

3. Memorization. Storytelling creates memorable appeals. A creative approach, a high-quality script and an interesting text leave the main appeal in the memory. The consumer will, if necessary, take the time to recall the story and find the information again.

4. Increase in sales volumes. With the manifestation of trust in the brand, a greater number of consumers become supporters and bearers of positive information about the brand.

5. Competitive positions of the brand. As the story spreads, more and more customers read it and become part of the story and thus the brand. This creates a competitive potential of the product and boosts sales.

6. Business expansion. Competitors read the stories and implement the ideas in their business.

7. Spreading experience. Involvement of customers and consumers in acquiring knowledge and general rules for choosing a specific product.

8. Increasing attention and establishing interest. A short story of success or innovation attracts attention, is remembered and spread among other contact groups.

9. Labor efficiency and involvement of specialists. When creating storytelling, photographers, models, video editors are involved, which makes them a team with a single goal.

Companies have actively started using the principles of viral marketing in mobile applications. According to the Cambridge dictionary, viral marketing is a

type of marketing activity in which information is distributed among people, in most cases through the Internet [45]. In general, viral marketing is a tool for spreading information at an increasing rate based on organic search or word of mouth [46]. In today's digital space, viral marketing is more common in mobile applications through the transmission of memes, holiday cards, gifs, individual avatars. In 2021, viral marketing in video format on the TikTok network is gaining momentum. The dissemination of information occurs according to the principle of progression: each person spreads information through several persons, thus creating a network for communication.

There are several types of viral marketing that marketers use to attract the attention of customers and consumers [47]:

1. Emotional. Consumers can react strongly to any informational link. Therefore, the purpose of this model of viral marketing is to evoke emotions of joy, happiness, pride, willingness to care, compassion, confusion, etc. Both tears and a smile can encourage a person to take active actions: share information, discuss it with loved ones, save it for later use, distribute it to the masses. For example, when selling shoes, negative emotions can be caused by videos with killed animals, the skin of which is used in production.

2. Incentive. Incentive viral marketing creates a reward for the active participation of its readers and viewers. The more a person encourages their contact audience to the brand, the more rewards they receive. For example, when offering a new range of pasta for children, every mother who shares a photo on Instagram of her child eating such pasta is offered the next package at a discount. Also, offering a reward for each subsequent customer is also considered by viral marketing. For example, bring a friend or relative to life insurance or home loan.

3. Engineering. Many viral marketing campaigns are well-planned and take into account the step-by-step involvement of consumers in the communication. The goal of engineering viral marketing is to gradually introduce a new brand into the consumer's life. For example, when selling dolls, the client will immediately

be offered to buy a basic set of elements and components so that the child has acquired superficial skills of playing with the doll. Next, the client will be offered to buy additional items (clothing, wardrobe item). After that, a mini-series or promo game with the main character Lyalko will be released on Internet channels with a link in the mobile application. After that, the child is encouraged to support other girls who do not have the opportunity to buy such clothes and to donate part of the purchased items to the created fund. Next to this, groups are created in the mobile application to support the doll: "fashionable hairstyles of the Doll".

4. Successful. Successful or unplanned viral marketing deals with an unexpected turn of events. With such a model, a brand can receive feedback after a certain period, or information can resonate with a potential audience of customers in a short time. Usually, this model of viral marketing is not planned, or expected, that some kind of advertising can potentially become an element of viral marketing. For example, setting up a photo zone and taking pictures near it can advertise the existing event even among those who did not attend it. At the same time, memes near the photo zone and incorrect photos can contribute to the negative spread of information about the brand.

5. Capricious. Whimsical viral marketing or gossip marketing should cause an explosion of emotions so that people try to spread information as quickly as possible among their contact audience, not only in the online space, but also in everyday life. The result of such a model of viral marketing can be that a person, without even seeing an information link, can become a full-fledged carrier of information.

John Berger, a famous American marketer, identifies six characteristics that make marketing viral [48]:

1. *Social currency:* we share viral ads because it makes us look good.
2. *Triggers:* we share this because it matters.
3. *Emotions:* we share them because they make us feel something.
4. *Publicity:* we share this to imitate what others are doing.

5. *Practical value:* we share this if it is useful to others.

6. *Stories:* we share this to tell a story.

Common characteristics that make viral marketing effective [48]:

– strategic planning of information dissemination stages;

– audience engagement and active actions of potential consumers;

– the spectacle in social networks and the involvement of the press in the discussion;

– use of humor and other positive emotions;

– value for consumers;

– attracting stars and opinion leaders;

– low barrier to penetration into information networks;

– promoting distribution among the audience;

– exclusivity and novelty of information;

– propagation speed.

Not every advertisement can become a part of viral marketing. Audience interest and engagement makes marketing viral [49]. Gamification engages customers through winning a prize at the end. The rooks try to collect as many bonuses as possible in order to receive the declared prize. Involving the press in a marketing event potentially increases the audience of people who will be interested in using the product. Resonant events are covered by well-known Internet bloggers. The interactivity that can be created in a viral ad encourages consumers to be a part of a uniquely created performance. In this case, an engaged target audience potentially increases brand recognition. Advertising companies actively practice the use of targeted marketing elements when creating a viral appeal, which makes it more personable. For example: “Hello guy”, “Dear lady”.

A strong factor in the success of viral marketing in mobile versions of sites is the involvement of famous people who automatically spread such an appeal among their audience. In this case, the main thing for viral marketing is to choose a star that has a group of fans that is relevant to the target audience of the brand.

Another tool of effective viral marketing is consumer activity when creating a new product or changing technology. In the mobile application, consumers are invited to take part in a discussion, questionnaire or focus group with the aim of creating a new taste of the product or a new design. Humor and positive emotions also play an important role in viral appeal. Consumers are already saturated with television products that highlight world issues. Moreover, they do not have time to spend on long entertainment programs.

In general, there are 6 rules of effective viral marketing in mobile versions [50]:

1. Create an appeal with an emotional undertone.
2. Make it shared.
3. Choose the perfect time.
4. Create uniqueness.
5. Radiate authenticity and reality.

While most people think of viral advertising as random, at the same time, viral marketing is a well-formed, strategic brand campaign based on careful research into consumer behavior and preferences. Marketers use 5 basic techniques to make an ad go viral [51]:

1. Get attention quickly. Consumers spend a lot of time on social networks, scrolling through information in search of interesting and useful information. In this case, it is necessary to create a text appeal that will evoke emotions, or use an image that could stop the consumer's gaze.

2. Engage your audience. The virality of advertising is based precisely on the active participation of the audience and the dissemination of information through potential consumers. The appeal should contain a call to action.

3. Evoke emotions. Each person has his own emotional mood when viewing an advertisement. Mundane, boring information is rarely remembered and remembered among consumers. With the manifestation of strong positive or negative emotions, there is a high probability that the information received at this

time will be remembered for a long time. Before publishing the appeal, it is necessary to re-read it and determine which part of the appeal attracts attention and is more memorable.

4. Create simple appeals. The simpler the text form, the more it is remembered, used in everyday life, and transmitted between listeners. Using two or more references can distract the audience from the main idea, or the idea can be distorted. What's more, short audible statements better match the beat of the music, which makes it possible to use audio alongside text and graphics. You should also pay attention to short appeals in social networks, and do not clutter it with hashtags and links to other contacts.

5. Set goals. The goal itself should be the basis of a viral appeal and should not focus on itself. The title of the appeal should reveal the purpose of viral advertising, and at the same time attract action. Moreover, all specialists involved in the work (photographers, models, text writers, video editors) must clearly understand the goals and desired result of viral marketing. The results should have a unit of measurement so that it is clear which KPIs have been achieved.

The main KPI today is recognized as the viral hit rate (formula 6.1) [52]:

$$V_i = \frac{(C \times R \times CR)}{100}, \qquad 6.1$$

where C – number of clients;

R – average number of referrals (distribution) per client;

CR – the average conversion rate of referrals (distributions).

Advantages of viral marketing:

1. Low costs. Spending is limited to creating a video or visual story that customers want and want to share.

2. Reach. Can reach more widely than planned and expected.

3. Speed. A network of thought leaders spreads information faster than conventional visual forms of communication.

4. Trust. The transfer of information creates a credit of trust among customers due to the provision of feedback and recommendations. Viral

marketing improves brand reputation through the opinions of its followers.

5. Discussion in the crowd. Information is usually shared among close people: relatives, friends, colleagues. Each medium can transmit messages to more than 10 people at the same time. Thus, the dissemination of information occurs according to an arithmetic progression.

6. Creativity. Viral information is remembered better than ordinary advertising and remains in memory longer. Thanks to creativity, consumers pay attention to the problem from the other side.

7. Innovativeness. Viral marketing helps spread the value and innovation of a product by attracting fans and consumers.

Questions for self-control:

1. Define the role of social media marketing in mobile application development.
2. Describe the classification of social networks.
3. Name three rules for the effective use of graphs, pictures and diagrams in the creation of a story.
4. What are the known principles and approaches when creating a business story?
5. What types of viral marketing do marketers use to gain the attention of customers and consumers?
6. What methods do marketers use to make an ad go viral?
7. Name the Advantages of Viral Marketing.

6.4. Principles of branding when creating mobile applications

Brands, as symbols of today's consumer culture, are becoming an important means of demonstrating identity, markers of social space, and a "mirror" of social

reality. The importance of brands and branding in this approach is particularly important. The analysis of brand advantages provides new opportunities for studying the dynamics and transformational changes in modern society.

It is necessary to distinguish between two concepts that are often used by representatives of Ukrainian enterprises, and sometimes in translation in professional literature, are perceived as identical: trademark and brand. In short, a trade mark is more of a legal term that indicates a company's ownership of a certain name, emblem, design, etc.

A brand is a differentiated trademark, i.e. a brand that is associated with certain advantages or benefits in the consumer's mind, clearly differs from competitors' brands and is characterized by a high level of consumer loyalty. In short, a brand is something that resides in the consumer's mind. The false identity of these concepts leads to the fact that Ukrainian manufacturers often mechanically, without proper marketing support, giving brand names to products of their own production believe that they have introduced a new brand to the market.

So, any brand is a trademark, but not every trademark is a brand. A trademark becomes a brand only when the relationship between the product and the buyer acquires permanent psychological ties. The transformation of a mark into a brand is possible if the product has a unique selling proposition (USP). The main role in the implementation of the branding mechanism, even in the mobile application, is played by advertising, creating and broadcasting informative and visual messages about the product to the target audience within the general strategy of promoting the brand. Now the struggle of corporations comes down to the positioning of their products, and brand perception is mostly emotional, given that most products are technologically the same with similar consumer properties.

In this standardized atmosphere, the phenomenon of anti-branding emerges. This is the rejection of the existing brand at the level of the consumer's consciousness, the change of the brand to its antithesis – something that cannot

be bought, which indicates the absence of consumer qualities declared by the brand; it is the destruction of the positive image of the product or the campaign in general and, finally, questioning the reputation of the brand of the campaign. Passive opposition to branding occurs in every consumer, because consumers do not see the need for this product, do not make significant claims to the product, because it is a product of everyday demand or people already have a similar product. When working with a brand in mobile applications, in this case, a situation occurs when the consumer does not immediately pay attention to the application, does not view the news, and then deletes the application altogether.

But the consumer quickly gets used to brands and avatars of mobile applications. Certain niches for different concepts and categories have formed in human consciousness. Protecting itself from the huge flow of information, the brain filters out most of it. The same applies to the advertising flow: consumers have already grouped products and brands according to certain sectors in their minds, accordingly, the brand that won the first place is perceived as UTP. The majority of companies occupy the 2nd and 3rd places in the specified niches of consciousness. In nine cases out of ten, an attack on the leader from the outside will not be successful, because anti-branding of the new product is taking place at the level of the consumer's consciousness. The way out is provoking new, non-standard marketing creative solutions to create new niches of non-standard perception of brands in the mind.

In the modern conditions of development of mobile applications and their competition between them for free space in the phone's memory, the brand must be recognizable, but at the same time not catch the eye. It should be like air – imperceptible, but vitally necessary with a minimalistic and concise identity. A single phrase, logo, color are used in different contexts, on different information channels.

Digital branding is based, as defined by the Digital Branding Institute, on the development of an individual or organizational identity, visible and authoritative

in society, which interacts with business on the Internet or with the help of other digital media. Such a concept makes digital branding important for own construction and creation of brand history, as well as presence in the digital world.

Digital branding involves a fully digital media influence strategy that goes beyond standard online tactics, as is often seen with internet branding, which is labeled as posting daily tweets, promotional messages, or emails. In mobile app branding, the company's logo or symbol, as used when downloaded and displayed on the phone, is extremely influential. In digital branding, the brand is considered from the standpoint of digital communication and its role in business strategy and media planning. It is determined that digital channels and assets are used to communicate brand positioning (or purpose) within the brand's multichannel engagement programs.

Thus, there is a change in the paradigm of investing in business development, which is transformed from the classic design: "company – consumers – product – brand" to a modern design that determines the primacy of the brand and the priority of consumers of the brand itself: "brand – consumers – product – company". So the chain starts with the brand and its digital story. Building a digital brand story focuses on creating a common brand myth, and the specifics of modern branding is to create your own digital story. The digital story defines the time when the brand moved to direct personal communication with the customer and shows when the brand began to transform from the object of the relationship to the subject of the relationship. That is, the brand in the digital branding system acquires certain human traits.

The set of trends of the "new economy" – the globalization of the market space, the introduction of innovative developments, new technologies of marketing and brand management, the strengthening of the role of the consumer, the emergence of new types of services, professional platforms for interaction and communities, interactive mobile applications – leads to the need to develop a new model of brand management. A. Kearney proves that traditional brand attributes

are less effective than a positive online consumer experience. The focus of the company's activities should be aimed at attracting new consumers to use applications on a daily basis, meeting the needs of these consumers, retaining them, and establishing long-term relationships with consumers through interactive interaction. The scientist offers an i-brand model with such components ("7C").

Convenience – a component that provides for the creation of a system of working with a mobile application that is as comfortable as possible for the user, as well as the ability to perform operations at any time of the day and easy search for information. Fast app loading and easy navigation are the most significant factors in building brand loyalty. E-loyalty is a system of indicators such as quality support, timely and free delivery, customer incentives, privacy and security.

Content reflects the reliability and completeness of information that meets the interests of consumers in the mobile version. According to research, 79 % of site visitors do not read, but "scan" the page in search of easy-to-understand information.

Unfortunately, the content of messages, the content of mobile applications is often not harmonized with the image of the company, its brands; the information content does not meet the principles of necessity and sufficiency, visibility and interactivity of the presentation; not the target audience's requests, but search robots' requests are satisfied.

Customization as a component of Internet branding provides the possibility of choosing personal settings of the mobile version in accordance with consumer tastes.

Connectivity (interaction, connection) involves the interaction of sites and mobile applications with each other and the connection of consumers, for example, through the placement of links in search engines, portals, social networks and popular sites, where the presence of the target audience is possible.

Customer care – consumer care, as a component of Internet branding,

involves providing all kinds of assistance to consumers online at all stages of contact with the brand. In mobile applications, various forms and methods are used for this purpose – electronic notification, online payment, delivery registration and other additional functions.

Communication ensures the construction of a dialogue with users with the help of bots, coordination of discussion in chats and forums, and by conducting online surveys.

Community involves the creation of a contextual space for user communication in the form of "interest clubs", forums, chats, etc.

A brand community is a set of people interested in maintaining emotional or rational contacts with a brand. The basis of the brand community is the customers who are loyal to the brand, as well as strategic partners and investors.

Researchers T. Andrew Young, Dan D. Kim, V. Dalwani, Trai K. Wee emphasize the need for one more component in the classic 7C model – collaboration. Scientist R. Cleland emphasizes the rapid dynamics of brand development, which requires a review of traditional strategies, tools and the search for new formats of activity, including an interactive approach to attracting customers and increasing loyalty (Table 6.2).

***Table 6.2* – Review of traditional strategies, tools and the search for new formats of activity, including an interactive approach to attracting customers**

Traditional approach	Interactive ("one-to-one") approach
Monologue	Dialogue
Public	Private
Mass	Individual
Anonymous	Named
Competition	Collaboration
The focus is on one-time transactions	Focus on long-term relationships
Remote studies	Personal sources of studying consumer behavior
Manipulative approach – "stimulus-reaction"	The service approach is driven by real needs
Standardized	Non-standard

The scientist offers an interactive model of brand-building in the Internet

environment, which consists of five stages: attraction (Attraction), engagement (Engage), retention (Retain), study (Learn) and connection (Relate).

Particular attention is directed to clarifying the specifics of communication interaction at the following levels:

– linear interaction or lack of interactivity, when the sent message is not related to the previous ones;

– reactive interaction, when the message is related to only one previous message;

– multiple or dialogic interaction, when the message is related to many previous messages and the relationships between them;

– interactive interaction, when the message is part of an information exchange in real time and is related to the context of other exchanges.

The directionality of actions of the communication process, which is characteristic of the offline environment, is vertical and limited by configurations: "from one to one", "from one to many", "from many to one". Therefore, traditional marketing communications implement a model of pushing information to consumers who play a passive role and have a rather limited choice of information channels, the mediation of which is mandatory. They are linear in nature and the flow scenario is "one to many"). Media receive revenue from advertisers, companies have access to media consumers, and consumers have access to relevant information.

The Internet facilitates non-linear free-flow communication and information exchange based on the many-to-many principle, which automatically includes both one-to-one and one-to-many models. That is, the basis of marketing communications on the Internet is the pull model, which assumes the active role of consumers, immediacy and interactivity of contacts. Information is provided upon request.

In today's conditions, it is necessary to emphasize the importance of attracting consumers through advertising, word-of-mouth technology, placing

links on partner sites, using cookie data, which help establish the habits and interests of each individual user by analyzing his profile, which contains data about viewed sites, searches, purchases in online stores, etc. Some companies collect "router" information, IP addresses and various environmental parameters for internal use, for example, to improve the security of the mobile version and transactions on it, or to improve the use of this site. Online surveys using e-mail, special applications and web pages offer real opportunities to better understand the needs of customers and are characterized by flexibility, fast processing.

In the second half of the 2000s, there was a mass transition of citizens to social networks, and the public was divided into two categories: Internet networkers and TV viewers, while the second category can understand events, but cannot discuss them, and the first one actively reacts to information and enters into a dialogue. Therefore, the focus of a large part of scientific research is the influence of user-generated content (UGC) and electronic word-of-mouth (eWOM) on brand equity, loyalty and purchase intention.

An effective mobile app strategy requires the balance and interdependence of company-generated content (FCC) and user-generated new media content (UGC) and the impact on brand equity (BE), brand attachment (BA) and purchase intent (PI). Branded content is the creation of content that is fully controlled by the company, driven by the agenda of the marketing strategy.

In Internet communities, the evolution of WOM theory is analyzed and four different communication strategies are proposed in social media (analysis, outreach, endorsement, and clarification). Each of which depends on the narrative nature of the narrator, the norms of the virtual community, the communication format (blogs, Facebook, Twitter, etc.) and the marketing elements of the promotion.

The effectiveness of brands of mobile applications and mobile versions of social networks can be determined through psychological determinants, under the influence of which the consumer begins to independently spread information

about the online brand: the strength of ties between community members; homophily; trust; interpersonal influence.

There is a model of online consumer behavior when interacting with a brand. Watching a video on YouTube, discussing a brand on Twitter and uploading brand-themed photos to Facebook, sharing, commenting on posts, and finally downloading a new application to a mobile device are all examples of consumers' online brand related activities (COBRAs).

Within this concept, scientists have clustered a wide range of behavioral characteristics (consumer – consumer; consumer – brand), integrating all concepts describing synchronized online behavioral phenomena. For example, electronic word-of-mouth (eWOM) is associated primarily with consumer-to-consumer brand relationships. The term user-generated content (UGC) is used in the Western literature mainly for data created and uploaded mostly by users rather than companies. In addition, the COBRA concept includes the typology of consumer behavior in the virtual environment, presented in the work of D. Hoffmann and T. Novak.

The spread of digital media makes it possible to visualize the brand through the implementation of the most creative ideas, while the cost of creating this visualization is much lower than creating traditional (classic) ones.

Visualization of a digital brand occurs through the use of professional photos, video shoots, commercials, infographics, gifs, reels. If some time later (roughly in the period 2000–2010) all digital channels fell under the single definition of Internet marketing, then starting in 2010 the identification of individual digital channels became more active, and this initiated the stage of rapid development of interactive mass media. Due to the development of TikTok in mobile applications, consumers pay more and more attention to reels. All this has further strengthened the importance of segmentation, targeting and positioning. And not so much socio-demographic characteristics as behavioral ones came to the fore. The growing importance of consumer analytics databases is becoming critical. This is

proven by Charles Duhigg in his work "The Power of Habit", where he thoroughly examines, how companies predict consumer habits and manipulate them based on the use of giant databases. The company identifies each client by its number and collects information accordingly.

Digital branding channels are gaining special importance. The advertiser's main goal is to find channels that lead to maximum two-way communication and improve the overall ROI for the brand. Determining which Internet media channels work best for business in general and for a digital brand in particular will allow you to effectively move your business forward. First of all, media advertising is of great importance. This channel includes designing graphic advertisements and placing them alongside content on the digital brand's own or company's websites, email messages and other digital media, as well as instant messaging applications. By participating in Internet surfing, the client receives letters from the digital brand or links to various events related to the digital brand, in addition.

In recent years, social networks such as Facebook, MySpace, LinkedIn, blogs, microblogging sites, Twitter, forums, Wikis or open encyclopedias, content from communities such as Flickr and YouTube, as well as podcasts of all forms of social media have become particularly important. All these forms involve the creation of networks or communities that enable users to interact with each other. Social media tools encourage users to share ideas, participate in discussions and interact with other people in real time. Thus, social media can be the best means to position a digital brand or company and maintain contact with customers in a "non-stop" mode 24/7/365.

Typically, when great brand stories are told, it's almost always about the sales funnel and its contribution to creating a positive brand experience and laying the foundation for building lasting brand loyalty. If the brand is firmly integrated into the consumer's memory, a certain context of expectations is created. The brand becomes emotional and is already chosen even before the purchase itself is

made. In the classic "brand-consumer" design, there are many more elements among its components: the company itself, retail chains (and/or branded stores), sellers. The era of digital branding eliminates these intermediate elements and brings the brand to the direct level of interaction with its consumer, moving to the model of direct interaction "brand-client" (Fig. 6.1).

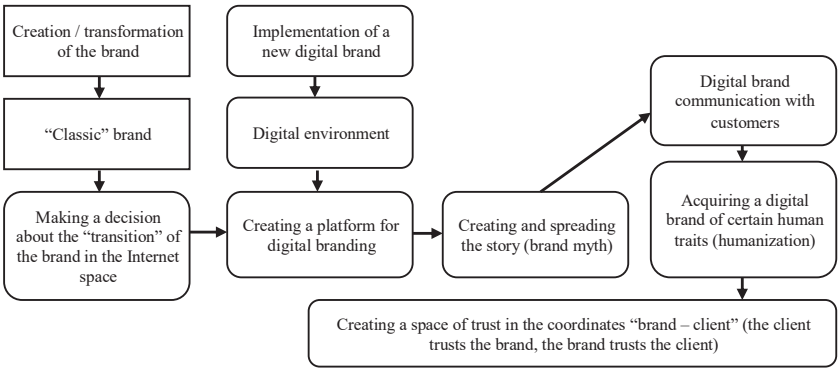

Fig. 6.1 – The process of building a digital history of digital brands

Timely delivery of the message is formed in real time and transmitted through Social Media. Thus, the conceptual principles of delivering brand appeal in the digital marketing system are much broader than identifying the nature of the brand. In this sense, the digital appeal itself requires that the interaction between the brand and the customer takes place in a "one-on-one" format and also in an appropriate emotional tone.

There are 4 digital components identified by D. Aaker that can play an important role in building a brand. In the consumer market, companies that are focused on digital marketing focus on so-called connective or connected brands through interaction points (so-called touch points) both in the online environment and in traditional means of information dissemination. In this sense, it is advisable to use a methodology that identifies opportunities specifically for the brand, which significantly increases relevance and memorability by the client, as well as optimizes the conversion rate and maximizes the company's income. It is digital capabilities that are becoming increasingly necessary for businesses looking to

build or expand their brands through branding programs. Digital branding is a powerful tool specifically for creating brands with many brand-building advantages, which are reproduced in Fig. 6.2.

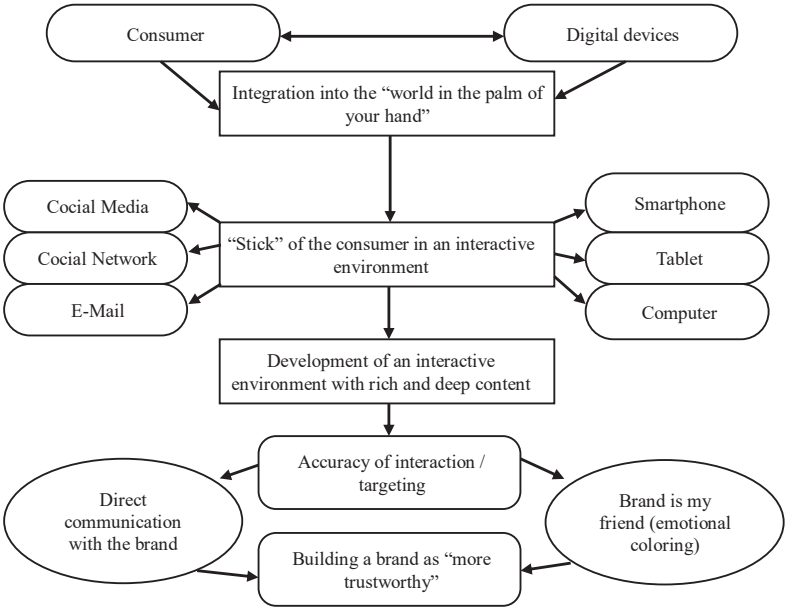

Fig. 6.2 – Advantages of using the Digital environment in creating brands

The creation of a digital brand should take place on the basis of a centralized media planning system, within which the media strategy and media tactics are determined, taking into account the fact that the construction and development of a digital brand takes place precisely in a mobile device. It is necessary to know: where the client is – in order to interact; how to stand out – to attract the attention of customers in the sea of Internet noise and spam; does the mobile app cause – to engage the consumer. However, it should be noted that the center of the brand's interaction with the consumer is the "voice" of the brand, which is formed by mixing the requests of the target audience and mass media.

The brand team creates the "voice" of the brand and speaks it to the target audience in general and to each individual customer. Therefore, the digital content

of the brand should collect as many impressions as possible. Usually, the consumer should get an answer to his question "why", why exactly the brand exists and what company values are inherent in it. At the point when the digital brand defines the "why", systemic and comprehensive marketing efforts and strategies of both the brand and the company itself can be integrated into digital branding.

R. Kay Green's research is interesting and thorough, where he specifies ways to implement maximum brand presence on the Internet and states that "an Internet brand is what people think of you when you are not available. Most customers today are technologically savvy and tend to rely on a company's online presence as a test of its credibility in the marketplace". Today's operations involve the ability to track all marketing efforts of both the brand and the business based on the use of new digital key performance indicators (KPIs) such as visibility, engagement, relationships, opportunities, sales. The effective development of a digital brand should contain the so-called "benchmark" points, which will determine the overall effectiveness of the promotion:

1. The relevance of digital brand'y is the main strategy of the firm reflected in the mobile application.

2. Creation and optimization of a mobile application (place in the digital environment).

3. Activation of social networks and other digital tools alongside the work of mobile applications (principles of search and communication with the client).

4. Improving and updating the quality of content (style and language of communication).

5. Press release (the main message about the company) on the main page of the mobile application.

6. Levers of communication (visualization, chats, blogging, chat bots).

Therefore, it is expedient to form a digital brand system based on "benchmark" points, which integrates the classical theory of branding, taking into

account the growing orientation of brands to promotion via the Internet. Due to the fact that for many goods or services the target audience is active users of the Internet in general and social networks in particular, it is necessary to actively integrate the work of all digital marketing technologies.

Questions for self-control:

1. Name the components of the i-brand model ("7C").
2. List traditional strategies, tools and search for new business formats, including an interactive approach to customer engagement.
3. Name the specific levels of communication interaction.
4. Name Modern Operations, which includes the ability to track all marketing efforts as a brand.
5. What should effective digital brand development contain?

6.5. Future mobile application tools

According to international marketing agencies, more than 30 % of the world's population uses voice search on the Internet. Most voice search users are under the age of 18. In 2020, the number of sales of smart speakers reached 150 million. Voice search takes much less time than text typing. Therefore, the number of voice search users will only increase in the future. 49 % of voice search users noted that they tried the same search method for the first time in the last six months, which corresponded to the first period of the lockdown. In the coming years, 50 % of searches will be conducted using voice technologies [53]. Voice search is an important tool for increasing mobile application users. A person tries to spend less time searching for information and getting goods, therefore trying to download and use the mobile version of the site. Moreover, mobile applications remember the client's past search results and reduce the time spent searching for

and choosing a product offer.

Search virtual assistants help not only find information, but also process it and offer additional solutions. For example, a consumer can find a washing machine in the mobile application of the market place by voice search, and the virtual assistant can additionally give advice on the peculiarities of washing different fabrics and the use of washing powders. There are search features for different virtual assistants, depending on the model of the mobile device (Table 6.3).

***Table 6.3* – Virtual assistants and their functions**

Virtual assistant	Devices	Functions	Benefits
Cortana	Windows, iOS, Android, Xbox OS	Creates a notebook, formulates requests and reminders	Cortana on mobile is capable of capturing notifications from the device and sending them to the Windows 10 device.
Siri	All Apple developments	Searches for any information, sends messages, sets reminders and appointments	Reformulates and narrows searches, if she does not understand, translates into different languages
Google Assistant	With any devices	Uses calendar information, controls music, creates timers and reminders	Provides privacy and security during voice search, controls a smart home
Amazon Alexa	With any devices	Searches for information, converts sound waves into text, plays music, live sports events	Allows you to control the TV/audio video system by voice, controls the smart home

Voice search is changing approaches to SEO on websites and mobile versions. Users request and search for information in different ways using voice and test search:

– a voice query is created in the form of questions, while a text query is created by a set of phrases. Therefore, when optimizing the search, it is necessary to take into account the question;

– in a voice search, a person uses more words to form an appeal, while a text search is limited to three to five words. This means that when optimizing,

keywords can be grouped into longer keyword phrases;

– voice and text search have geographic differences. Voice search is more about local search. A person is looking to find a local restaurant, children's entertainment center, shoe repair, etc.;

– a text search displays a list of pages that most closely match the keyword query. Only one link is displayed in voice search. Therefore, optimization and a set of keywords must be selected more carefully;

– in voice search, the consumer's speech and query may be slurred, inarticulate and quiet.

Today you can order Domino's pizza without entering the online store. You just need to make a voice order in the search. PayPal users can enlist Siri to send money to friends or family. Tide provides advice on removing stains caused by more than 200 different substances [54].

There are principles and approaches to managing voice search when using mobile applications [55–56].

Search principles are not based on optimization and efforts to be on the first search page. With the text search format, the first 10 messages that are more relevant to the search query appear on the first page. Only one link is provided in voice search.

During voice search, users use full sentences that consist of a large number of words. You can't limit yourself to phrases and abbreviated sentences. The search query should consist of frequently used, natural questions.

Voice search is local rather than national. When speaking a question, users are looking for the location or the possibility of choosing a product in the region. When creating a search, you need to focus on key issues related to brand localization.

Voice search is faster in the set, so users do not pay attention to the screen and the image on it. In this case, voice search requires higher quality search word content. Moreover, it is desirable to concentrate the main questions and their

answers in the FOQ section, which Google will automatically pull up in the search.

Influencer marketing is a type of marketing that uses opinion leaders and experts and brand promotion in the market. Unlike targeted marketing, in which the marketing tools are search optimization, influencer marketing invites influencers to spread the word about the product and give a positive expert opinion.

According to statistics, 9 out of 10 world-famous brands use influence marketing. 84 % of enterprises plan to develop and activate influence marketing strategy in the next year. For every dollar spent on a marketing campaign, the company receives $ 18 in revenue [57].

Influence marketing is used in the event that the company has lost contact with the client, it is necessary to form awareness about the brand, or there is a need to enter new markets.

Influencers can be not only screen stars or famous people in the country, but also ordinary bloggers or experts in the field, who have a potential influence on the consumer segment. In the case of clothing advertising, influencer marketing can involve a person of the same age and gender for whom the clothing is being offered. When selling milk and dairy products, an influencer can be a person who certifies products, deals with allergy treatment, etc. The main thing in choosing a person of influence is the scale of his audience and a quick channel of communication with it. For consumers, such a person is a reliable source of information. Influential people will convey the necessary information in a language that is natural for the audience.

Marketers use various types of cooperation with influencers when introducing mobile applications and their advertising [58]:

1. Paid posts. Such a post should contain relevant information for the consumer about the benefits of using the product.

2. Partnership in social networks. An influencer makes a post linking to a

mobile app and invites their followers to engage with that brand.

3. Known content. Influencers amplify and generate mobile app content through their social networks.

4. Customer reviews. Not all customers leave feedback after using a product or visiting an establishment. Influencers provide information about positive experiences so that potential consumers feel more confident in purchasing a product.

5. Brand ambassador. This is a person who for some time represents the interests of the brand and is an active user of the products. She provides advisory support to advocates who may be potential consumers of the product.

Famous persons participating in the organization of an influence campaign have their own income from participation. According to an analysis by *Influence.co*, the average price per post of a person with 1,000 followers is $ 83, and the price of a post of a person with an audience of 100,000 is $ 763. Bigcommerce names 4 reasons why influencer marketing will grow in the future:

1. More and more people are becoming influencers.

2. Influencer marketing agencies are growing in popularity.

3. The possibilities of content are increasing.

4. Influencers are more real.

Before developing a strategy of marketing influence, it is necessary to determine whether this type of communication is effective for the enterprise when creating a mobile application. To do this, it is necessary to justify the goals of the future strategy (increasing sales of a certain product for a certain period of time, generating more visitors to the website, increasing the number of mentions of the brand on the Internet, etc.). According to the conducted analysis, it is necessary to determine whether this industry, product, brand is popularized in social networks. It is also necessary to take into account the return on investment from influence marketing (average revenue per unit of cost of the post). Calculate the campaign budget and justify the expediency of its organization.

There is a mechanism for finding an influencer [59]:

1. Choose the app store that your customers use.

2. Create your brand presence in this store.

3. Enter search terms related to the benefits of a mobile app to find someone who posts about it.

4. Determine how many followers the influencer you plan to engage should have. The cost of the influencer marketing campaign will depend on this.

5. Calculate the budget and main KPIs.

6. Choose a few potential influencers for your company and establish contact.

7. Enter into a contract.

Individual branding is a company's marketing strategy in which each product has its own brand (mission, vision, appeal). Along with the existence of different classifications of branding, brands are divided into individual (each product has its own brand) and family (all products under one brand). There is a fundamental difference between them. The role of personal branding increases during the reduction of risks in the market. When it is impossible to support the entire range of products and all subsidiaries, the market remains more competitive.

Individual brand. The company uses a different philosophy, symbolism, appeal for each product. The uniqueness of the brand and its name emphasizes the value of the product and makes it possible to conquer the market as quickly as possible. If there are problems with one product, it does not affect the others in any way. Each of the brands can be aimed at a different market segment.

A family of brands. The company uses a single concept for the maximum possible product lines. Promotion of one product or assortment helps promote the entire brand. If a new product appears, it is offered to an existing customer under a brand name known to him. This creates an economic effect: the costs of promoting the brand are dispersed among all product lines.

Examples of personal (individual) branding are Nestle, Unilever and P&G.

All these companies take into account the peculiarities of the national market and create national brands. For example, Svitoch chocolate of the Lviv factory, which is part of the Nestle brand, is widely in demand in Ukraine.

However, in order to form an effective marketing campaign, it is necessary to know all the pros and cons of personal branding [60–62].

Advantages of using personal branding:

– the parent company will cover a larger market through different brands;

– the reputation of the parent brand will not suffer if one of the personal brands is uncompetitive on the market;

– a personal brand reduces the pressure of the corporate style of the parent brand;

– the ability to use different marketing strategies for different brands;

– companies can use different approaches to meet consumer needs;

– brands can produce products of lower quality without affecting the image of products of other brands;

– each brand can have its own distinctive corporate style;

– each personal brand will have its own consumer properties;

– products can be branded so that different products can cater to different target audiences;

– the ability to get several levels of customer loyalty.

Disadvantages of using personal branding:

– high level of risk within the parent brand;

– high costs of releasing a new brand to the market;

– it takes time to build customer loyalty;

– constant support of customer presence for each brand;

– the need to attract more specialists to support brands;

– customers do not always associate a personal brand as part of a well-known parent brand;

– different brands may compete internally;

– consumers do not always trust the quality of a personal brand, especially if it is new on the market;

– the presence of competition in the company due to the fact that employees who are involved in a more successful brand will be considered more professional.

To form a personal brand and implement it in the mobile version, the following requirements must be met [63]:

– availability of capital;

– involvement of specialists in brand creation;

– the possibility of using technological resources, innovations and ideas;

– the credit of the company's trust in the market;

– excellent marketing opportunities.

With the development of artificial intelligence, augmented reality, robotics, approaches to business development are changing. Marketing is becoming more customer-oriented and personalized. The main principles of modern communication channels are [64]:

– ***flexibility*** – social media and communication channels are constantly changing to keep your customers online. If the company will change its concept along with changes in digital channels, then it will have competitive advantages unique to it in the future;

– ***continuous learning and research*** – It is impossible to introduce innovations in your business, and it is also impossible to take into account modern approaches to the work of Internet networks in your business, if the company's specialists do not monitor changes in such processes. Staff must constantly, continuously learn and explore the digital market to meet the most relevant consumer demands;

– ***quality content*** – today, consumers pay attention to high-quality concise, short content that is divided into subsections, has an emphasis on key issues. The content can be not only text, but audio, video or graphic format;

– ***empathy and interest*** – in order to interest a consumer in a brand today,

you need to understand and feel his needs and pain. When an entrepreneur puts himself in the place of a consumer, he finds the most effective communication channels, which provides an opportunity to establish deeper business relationships.

In order to maintain relations after the purchase of products and inform about the brand in the future, attention will be paid to the following communication tools:

– creation of an individual brand;
– organization of interactive events;
– encouragement to communicate and share experiences;
– raising awareness through news content;
– creation of interaction with customers through live broadcasts;
– additional customer service, advice on using products;
– risk management;
– organization of entertainment events;
– consumer education.

Questions for self-control:

1. Describe virtual assistants and their functions.
2. Describe how voice search is changing approaches to SEO on websites and mobile versions.
3. How do users request and search for information in different ways using voice and test search?
4. Name 4 reasons why influencer marketing will evolve in the future.
5. Describe the influencer search mechanism.
6. Name the advantages of using personal branding.
7. Name the disadvantages of using personal branding.
8. What needs to be done to form a personal brand and implement it in the mobile version?

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UDC 004.056

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Chapter 7
METHODS OF INFORMATION PROTECTION OF ELECTRONIC DATA

Content

The constant development of information technologies makes adjustments to the life of a person as a member of a digital society. Using the digital world also requires new solutions for information protection. The use of cloud technologies, IoT systems, and blockchain technologies in everyday and professional activities require new knowledge and competencies from a modern specialist regarding the

protection of information and digital data in cyberspace in particular.

To prevent the leakage of information and counteract unauthorized access to it, in particular digital, to reduce damages from the disclosure of confidential information and loss of data, it is necessary to carefully choose measures and means of information protection and correctly use modern information technologies.

Let's first analyze the main terms for understanding information protection processes and further mastering the methods and technologies of digital data protection. It is also necessary to know the main legislative provisions in this area, organizational, software and technical, and other measures to protect information.

7.1. Basic concepts and definitions

The concept of "information" is used quite widely and is versatile today. It is difficult to find such a field of knowledge, wherever it is used. By the middle of the 20th century, information was interpreted as information transmitted by people orally, in writing, or in another way. After the appearance of electronic computing machines, the interpretation of the concept of "information" has changed somewhat. Information according to Shannon (entropy approach, American mathematician D.E. Shannon) began to be understood as a decrease in the degree of uncertainty of knowledge about any object, system, process, or phenomenon, as a change in the uncertainty of the state of the object, system, phenomenon, process itself [18].

At this time, a general scientific interpretation of the concept of "information" as changes in the volume and structure of knowledge of system perception appears. Here, the perceptual system is understood not only as of the person himself or his derivatives (collective, society), but also as any system, for example, a biological cell that is a carrier of genetic information.

According to ISO/IEC 27002:2022, “information” is property (or assets) that, like other important business assets, has value to the organization and therefore must be protected accordingly. Two types of assets are distinguished:

– *primary* (information, business processes, and activities);

– *auxiliary* (hardware, software, computer network, personnel, site, organizational structure) [10].

“Attack” means a successful or unsuccessful unauthorized attempt to destroy, modify, delete or gain access to an asset for disclosure, theft, or unauthorized use of assets.

Information is characterized by a life cycle, which can be represented by the following components (Fig. 7.1) [18]: obtaining information is the acquisition, acquisition, and accumulation by the current legislation of documented or publicly announced information by citizens, legal entities, or the state; information processing – the entire set of operations (collection, input, recording, conversion, reading, storage, destruction, registration) carried out with the help of technology and software tools, including exchange via data transmission channels; the use of information is the satisfaction of the information needs of citizens, legal entities, and the state; information storage means ensuring the proper state of information and its material carriers; destruction; updating – formation of information in the source of information.

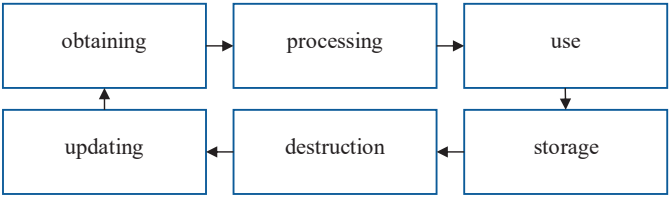

Fig. 7.1 – The life cycle of information

Together with the term “information” the term “data” is used. Data differ from the information in a specific form of presentation and is a certain subset, defined by the purpose and tasks of information collection and processing. For

example, data on employees of any organization in the form of formalized record cards of the personnel department contain only a certain list of the necessary information, in contrast to a huge amount of information characterizing each specific person.

Unstructured and structured forms of data presentation can be distinguished. Examples of unstructured forms are coherent text, graphic data in the form of photographs, drawings, and other unstructured images. Examples of structured data are questionnaires, tables, and graphic data in the form of drawings, schemes, and diagrams.

Information has always been, is, and will be the most important communication resource. The famous stock player Nathan Rothschild used to say: "He who owns information owns the world".

The main factors that increase its vulnerability are:

– increasing the amount of information that is accumulated, stored, and processed with the help of computers;

– concentration in databases of information of various purposes and belonging;

– expansion of the circle of users who have direct access to the resources of the computing system and data arrays;

– a complication of operating modes of technical means of computing systems;

– exchange of information in local and global networks, including over long distances.

Features of the information:

– immateriality (has no mass, energy, etc.);

– transmitted and stored on physical media (books, disks, external hard drives, flash drives, etc.);

– any material object contains information about itself or another object.

Information has the following properties [18]:

1. Information, if it is contained in a physical medium, is accessible to a person.

2. Information has value. The value of information is determined by the measure of its usefulness for the owner. Possession of valid (reliable) information gives its owner certain advantages. Information that distorts reality (unreliable information) can cause significant material and moral damage to the owner. If information is intentionally distorted, it is called disinformation.

3. The value of information changes over time. As a rule, the value of information decreases over time. Dependency is defined by the following expression (formula 7.1):

$$C(t) = C_0 e^{-\frac{2,3t}{t}} \quad , \qquad 7.1$$

where C_0– the value of the information at the time of its occurrence (acquisition);

t – the time from the moment of information generation to the moment of determining its value;

τ – the time from the moment of information creation to the moment of its aging.

4. Information is bought and sold. Information should be considered as a commodity that has a certain price. The price, as the value of information, is related to the usefulness of information for specific people, organizations, and states. Information may be valuable to its owner, but not valuable to others. In this case, information cannot be a commodity. Information can be obtained in three ways: conducting scientific research; purchasing information; illegal acquisition of information.

5. The difficulty of objective assessment of the amount of information. There are several approaches to measuring the amount of information:

– entropy approach (the amount of information is estimated by the decrease in the recipient's uncertainty (entropy) of choice or decrease in the expectation of events after obtaining information);

– thesaurus approach (proposed by Yu.A. Shrader). The thesaurus approach

is based on the understanding of information as knowledge. The amount of information obtained by a person from a message can be estimated by the degree of change in his knowledge);

– practical approach (in practice, the amount of information is measured by volume – pages, bits, bytes).

As a result of copying without changing the information parameters of the medium, the amount of information does not change, and the price is reduced.

By information security, we will understand the state of a certain system in which, on the one hand, it can resist the destabilizing action of external and internal information threats, and on the other hand, its functioning does not pose an information threat to the elements of the system itself and the external environment.

Information security – protection of information from factors that pose a threat to its confidentiality (disclosure), integrity (distortion), and availability.

Through **information protection**, we will understand the activity of preventing leakage of the protected information, and unauthorized intentional influences on the protected information. That is, information protection is a set of methods, means, organizational and technical measures, and legal norms to prevent harm to the interests of the owner of the information or IS and persons who use the information.

The main problems of information protection are:

1) prevention of leakage, theft, loss, distortion, and forgery of information;

2) prevention of threats to the security of the individual, society, and the state;

3) prevention of unauthorized actions to destroy, modify, twist, copy, or block information;

4) prevention of other forms of illegal interference in information resources and information systems; ensuring the legal regime of documented information as an object of ownership;

5) protection of the constitutional rights of citizens to preserve personal secrets and confidentiality of personal data contained in information systems;

6) preservation of state secrets, the confidentiality of documented information by legislation;

7) guarantee the rights of subjects in information processes and the development, production, and application of information systems, technologies, and means of their support.

System vulnerability is the inability of the system to resist the implementation of a certain threat or set of threats.

Protection defects are a set of reasons, conditions, and circumstances, the presence of which can lead to a violation of the normal functioning of the system or information security policy. For the most part, security defects are understood as features of the construction of software protection tools, which under certain circumstances cause their inability to resist threats and perform their functions. That is, protection defects are a special case of system vulnerability.

They are classified according to the relation of the threat source to the information system (IS) (external and internal threats), according to the type of threat source [18]:

a) *physical* – reflect physical actions on the system;

b) *logical* – means by which a person gets access to the logical information of the system;

c) *communication* – refer to the processes of data transmission over communication lines;

d) *humans* – are the most difficult to control and are directly related to physical and logical threats), to the extent of malicious intent (accidental and intentional), etc.

Intentional threats, in turn, can be divided into active (unauthorized modification of data or programs) and passive (unauthorized copying of data or programs).

It is interesting to classify information security threats according to the methods of their possible negative effect. This classification is supported by the vast majority of specialists in the field of information protection and provides for the division of threats into informational, software-mathematical, physical and organizational. **Informational threats** are implemented in the form of: violation of addressability and timeliness of information exchange; illegal collection and use of information; unauthorized access to information resources and their illegal use; theft of information resources from banks and databases; violation of information processing technology.

Software-mathematical threats are implemented in the form of:

1) introduction into hardware and software products of components implementing functions not described in the documentation for these products;

2) development and distribution of programs that disrupt the normal functioning of information systems or their information protection systems.

Physical threats are implemented in the form of:

– destruction, damage, radio-electronic suppression or destruction of means and systems of information processing, telecommunications, and communication;

– destruction, damage, destruction, or theft of a computer and other information carriers;

– theft of software or hardware keys and means of cryptographic protection of information;

– interception of information in technical communication channels and telecommunication systems;

– introduction of electronic devices for interception of information in technical means of communication and telecommunication systems, as well as on office premises;

– actions on password-key protection systems for means of information processing and transmission.

Organizational threats are implemented in the form of non-compliance

with the requirements of legislation in the information sphere; illegal purchase of imperfect or outdated information technologies means of informatization, telecommunications, and communication.

We note that as a result of information security threats, serious damage may be caused to the country's vital interests in the political, economic, defense, and other spheres of state activity, as well as causal socio-economic damage to society and individual citizens. The realization of threats can make it difficult to make the most important political, economic, and other decisions, undermine the state authority of the country in the international arena, disrupt the balance of the interests of the individual, society, and the state, discredit the state authorities and management, disrupt the functioning of the system of public administration, credit and financial and banking spheres, as well as systems for managing troops and weapons, objects of increased danger.

The consequence of the implementation of threats can be significant economic damage in various spheres of public life and business, a decrease in the rate of scientific and technical development of the country, and an undermining of the defense potential. It is clear from the above that a large number of various threats to information security of various origins are known. Different authors offer some approaches to their classification. At the same time, the types of dangers generated, the degree of malicious intent, the sources of threats, and so on, are used as criteria for dividing a multitude of threats into classes. Based on the methods of system analysis, it can be reduced to some system classification given in Table 7.1 [18].

Table 7.1 **– System classification of information security threats**

Classification parameters	**Classification parameters**	**Classification parameters**
1	*2*	*3*
1. Species	1.1. Physical integrity	Destruction (distortion)
	1.2. Logical structure	Distortion of the structure
	1.3. Content	Unauthorized modification
	1.4. Privacy	Unauthorized receipt
	1.5. Property right	Appropriation of someone else's right

Continuation of Table 7.1

1	*2*	*3*
2. Nature of origin	2.1. Accidental	Failures, failures, errors, natural disasters, side effects
	2.2. On purpose	Malicious actions of people
3. Prerequisites of appearance	3.1. Objective	Quantitative insufficiency of system elements, qualitative insufficiency of system elements
	3.2. Subjective	Foreign intelligence, industrial espionage, punitive elements, unscrupulous employees
4. Sources of threats	4.1. People	Third parties, users, staff
	4.2. Technical devices	Registration, transfer, storage, processing, issuance
	4.3. Models, algorithms, programs	General purpose, applied, auxiliary
	4.4. Technological schemes of processing	Manual, interactive, intra-machine, network
	4.5. Environment	The state of the atmosphere, side noises, side signals

1. *Types of threats.* This parameter is the main one, which determines the target orientation of information protection.

2. *Origin of threats.* The table highlights two values of this parameter: accidental and deliberate. Accidental refers to the origin of threats, which are caused by spontaneous and independent circumstances that arise in IS during its functioning. The most famous events of this plan are failures, failures, errors, natural disasters, and adverse effects. The essence of the listed events (except for natural disasters, the essence of which is clear) is defined as follows:

– *refusal is* a malfunction of any element of the system, which makes it impossible to perform its main functions;

– *failure is* a temporary malfunction of any element of the system, the consequence of which may be its incorrect performance of its function at that moment;

– *an error* is an incorrect (one-time or systematic) performance of one or more functions by an element, which occurs as a result of its specific (permanent or temporary) state;

– *a side effect* is a negative effect on the system as a whole or individual elements, which is caused by any phenomena that occur inside the system or in

the external environment.

The intentional origin of the threat is determined by the malicious actions of people.

3. *Prerequisites for the emergence of threats.* The table shows two possible types of prerequisites: objective (quantitative or qualitative insufficiency of system elements) and subjective (intelligence activities of foreign states, industrial espionage, activities of punitive elements, actions of unscrupulous system employees).

The listed types of prerequisites are interpreted as follows:

– *quantitative deficiency* – physical shortage of one or more elements of the system, which disrupts the technological process of data processing and overloading of existing elements;

– *quality deficiency* – imperfection of the design (organization) of the system elements, due to which the possibility of accidental or intentional negative impact on the information being processed or stored may appear;

– *intelligence activity* of foreign countries is a specially organized activity of state bodies, professionally-oriented to obtain the necessary information by all available methods and means.

The main types of intelligence include:

– **intelligence** (unauthorized activities of professional intelligence agents, recruited agents, and so-called "well-wishers") and technical intelligence, which includes radio intelligence (interception by radio-electronic means of information circulating in telecommunications channels), radio-technical intelligence (registration of electromagnetic radiation of technical systems by special means) and space reconnaissance (use of spacecraft and artificial satellites of the Earth to observe the territory, photograph it, register radio signals and obtain useful information by any other available means);

– ***industrial espionage*** is the clandestine activity of an organization (that is, its representatives) to obtain information that is specially protected against its

unauthorized leakage or theft, to create favorable conditions for itself, and obtain maximum benefits (unfair competition);

– ***malicious actions of criminal elements*** – theft of information or computer programs for profit;

– ***actions of unscrupulous employees*** – theft (copying) or destruction of information arrays and programs for selfish or selfish motives, as well as a result of non-compliance with the established procedure for working with information.

4. *Sources of threats.* The threat source is understood as its immediate generator or carrier. Such a source can be people, technical means, models (algorithms), programs, external environment.

Let's try now, based on the given system classification of threats to information security, to determine the full set of threats that are potentially possible in modern information systems. At the same time, we must take into account not only all known (previously manifested) threats, but also such threats that were not manifested before, but could potentially arise with the current concepts of the architectural construction of IS and technological schemes of information processing.

We classify all possible channels of unauthorized obtaining of information (CUOI) according to two criteria: the need for access (physical or logical) to IS elements for the implementation of one or another CUOI and the dependence of the appearance of CUOI on the state of the IS.

According to the first criterion, CUOI can be divided into those that do not require access, that is, which allow obtaining the necessary information remotely (for example, by visual observation through the windows of the IS premises), and those that require access to the IS premises. In turn, CUOI, which can be used only after gaining access to the IS premises, are divided into traces that do not leave in the IS (for example, visual viewing of images on monitor screens or documents on paper media) and CUOI, the use of which leaves those or other traces (for example, theft of documents or computer media).

According to the second criterion, the CUOI are divided into those potentially existing regardless of the state of the IS (for example, information carriers can be stolen regardless of whether the IS means are in working order or not) and existing only in the working state of the IS (for example, side electromagnetic radiation and guidance).

According to the above, the classification structure of CUOI can be represented by the following table (Table 7.2) [18].

***Table 7.2* – Classification structure of channels of unauthorized information acquisition**

Dependence on access to system elements	Attitudes to information processing	
	Appears unrelated to processing	Appears during processing
Do not require access	***1st class*** Public constants	***2nd class*** Publicly available functional
Requires access without changing system elements	***3rd class*** Narrowly accessible permanent without leaving traces	***4th*** Narrowly available functional without leaving traces
Requires access to change system elements	***5th grade*** Narrowly available specials that leave traces	***6th grade*** Narrowly accessible functional with leaving traces

We will give an approximate list of channels of unauthorized obtaining of information about the classes we selected. *1st-class CUOI* – channels that appear regardless of information processing and without the attacker's access to system elements. This may include eavesdropping on conversations, as well as provoking conversations of persons related to IS, and the use of visual, optical, and acoustic means by the attacker. This channel can also manifest itself through the theft of information carriers when they are outside the premises where the IS is located.

2nd-class CUOI – channels that appear in the process of information processing without the attacker's access to IS elements. This can include electromagnetic radiation from various PC devices, equipment, and communication lines, parasitic guidance in power circuits, telephone networks, heat supply, ventilation, and sewage systems, grounding buses, connection to the information and computing network of interference generators, and recording equipment. The same class can include inspection of production waste falling

outside the controlled zone.

CUOI of the 3rd class – channels that appear regardless of information processing with the attacker's access to IS elements, but without changing the latter. These include all kinds of copying media and documents, as well as theft of industrial waste.

CUOI of the 4th class – channels that appear in the process of processing information with the attacker's access to IS elements, but without changing the latter. This may include memorizing and copying information during processing, using software traps, flaws in programming languages and operating systems, as well as affecting software with malicious bookmarks, and masquerading as a registered user.

CUOI of the 5th class – channels that appear regardless of information processing with the attacker's access to IS elements and with the change of the latter. Among these channels: substitution and embezzlement of information carriers and equipment, inclusion in programs of blocks such as "Trojan horse", "computer worm" and the like, reading residual information contained in memory after the execution of authorized requests.

CUOI of the 6th class – channels that appear in the process of processing information with the attacker's access to IS elements and with the change of the latter. This may include illegal connection to equipment and communication lines, as well as the removal of information on the power buses of various IS elements.

Information protection must be ensured at all stages of its life cycle in the IS, at all technological stages of information processing, and in all operating modes of the AS.

The main tasks of protection can be:

1) organization and coordination of work on the protection of information that is processed and transmitted by IS means;

2) definition, classification of IS resources subject to protection;

3) ensuring the specified confidentiality, integrity, and availability of

information during the creation (IDC) and operation of IS, preventing the leakage of restricted information and the loss of its physical media;

4) creation of a mechanism and conditions for prompt response to threats to information security;

5) effective prevention, timely detection, and neutralization of threats to IS resources, causes, and conditions that cause or may lead to disruption of its functioning;

6) organization of the information protection service;

7) organization and implementation of a system for admitting personnel (users) to work with information that needs protection;

8) management of information protection means, management of user access to IS resources, monitoring of their work by information protection service personnel, prompt notification of NSD attempts to access IS resources;

9) creation of conditions for the maximum possible compensation and localization of damages caused by illegal and unauthorized actions of violators, reduction of the negative impact of the consequences of a security breach on the functioning of IS;

10) ensuring the confidentiality regime during the processing of classified information;

11) development of organizational, administrative, and working documentation, which defines the requirements and procedure for protection and processing of IDC;

12) organization of accounting, storage, and circulation of information that needs protection and its material carriers;

13) registration, collection, storage, and processing of data on all events in the system that are related to information security;

14) implementation of control over the protection of IDC and the preservation of its material carriers.

The threat model is developed for a specific IS and must take into account

the features of functioning, the composition of the IS, information processing technology, etc. The main types of threats to information security that can be implemented about IS should be determined and should be taken into account in the threat model (threats of an objective nature, accidental and intentional threats of a subjective nature).

An offender model is an abstract formalized or informal description of an offender. The offender's model reflects his practical and potential capabilities, a priori knowledge, time and place of action, etc. [14; 18].

When developing a model of a violator, the following are defined:

– assumptions about the category of persons to which the offender may belong;

– assumptions about the motives of the violator's actions (the goals he has);

– assumptions about the level of qualification and awareness of the violator and his technical equipment (regarding the methods and means used in committing violations);

– restrictions and assumptions regarding the nature of possible actions of violators (by time and place of action and others).

It is assumed that according to his level, the offender is a highly qualified specialist who has complete information about the system. Usually, 5 types of violators are considered. First, they are divided into two groups: external and internal violators. Among the external violators, the following are distinguished:

a) a well-armed and well-equipped force group that acts from the outside quickly and head-on;

b) a lone intruder who does not have access to the facility and tries to act stealthily and cautiously because he is aware that the response forces have advantages over him.

Among the potential internal violators can be noted:

a) auxiliary personnel of the facility, admitted to the facility, but not admitted to the vital center (VC) of the IC;

b) the main personnel admitted to the VC (the most dangerous type of violators);

c) employees of the security service, who are often formally not admitted to the VC but have wide enough opportunities to collect the necessary information and carry out the action.

The possibility of collusion between violators of different types must also be considered, which further complicates the task of formalizing violator models. But it should be noted that such a division is very general, and not all groups are important for all ICs.

The following categories of personnel can be distinguished among internal violators:

1) users (operators) of the system;

2) personnel servicing technical equipment (engineers, technicians);

3) employees of software development and maintenance departments (application and system programmers);

4) technical personnel serving the building (cleaners, electricians, plumbers, and other employees who have access to the building and the premises where IS components are located);

5) employees of the security service;

6) heads of various levels and job hierarchies.

Third parties who may be violators:

a) clients (representatives of organizations, citizens);

b) visitors (invited for any reason);

c) representatives of organizations engaged in ensuring the vital activities of the organization (energy, water, heat supply, etc.);

d) representatives of competing organizations (foreign services) or persons acting on their behalf;

e) persons who accidentally or intentionally violated the access regime (without the intention of violating security);

f) any persons outside the controlled zone.

Three main motives for violations can also be distinguished: irresponsibility, self-assertion, and a useful purpose.

In the case of violations caused by irresponsibility, the user purposefully or accidentally performs destructive actions that are not related, however, to malicious intent. In most cases, this is the result of incompetence or negligence. Some users consider gaining access to system data sets a significant success, starting a sort of user-versus-system game for self-affirmation, either in their own eyes or in the eyes of their colleagues.

A breach of IS security can be caused by the self-interest of the system user. In this case, he will purposefully try to overcome the protection system to access information in the IS. Even if the IS has means that make such penetration extremely difficult, it is almost impossible to completely protect it from penetration.

All violators can be classified according to the level of knowledge about IS [9; 12–15; 18]:

1) knows the functional features of the IS, the basic regularities of the formation of data arrays in it and the flow of requests to them, and knows how to use standard tools;

2) has a high level of knowledge and experience in working with technical means of the system and their maintenance;

3) has a high level of knowledge in the field of programming and computing, design and operation of information systems;

4) knows the structure, functions, and mechanism of action of protective equipment, their strengths, and weaknesses.

By level of capabilities (methods and means used):

1) uses purely agent methods of obtaining information;

2) uses passive means (technical means of interception without modification of system components);

3) uses only standard means and shortcomings of the protection system to overcome it (unauthorized actions using authorized means), as well as compact magnetic media that can be secretly passed through security posts;

4) applies methods and means of active influence (modification and connection of additional technical means, connection to data transmission channels, implementation of program bookmarks, and use of special instrumental and technological programs).

By the time of action:

– in the process of functioning (during the operation of the system component);

– during the period of system inactivity (during non-working hours, during planned breaks in its work, breaks for maintenance and repairs, etc.);

– both in the process of functioning and during the period of inactivity of system components.

By place of action:

– without access to the controlled territory of the organization; from the controlled territory without access to buildings and structures;

– inside the premises, but without access to technical means;

– from workplaces of end-users (operators);

– with access to the data area (databases, archives, etc.);

– with access to the security control area.

The following limitations and assumptions about the nature of the actions of possible violators are also taken into account: recruitment work and special measures make it difficult to create coalitions of violators, that is, unification (collusion) and purposeful actions to overcome the protection system of two or more violators; the violator, planning an attempt at NSD, hides his unauthorized actions from other employees; NSD can be the result of errors by users, system administrators, as well as errors in the adopted information processing technology, etc.

Determining the specific characteristics of potential infringers is largely subjective. The model of the violator, built taking into account the specifics of a specific subject area and information processing technology, can be presented by listing several variants of his image. Each type of violator must be characterized according to the classifications given above. All values of the characteristics must be evaluated and reduced to the appropriate forms.

However, when forming a model of the violator, the following must be determined at its output: the probability of the threat's realization, the timeliness of detection, and information about the violation. It should be noted that all crimes, including computer crimes, are committed by humans. IS users are its component, a necessary element. On the other hand, they are the main cause and driving force of violations and crimes. Therefore, the issue of security of protected IS is a question of human relations and human behavior.

Based on the above, a differentiated approach is appropriate for choosing the initial behavior model of a potential violator. Since the qualification of the violator is a rather relative and approximate concept, four security classes can be taken as a basis [18]:

– *1st class* – to protect vital information, the leakage, destruction, or modification of which could lead to losses for the user. The strength is designed for a professional offender;

– *2nd class* – used to protect important information when several users are working, having access to different data arrays, or creating their files, inaccessible to other users. The strength is designed for a high-class offender, but not professional.

The 3rd class is recommended for the protection of important information, the permanent NSD which, through its accumulation, may lead to the leakage of more important information. At the same time, the strength of protection should be calculated for a relatively qualified violator – a non-professional.

Class 4 is recommended to protect other information that is not of interest to

serious infringers. However, its necessity is dictated by the observance of the technological discipline of accounting and processing of official use information for protection against NSD.

The implementation of the listed security levels should be ensured by a set of appropriate protection means that cover a certain number of possible NSD channels by the expected class of potential violators. The security level of protection within the class is provided by a quantitative assessment of the strength of individual protection means and an assessment of the strength of the circuit of protection against intentional means of protection and an assessment of the strength of the circuit of protection against intentional NSD.

Questions for self-control:

1. Name the factors that increase the vulnerability of information.
2. Define the terms “information protection”, “information security”.
3. List the components of the information life cycle.
4. What data are structured?
5. List the features of the information.
6. Name the properties of information.
7. What data cannot be classified as restricted-access information?
8. Define the terms “threat model”, and “electronic viruses”.
9. In what form information threats are implemented.
10. In what form are organizational threats implemented?
11. Name the parameters of information security threat classification.

7.2. Methods and means of information protection

The main ways to prevent leakage of information through technical channels include organizational measures and the use of various technical means of

protection. Moreover, effective protection is achieved with the complex application of the mentioned approaches.

All used technical means are used either to detect information capture or to prevent it. Currently, there are three areas of implementation of these tasks [18]:

a) detection of active means of covert recording of acoustic information (radio microphones, microphones transmitting information via alternating current power grid circuits, radio broadcasting and other wired networks, telephone transmitters transmitting information via a radio channel, radio stethoscopes, and the like);

b) constant or periodic monitoring of the loading of the radio range (radio monitoring), detection and analysis of new emissions, and potential and specially organized radio channels of information leakage (for example, digital radio jamming devices or devices with storage and subsequent transmission);

c) conducting special studies of confidential information processing systems to determine the leakage channels, the level of information security, and the subsequent implementation of measures to ensure the fulfillment of information protection requirements.

Let's take a closer look at the technical solutions used here. Protection against information leakage through the acoustic channel. It should be noted right away that detecting the presence of acoustic control with the help of directional microphones, electronic stethoscopes, and laser detectors is rather complicated. Therefore, for protection purposes, means of preventing the removal of information are more often used. These include audio jamming generators that produce a noise jamming signal with varying amplitude and frequency and can be portable (pocket), desktop, or stationary.

More or less effective means of detection include only devices that allow establishing the fact of the use of recording dictaphones. The principle of operation of such devices is based either on the registration of the magnetic fields of the working electric motor of the recorder or the registration of the fields of

magnetization and erasure currents. Modern digital recorders do not have an electric motor, so it is almost impossible to detect them.

To protect against the control of acoustic information, in exceptional cases, special transparent protective booths are used, which guarantee protection against any type of listening. The material for such cabins and interior furniture is transparent plastic. Such cabins are used as the most effective means of protection against eavesdropping in the embassies of the world's leading countries.

The spectrum of technical means designed to detect special electronic speech control devices is significantly wider. According to the principle of operation, they can be divided into two groups:

– electromagnetic radiation search and control equipment, which is used only to detect working electronic data acquisition devices emitting radio waves (radiation detectors, receivers, scanners, spectrum analyzers, frequency meters, selective microvoltmeters, as well as automated software and hardware complexes that perform radio monitoring functions);

– passive detection equipment, which is used to detect technical means of recording information regardless of their mode of operation (non-linear locators, endoscopes, flaw detectors, metal detectors, thermal imagers, and the like).

Passive detection equipment allows you to detect technical means of information capture even if they are not functioning at the moment. The principle of their work is based on the detection of abnormal features in premises and building structures. For example, with the help of nonlinear locators, the presence of semiconductor devices can be detected, with the help of endoscopes, defect scores, metal detectors, changes in the traditional structure of the structures of rooms and buildings, and with the help of thermal imagers, and anomalies in temperature.

Protection of information in communication channels. The technical means of protecting information in communication channels include devices that establish the fact of connection of eavesdropping devices to telephone channels,

spectrum analyzers of communication channels, and devices for protecting confidential conversations on telephone channels. Modern spectrum analyzers of communication channels, as a rule, are combined devices that are also decisive for the task of radio monitoring.

In speech communication systems, there are two main methods of closing speech signals, which are divided by the method of transmission over communication channels: analog scrambling and speech discretization followed by encryption. Scrambling means changing the characteristics of a speech signal in such a way that the received modulated signal, having the properties of intelligibility and unrecognizability, occupies the same frequency band as the original open speech signal.

In discretization systems, speech components will be transformed into a digital data stream using an analog-to-digital converter, which is mixed according to a certain algorithm with a pseudo-random sequence produced by a key generator according to one of the cryptographic algorithms, and the closing speech message obtained in this way is transmitted to the communication channel. At the receiving end, the conversion is performed in reverse order.

Protection of information from leakage through the side electromagnetic radiation and guidance (SERG) channel. Passive, active, and combined methods are used to protect information from leakage at the expense of SERG. Passive protection consists in reducing radiation levels to values commensurate with natural noises, using a special elemental base, and constructive refinement of equipment processing confidential information.

There are different ways to implement this method. One of the simplest technical solutions is to place all the equipment in a safe and shielding radio radiation environment. This is used for small-sized equipment, allowing to keep its cost at an acceptable level. For large systems, shielding entire halls and even buildings can be extremely expensive, so the problems of providing electronic protection for them are considered at the design stage.

For example, for communication systems, the safety requirements of individual components of each section of the entire system are defined. The developer can require shielding of individual devices of the system using a metal protective coating or use standard shielded housings for equipment blocks. я Where shielding of components is impractical, sufficient isolation of data and power lines is assumed due to various combinations of filters, signal suppression devices, and low-impedance grounding.

Active protection involves hiding information signals due to noise or blocking interference with the help of special noise generators. *Active radio technical masking* consists of the formation and emission of a masking signal near the masked system. In this case, energetic and non-energetic methods of active radio technical masking are distinguished.

During energy masking, a broadband noise signal is obtained with a level that significantly exceeds the level of system radiation in the entire frequency range. At the same time, noise oscillations are induced in the outgoing circuits. Energy masking can be implemented only if the level of radiation is significantly less than established by existing standards for electromagnetic compatibility and medical requirements. Otherwise, the cloaking device will either cause interference to various radio devices located in the vicinity of the protected system, or it cannot be used for medical reasons.

The non-energetic method of active radio technical masking (statistical) consists in changing the probability structure of the signal that can be received by the attacker's receiver. Such a signal change requires a special device that can be built directly into the system or placed nearby. The level of the masking signal emitted by this device does not exceed the level of informative radiation of the system, so such devices do not create noticeable interference for other electronic devices located nearby, and are also safe for the health of the system operator.

Combined protection is the reduction of radiation levels to specified values with the simultaneous use of both passive and active protection.

Closing the channels of unauthorized information acquisition should begin with the control of user access to IS resources. This task is solved based on some fundamental principles [18]:

1. *The principle of the reasonableness of access.* This principle consists of the mandatory fulfillment of two main conditions: the user must have a sufficient "form of admission" to receive information of the required level of confidentiality, and he needs this information to perform his production functions. Let's note here that in the field of automated information processing by users, active programs and processes, as well as information carriers of various degrees, can act. Then the access system assumes the definition for all users of the appropriate software and hardware environment or information and software resources that will be available to them for specific operations.

2. *The principle of sufficient access control depth.* Information protection means should include mechanisms for controlling access to all types of information and software resources of the IS, which should be divided between users by the principle of the reasonableness of access.

3. *The principle of separation of information flows.* To prevent a violation of information security, which, for example, may occur when the secret information is recorded on non-secret media and in non-secret files, it's transferred to programs and processes not intended for processing secret information, as well as when the secret information is transmitted over unprotected channels and communication lines connection, it is necessary to carry out appropriate separation of information flows.

4. *The principle of purity of reused resources.* This principle consists of cleaning resources containing confidential information when they are deleted or released by the user before redistribution of these resources to other users.

5. *The principle of personal responsibility.* Each user must bear personal responsibility for his activities in the system, including any operations with confidential information and possible violations of protection, that is, any

accidental or intentional actions that lead or may lead to unauthorized access to confidential information, its distortion, or destruction, or make such information unavailable to legitimate users.

6. *The principle of the integrity of means of protection.* This principle implies that the means of information protection in the IS must accurately perform their functions by the listed principles and be isolated from users, and their support must include a specially protected interface for control means, signaling about attempts to violate the protection of the processes in the system.

The implementation of the listed principles is carried out with the help of the so-called "request monitor", controlling any requests to data or programs from users according to the types of access to these data and programs established for them. Schematically, such a monitor is presented in Fig. 7.2.

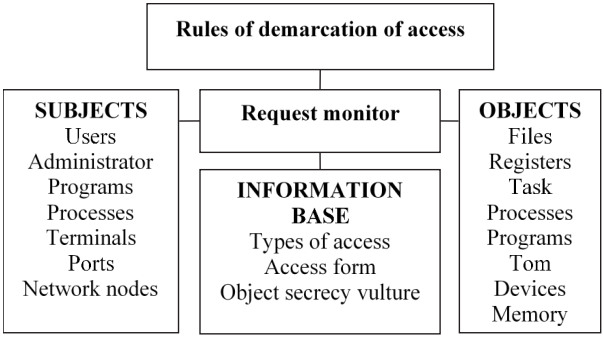

Fig. 7.2 – The structure of the request monitor

The practical creation of an access monitor, as can be seen from the given figure, involves the development of specific rules for demarcating access in the form of a so-called information protection model.

The behavior of this model is described by the following simple rules:

a) the user is allowed access to the system if he is part of the set of users known to the system;

b) the user is allowed access to the terminal if he is part of the subset of users assigned to this terminal;

c) the user is allowed access to the file if the user's confidentiality level is not lower than the file's confidentiality level; the application area of the file is included in the application area of the user task; user task access mode includes file access mode; the user is included in the subset of users allowed in the file.

Hartson's model [18] uses the set of the so-called five-dimensional "security space" as the main characteristics (Fig. 7.3):

– established powers;

– users;

– operations;

– resources;

– states.

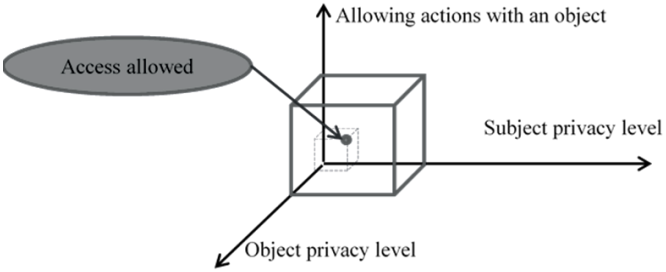

Fig. 7.3 – Hartson model

The area of safe states of the system is represented as a Cartesian product of the listed measurements. Each access request is represented by a four-dimensional projection of the security space. Requests are eligible for access when they are completely placed in the appropriate subspaces.

One of the first fundamental defense models was developed by Lampson and then improved by Graham and Danning (Fig. 7.4) [18]. The basis of their model is the **access matrix (table)** A, in which:

1) columns $O_1, O_2, \ldots, O_n$ are access objects;

2) lines $S_1, S_2, \ldots, S_m$ are access subjects;

3) the table element $A[S_i, O_j]$ contains a list of types of access $T_1, T_2, \ldots, T_k$, which determines the privileges of the subject regarding the object O_j.

	O_1,	O_2 …	O_j,		O_n
S_1	R	R, W	E		R
S_2	R, N	–	R		E
… S_i	R	–	–		R
…					
S_m	RW	–	E		E

Fig. 7.4 – Matrix model

This model assumes that all attempts to access objects are intercepted and checked by a special controlling process. Thus, the subject S_i will receive access T_k, initiated by him to the object O_j only if the element of the matrix $A[S_i, O_j]$ has the value T_k.

These models can be used both for the protection of operating systems (OS) and for the protection of databases (DB). Taking into account that such single models, as practice shows, significantly complicate the consideration of security issues, some authors have made attempts to develop special models of database protection.

The information protection models considered above belong to the matrix class and have become the most widespread because they serve not only to analyze the logical functioning of the system but also can be successfully implemented in specific programs.

The rule of demarcation of access is as follows: a person is allowed to work with a document only if the access subject's permission level is equal to or higher than the document's confidentiality level, and the set of categories assigned to this access subject contains all the categories defined for this document. In IS, all rights of the access subject are fixed in its mandate. The entity must have a set of mandates to access all the objects it needs. Mandate management allows you to simplify the access control process because when creating a new object, it is enough to create its mark. However, with such management, the confidentiality

of information has to be overestimated due to the impossibility of detailed demarcation of access. The Bella-La Padula multi-level protection model (Fig. 7.5) [18], became the most widespread.

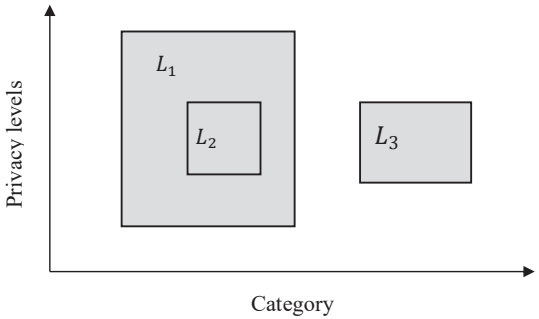

Fig. 7.5 – Model Bella La Padula

The basis of this model is the concept of the level of confidentiality (a form of admission) and category (application area) of the subject and the object of access. Based on the specific levels and categories assigned to each subject and access object, their security levels are determined in the model, and then their interaction is established. At the same time, the model assumes that one level of security dominates another if and only if its corresponding level of confidentiality is greater than or equal to the level of confidentiality of another, and the set of categories includes the corresponding set of others. *Privacy levels are ordered, while security levels are partially ordered, so some subjects and objects may not be comparable.*

Since programs in these models act as subjects in the access rules, they can, if necessary, extend the rights of specific users. For example, an application may have the right to sort a file that the user is not allowed to read.

Another type of model is the multi-level model. They differ from matrix models in several aspects. First, these models consider access management not within the framework of those set by some rights administrator, but within the framework of representing the entire system so that data of one category or area is not available to users of another category. Secondly, multi-level models

consider not only the fact of access to information but also information flows within the system.

Summarizing the consideration of two classes of information protection models, we note that the advantage of matrix models is the ease of presenting a wide range of information security rules. The main drawback of these models is the lack of control over information flows. For its part, the main drawback of multi-level models is the impossibility of managing access to specific objects based on accounting for the individual characteristics of each of the subjects. So, both approaches seem to suggest the search for different compromises between efficiency, flexibility, and security. The optimal solution to security issues should be developed using both types of protection models.

The implementation of specific models of protection against unauthorized access should be based on appropriate administrative (procedural) measures and technical means aimed primarily at the identification and authentication of users of the automated system.

The identification of IS users consists in establishing and securing for each of them a unique identifier in the form of a number, cipher, code, etc. This is because the traditional identifier of the surname-name-patronymic type cannot always be used in a specific IS. For identification purposes, various systems are widely used, for example, the so-called personal identification number (PIN), social security number (SSN), personal number, security code, etc. [18]. Such identifiers are used in the construction of various access delimitation and information protection systems.

Authentication consists in verifying the authenticity of the user based on the identifier presented to him, for example, when logging into the system. Such verification should exclude falsification of users in the system and their compromise. Without verification of authenticity, the very meaning of user identification and the use of access control tools built based on personal identifiers is lost. The lack of reliable means of verifying the authenticity of users can

significantly complicate the implementation of the principle of personal responsibility, which was mentioned above.

Verification of authenticity (authentication) can be carried out by various methods and means (Fig. 7.6) [18]. Currently, the systems use three main methods of authentication based on the following characteristics:

1) password or personal identification number (the user “knows”);

2) some item that the user has (the user “has”);

3) any physiological signs characteristic of specific individuals (the user “is”).

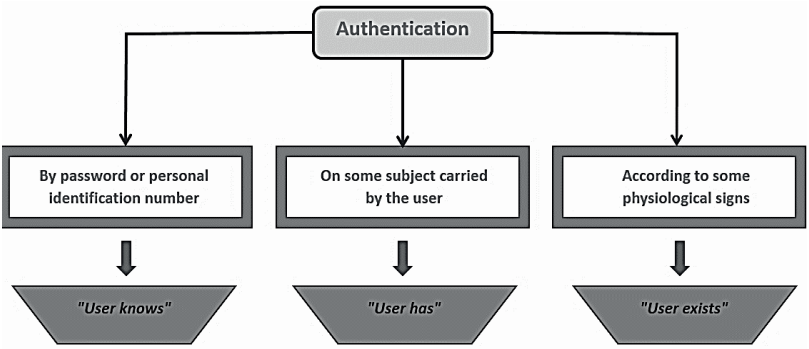

Fig. 7.6 – Authentication methods

The first method is implemented by software authentication tools used in most operating systems, database management systems, teleprocessing monitors, and network packages. The essence of this method is that each registered user is given a personal password, which he must keep secret and enter into the system every time he accesses it. The special program compares the entered password with the standard stored in memory, and if the passwords match, the user’s request is accepted for execution.

The simplicity of this method is obvious, but its obvious disadvantages are also obvious: the password can be selected by going through possible combinations, and a skilled attacker can penetrate the memory area where the reference passwords are stored. Measures to increase the security of password

authentication systems include storing password lists in an encrypted form and shortening the validity of passwords up to the use of single-use passwords. Recently, the so-called "request-response" method is widely used for authentication purposes, which allows not only to authenticate the user but also enables the user to authenticate the system with which he works. This is of fundamental importance when working in a network since the use of a fake PC, OS or program is one of the ways of unauthorized receipt of messages or passwords of legitimate users. It should be noted that the need for such mutual authentication is confirmed by the international standard for interoperability of open systems.

A variant of the first method of authentication is the so-called recognition in dialogue mode, carried out according to the following scheme. In the files of the protection mechanisms, personalizing records containing the user's data (date of birth, height, weight, names, and dates of birth of equals and relatives, etc.) or a fairly large and ordered set of passwords are created in advance. At the user's request, the protection program offers him to name some data from an existing record, which is compared with those stored in the file. Based on the results of the comparison, an admission decision is made. To increase the reliability of knowledge, the data requested from the user can be selected differently each time.

As an item available to the user (the second method of authentication), so-called identification cards (IC) are used, on which data personalizing the user are applied: a personal identification number, a special cipher or code, etc. These data are recorded on the card in an encrypted form, and the encryption key can be an additional identifying parameter since it can be known only to the user, it is entered by him every time he accesses the system and is destroyed immediately after use.

The information on the card can be written and read in different ways or a combination of several ways. For example, the IC is placed in the reader, the light source illuminates the microcrystalline dot-matrix installed on the card. Since

only the non-polarized elements of the matrix will be transparent to light, the corresponding code containing information about a particular user will be read.

Another type of IC is an information card with several rows of signs, letters, etc. specially applied to its surface using phosphor. Reading data from the device in this case is two electrodes, one of which is transparent.

Another type of IC is an electronic identification card built on an integrated microcircuit. Individual magnetic cards were the most widespread among authentication devices of the "user has" type. The popularity of such devices is explained by the universality of their use, relatively low cost, and high accuracy, they are easily completed with a terminal and a PC. Since the readers of these devices do not identify a person, but a magnetic card, they are equipped with a special, often digital keyboard for the card owner to enter his cipher, and password. To protect cards from unauthorized reading and forgery, as in previous cases, special physical and cryptographic methods are used.

To learn the components of data processing, i.e. PC, OS, functional processing programs, data arrays (such knowledge is especially relevant when working in a network), special hardware units-set-top boxes are used, which are devices that generate individual signals. To prevent the interception of these signals and their subsequent malicious use, they can be transmitted in an encrypted form, and not only the encryption key, but also the used method (algorithm) of cryptographic transformation can change periodically.

Physiological user recognition systems have recently begun to gain increasing importance. Only with this approach is it established that the user claiming access to the terminal is exactly who he claims to be. When using this class of authentication means, the problem of "social acceptability" arises: the authentication procedure should not degrade human dignity, create discomfort, simply be too cumbersome and take a lot of time.

There are quite a few physiological signs that indicate a specific person, (Fig. 7.7) [18]. These include prints of feet and hands, teeth, enzymes, breathing

dynamics, facial features, and so on. For the authentication of terminal users of automated systems, fingerprints, hand geometry, voice, and personal signature are considered the most acceptable.

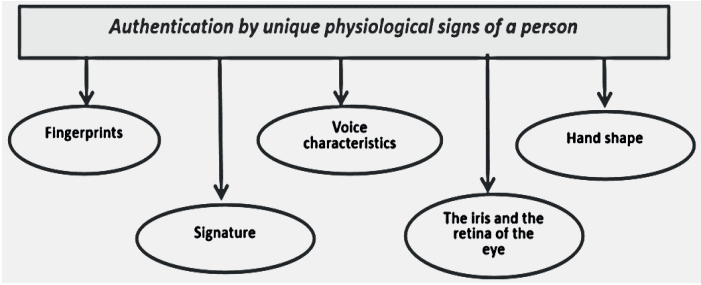

Fig. 7.7 – Physiological methods of authentication

The main conclusion that comes from the experience of creating authentication devices is that obtaining high accuracy of user knowledge is possible only by combining different methods.

It should be noted that all considered authentication methods in the event of non-authentication must implement a temporary delay before serving the next request. This is necessary to reduce the threat of identification features (especially passwords) being picked up automatically. At the same time, all unsuccessful attempts to gain access should be registered to ensure effective supervision (control) of system security.

Cryptography is an extremely important mechanism for protecting information. Since this complex and broad branch of mathematics requires a separate detailed study, here we will present only the basic information on cryptology.

The problem of protecting information by transforming it, which excludes its reading by an outsider, has troubled the human mind since ancient times. The history of cryptography is the same age as the history of human writing. Moreover, initially writing itself was a cryptographic system, because in ancient societies it was possessed only by the chosen ones. With the spread of writing, cryptography began to form an independent science. The first cryptosystems are

found already at the beginning of our era. So, in his correspondence, Caesar already used a more or less systematic cipher, which received his name. Cryptographic systems developed rapidly during the First and Second World Wars. From the post-war period to the present day, the advent of computing has accelerated the development and improvement of cryptographic methods.

Cryptology deals with the problem of protecting information by transforming it (Kryptos – secret, logos – science). Cryptology is divided into two areas: cryptography and cryptanalysis. The goals of these directions are directly opposite [18].

Cryptography deals with the search and research of mathematical methods of information transformation. The sphere of interest of cryptanalysis is the study of the possibility of deciphering information without knowing the keys.

Modern cryptography includes four major sections [18]:

1. Symmetric cryptosystems.
2. Cryptosystems with a public key.
3. Electronic signature systems.
4. Key management.

Among the main areas of use of cryptographic methods, we note transmission through information communication channels (for example, e-mail), establishing the validity of transmitted messages, and saving information (documents, databases) on media in an encrypted form. Here are some of the most commonly used cryptography terms.

As information is subject to encryption and decryption, texts built on some alphabet are considered. The *alphabet* is a finite set of signs used to encode information. *Text* is an ordered set of elements of the alphabet.

Encryption is a transformation process: the original text, also known as plaintext, is replaced by encrypted text. *Decryption* is the reverse process of encryption. Based on the key, the encrypted text is converted into the original. *A key* is an information that is necessary for seamless encryption and decryption.

A cryptographic system is a family of plaintext transformations. Members of this family are indexed or denoted by the symbol *k*; parameter *k* is the key. The space *K* is a set of possible key values. Usually, the key is a consecutive series of characters from the alphabet.

Cryptosystems are divided into symmetric and public keys. In symmetric systems, the same key is used for both encryption and decryption.

Public key systems (PKS) use two keys – public and private – which are mathematically linked to each other. Information is encrypted using a public key available to anyone and decrypted using a private key known only to the recipient of the message.

The terms *"key distribution"* and *"key management"* refer to the processes of the information processing system, the content of which is the compilation and distribution of keys between users.

An electronic (digital) signature is its cryptographic transformation attached to the text, which allows when the text is received by another user to check the authorship and validity of the message.

Cryptoresistance is the characteristic of a cipher that determines its resistance to decryption without knowledge of the key (i.e., cryptanalysis). There are several indicators of crypto-resistance, including:

1. Number of all possible keys.

2. Average time required for cryptanalysis.

The transformation of the text is determined by the corresponding algorithm and the value of the parameter *k*. The effectiveness of encryption to protect information depends on the preservation of the secret of the key and the cryptoresistance of the key.

Abstractly, an *encrypted communication system* can be described as a set of mappings of a set of open messages into a set of closed ones. The choice of a specific type of conversion is determined by the encryption (or decryption) key. The mappings must have the property of mutual ambiguity, that is, when

deciphering, a single result must be obtained that coincides with the original open message (Fig. 7.8) [18].

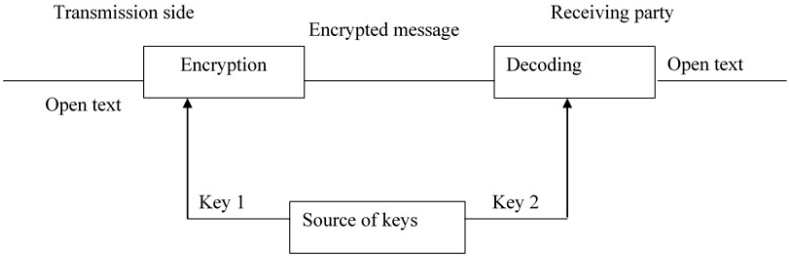

Fig. 7.8 – The general structure of the classified communication system

The encryption and decryption keys may in general be different, although for the sake of simplicity we will assume that they are identical. The set from which the keys are selected is called the *key space.* A set of encryption processes, a set of open messages, a set of possible closed messages, and a key space is called an *encryption algorithm*. A set of decryption processes, a set of possible closed messages, a set of open messages, and a key space is called a *decryption algorithm.*

The operation of the classified communication system can be described as follows:

1. An encryption key *K* is selected from the key space and sent over a reliable transmission channel.

2. A specific transformation F_k determined by the key *K* is applied to the open message *C* intended for transmission to obtain an encrypted message $M: M = F_k(C)$.

3. The received encrypted message *M* is forwarded over the data channel.

4. On the receiving side, a specific transformation D_k, determined from all possible transformations by the key K is applied to the received message M to obtain an open message $C: C = D_k(M)$.

Let's consider the basic requirements for cryptosystems. The process of cryptographic closure of data can be carried out by both software and hardware.

The hardware implementation is significantly more expensive, but it also has advantages: high performance, simplicity, security, etc. The software implementation is more practical and allows for certain flexibility in use.

The following generally accepted requirements are formulated for modern cryptographic information protection systems:

1) an encrypted message must be readable only in the presence of a key;

2) the number of operations required to determine the used encryption key based on a fragment of the encrypted message and the corresponding plaintext must not be less than the total number of possible keys;

3) the number of operations required to decrypt the information by sorting through various keys should have a strict lower estimate and go beyond the capabilities of modern computers (taking into account the possibility of using network computing);

4) knowledge of the encryption algorithm should not affect the reliability of protection;

5) a slight change in the key must lead to a significant change in the appearance of the encrypted message;

6) the structural elements of the encryption algorithm must be unchanged;

7) additional bits are introduced into the message during the encryption process. must be completely and securely hidden in the encrypted text;

8) the length of the encrypted text must be equal to the length of the original text;

9) there should be no simple and easily established dependencies between keys used consistently in the encryption process;

10) any key from a set of possible ones must ensure reliable protection of information;

11) the algorithm should allow both software and hardware implementation while changing the key length should not lead to qualitative deterioration of the encryption algorithm.

Cryptographic algorithms are based on mathematical transformations that allow to achieve high practical stability of most algorithms (Fig. 7.9) [18].

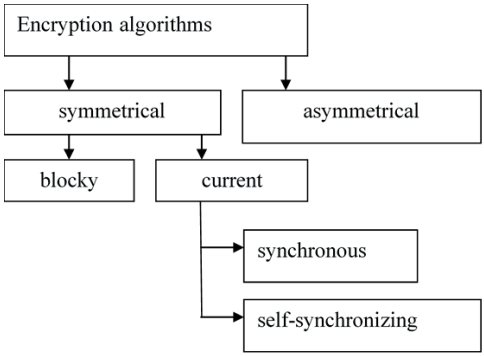

Fig. 7.9 – Classification of encryption algorithms

It has been proved that there are only two main types of transformations in cryptography – substitutions and permutations, all others are just a combination of these two types. In permutation ciphers, the symbols of the plaintext change their location. On the other hand, in substitution ciphers, one plaintext symbol is replaced by a ciphertext symbol.

In classical cryptography, four types of substitution ciphers are distinguished:

– ciphers of simple substitution (monoalphabetic ciphers). One plaintext character is replaced by one ciphertext character;

– ciphers of complex substitution. One character of the plaintext is replaced by one or several characters of the encrypted text, for example: “A” can be replaced by “З” or “PO4E”;

– block substitution ciphers. One block of open text symbols is replaced by a block of closed text, for example: “ABC” can be replaced by “CPT” or “KAP”;

– polyalphabetic substitution ciphers, in which several simple substitution ciphers are applied to the plaintext.

After some time, symmetric algorithms were divided into two larger classes – block and stream. In the former, the plaintext is divided into blocks of a

suitable length, and each block is encrypted. In streaming algorithms, each character of the plaintext is encrypted independently of the others and decrypted in the same way. In other words, the transformation of each plaintext character changes from one character to another, while block algorithms use the same cryptographic transformation as part of block encryption.

The main idea embodied in-stream encryption algorithms is to generate a sequence of characters from the input alphabet, with which the encryption algorithm works, based on the secret key. These can be, for example, English characters and numbers of the decimal system, while the input text will be converted according to the selected alphabet. It should be noted that such a sequence has a length equal to the plain text. It is sometimes called gamma.

Encryption and decryption can, for example, be done by modular addition of a plaintext symbol with a gamma symbol. The stability of stream encryption algorithms depends on the extent to which the generated gamma will have the property of equal probability of the appearance of the next symbol. Flow algorithms have a high encryption speed, but certain difficulties arise when using software, which narrows the scope of their practical application.

It should be noted that in recent years, based on the improvement of electronic technologies, new theoretical developments in the field of quantum cryptography, based on the principles of Heisenberg's uncertainty, have appeared. All the variety of existing cryptographic methods can be reduced to such classes of transformations (Fig. 7.10) [18].

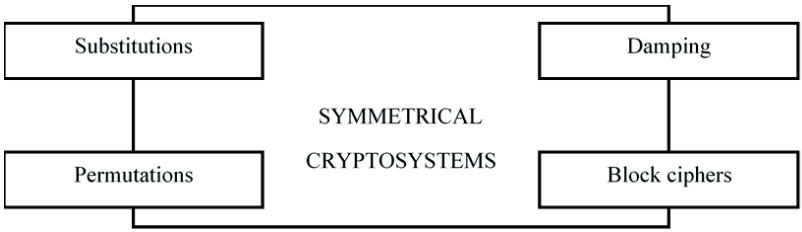

Fig. 7.10 – Classification of symmetric cryptosystems

Permutations – a method of cryptographic transformation, which consists in

permuting the symbols of the source text according to a more or less complex rule. It is used, as a rule, in combination with other methods.

Substitution systems are the simplest type of transformation, which consists in replacing the characters of the source text with others (of the same alphabet) according to a more or less complex rule. High cryptographic strength requires the use of large keys.

Hamming is a widely used cryptographic transformation. The principle of encryption by gamming consists of generating a cipher gamma using a pseudorandom number sensor and superimposing the resulting gamma on the open data (for example, using modulo 2 addition).

Block encryption is widely used, which is a sequence (with possible repetition and alternation) of basic transformation methods applied to a block (part) of the text to be encrypted. Block ciphers in practice are more common than "pure" transformations of one or another class, due to their higher cryptoresistance.

No matter how complex and reliable cryptographic systems are, their weak point in practical implementation is the problem of key distribution. For confidential information to be exchanged between two IS entities, a key must be generated by one of them, and then somehow transferred again in a confidential manner to the other. That is, in the general case, the transfer of the key again requires the use of some cryptosystem.

What is the problem with data authentication? At the end of an ordinary letter or document, the executor or responsible person usually puts his signature. Such action usually has two purposes. First, the recipient has the opportunity to verify the authenticity of the letter by comparing the signature with the sample available to him. Secondly, a personal signature is a legal guarantor of the document's authorship. The last aspect is especially important when signing various types of trade agreements, drawing up instructions, commitments, etc.

If it is very difficult to forge a person's signature on paper, and establishing

the authorship of a signature using modern forensic methods is a technical detail, then everything is completely different with an electronic signature. Any user can fake a string of bits by simply copying it, or subtly making illegal corrections to a document.

With the significant spread in the modern world of electronic forms of documents (including confidential ones) and the means of their processing, the problem of establishing the validity and authorship of paperless documentation has become especially relevant. It has already been shown that of all the advantages of modern encryption systems, they do not allow for data authentication. Therefore, means of authentication must be used in combination with cryptographic algorithms.

An electronic signature is data in electronic form, which is added to other electronic data or is logically connected with them and is intended to identify the signer of this data.

An electronic digital signature is a type of electronic signature obtained as a result of the cryptographic transformation of a set of electronic data, which is added to this set or logically combined with it and makes it possible to confirm its integrity and identify the signer. An electronic digital signature is created using a private key and verified using a public key.

Let there be two users – Oleksandr and Boris. What violations and actions of an attacker should the authentication system protect against?

Refusal (renegade). Oleksandr declares that he did not send a message to Boris, although in fact, he did. To exclude this violation, an electronic (or digital) signature is used.

Modification (processing). Boris changes the message and claims that Oleksandr sent him this (changed) message.

Fake. Boris forms a message and claims that Oleksandr sent him this (modified) message.

Active interception. Volodymyr intercepts messages between Oleksandr and

Boris for covert modification. Digital signatures are used to protect against modification, forgery, and masking.

Masking (imitation). Volodymyr sends a message to Boris on behalf of Oleksandr. In this case, an electronic signature is also used for protection.

Repeat. Volodymyr repeats the message that Oleksandr sent earlier to Boris. Even though various measures are taken to protect against repetition, it is this method that accounts for the majority of cases of illegal withdrawal and spending of money in electronic payment systems.

The most effective method from repetitions is:

1) use of imitation inserts;

2) accounting of incoming messages.

Sometimes it is not necessary to encrypt the transmitted message, but it is necessary to seal it with an electronic signature. In this case, the text is encrypted with the private key of the sender, and the resulting string of characters is attached to the document. The recipient uses the sender's public key to decrypt the signature and compare it with the text.

A hash function is a one-way function designed to obtain a digest or "fingerprint" of a file, message, or some block of data. The hash code is generated by the function 7.2 H:

$$h = H(M) \tag{7.2}$$

where M is a message of arbitrary length;

h is a hash code of fixed length.

Consider the requirements that a hash function must meet for it to be used as a message authenticator. Consider a very simple example of a hash function. Then we will analyze several approaches to constructing hash functions.

The hash function H, which is used for message authentication, should have the following properties [18]:

1. The hash function H should be applied to a block of data of any length.

2. The hash function H produces a fixed-length output.

3. $H(M)$ is relatively easy (in polynomial time) to calculate for any value M.

4. For any given value of the hash code h, it is computationally impossible to find M such that H $(M) = h$.

5. For any given x it is computationally impossible to find $y \neq x$, such that $H(y) = H(x)$.

6. It is computationally impossible to find an arbitrary pair (x, y) such that $H(y) = H(x)$.

The first three properties require the hash function to produce a hash code for any given message. The fourth property determines the requirement of the one-sidedness of the hash function: it is easy to create a hash code for a given message, but it is impossible to recover a message from a given hash code. This property is important if authentication using a hash function includes a secret value. The secret value itself may not be sent, however, if the hash function is not one-sided, an adversary can easily reveal the secret value in this way.

When the transmission is intercepted, the attacker receives the message M and the hash code $C = H(S_{AB})||M$. If the attacker can invert the hash function, then he can obtain $S_{AB} \,||\, M = H^{-1}(C)$. Because the attacker now knows M i $S_{AB} \,||\, M$, get S_{AB} quite simply.

The fifth property ensures that it is impossible to find another message whose hash function value matches the hash function value of this message. This prevents authenticator spoofing when using an encrypted hash code. In this case, the adversary can read the message and generate its hash code. But because the adversary does not have the secret key, there is no way for the adversary to change the message without the recipient discovering it.

If this property is not fulfilled, the attacker has the opportunity to perform the following sequence of actions: intercept the message and its encrypted hash code, calculate the hash code of the message, create an alternative message with the same hash code, replace the original message with a fake one. Since the hash codes of these messages match, the recipient will not detect tampering.

A hash function that satisfies the first five properties is called a simple or weak hash function. If, in addition, the sixth property is fulfilled, then such a function is called a strong hash function. The sixth property protects against a class of attacks known as the birthday attack.

In many countries today there are standards for electronic (digital) signatures. The digital signature standard DSS (Digital Signature Standard) was adopted in the USA in 1991 and revised in 1994. The standard is based on the DSA (Digital Signature Algorithm) algorithm, which is a variation of the El-Gamal signature [18]. The algorithm uses a unidirectional hash function *H(m).* As a hash algorithm, the DSS standard provides for the use of the SHA-1 algorithm.

Let's consider the EDS generation algorithm itself [18]. First, three general (non-secret) parameters are selected for a group of subscribers p, q, a:

1) the parameter p must be a simple number between 512 and 1024 bits long;

2) q – a simple number with a length of 160 bits; between p and, q the ratio must be fulfilled $p = bq + 1$ for some whole b. Older bits in p and, q must be equal to units (thus $2^{159} < q < 2^{160}$);

3) number a satisfies the inequalities $1 < a < p - 1$ and is a root of the equation $a \, mod \, p = 1$.

Knowing these numbers, each subscriber of the system randomly chooses a number x that satisfies the inequalities $0 < x < q$, and calculates:

$$y = a^x mod \, p. \tag{7.3}$$

The number x will be the user's secret key and the number y will be the public key. Calculating y from known x is quite simple. However, given the public key y, it is computationally infeasible to determine x, which is the discrete logarithm of y to the base a.

All users' public keys are supposed to be specified in some non-secret but "certified" directory that everyone who is going to verify signatures must-have. At this stage, the selection of parameters ends and subscribers are ready to form and verify signatures.

Let there be a message m that one of the users wants to sign. To generate a signature, the user must perform the following actions:

1. Calculate the value of the hash function $h = H(m)$ for a message m. 3the value of the hash function must be within the range $0 < h < q$.

2. Then generate a random number k, $0 < k < q$.

3. Calculate $r = (a^k mod\ p)\ mod\ q$.

4. Determine $s = [k^{-1} \times (H(m) + x \times r)] mod\ q$.

As a result, the user will receive a signature consisting of a pair of numbers *(r, s)* for the message m. The message together with the signature can be sent to any other subscriber of the system. You can check the signature in the following way:

1. Calculate the value of the hash function $h = H(m)$ for a message m.

2. Check the fulfillment of inequalities $0 < r < q$, $0 < s < q$.

3. Calculate $w = s^{-1} mod\ q$.

$$u_1 = [H(m) \times w]\ mod\ q \tag{7.4}$$

$$u_2 = r \times w\ mod\ q; \tag{7.5}$$

$$v = [(a^{u1} \times y^{u2}) mod\ p]\ mod\ q. \tag{7.6}$$

4. Check the implementation of equality $v = r$. If $v = r$, then the signature is considered authentic, otherwise the signature is considered invalid.

Due to the complexity of computing discrete logarithms, an attacker cannot recover *k* from *r* or *x* from *s*, and therefore cannot forge the signature. For the same reason, the author of the message will not be able to renounce his signature, because no one but him knows the private key *x*.

In addition to choosing a cryptographic system suitable for a particular IS, key management is an important issue. No matter how complex and reliable the cryptosystem itself is, it is based on the use of keys. If the key exchange process is trivial to ensure the confidential exchange of information between two users, then in IS where the number of users is tens and hundreds, key management is a serious problem. The key information is understood as the totality of all keys

active in the IS. If the management of key information is not sufficiently reliable, then, after taking possession of it, an attacker gets unlimited access to all information.

Key management is an information process that includes three elements:

– generation of keys;

– accumulation of keys;

– distribution of keys.

Let's consider how they should be implemented to ensure the security of key information in IS. At the very beginning, it was said that you should not use non-random keys for the sake of ease of remembering them. In serious IS, special hardware and software methods of random key generation are used. As a rule, sensors of pseudorandom numbers (PRN) are used. However, the degree of randomness of their generation should be quite high. Ideal generators are devices based on "natural" random processes. For example, serial samples of key generation based on white radio noise have appeared. Another random mathematical object is the decimals of irrational numbers, such as π or ε, which are calculated using standard mathematical methods.

In IS with average security requirements, software key generators that calculate PRN as a complex function of the current time and/or number entered by the user are quite acceptable.

The accumulation of keys means the organization of their storage, accounting, and deletion. Since the key is the most attractive object for the attacker, which opens the way to confidential information, it is worth paying special attention to the issue of key accumulation.

Secret keys should never be written in an explicit form on a medium that can be read or copied.

In a rather complex IS, one user can work with a large amount of key information, and sometimes there is even a need to organize mini-databases with key information. Such databases are responsible for accepting, saving,

accounting, and deleting used keys.

Therefore, all information about the use of keys must be stored in an encrypted form. Keys that encrypt key information are called master keys. It is desirable that each user knows the master keys by heart and does not store them on any physical media at all.

A very important condition for information security is the periodic recovery of key information in IS. At the same time, both ordinary keys and master keys must be reassigned. In particularly responsible IS, it is advisable to restore key information daily.

The issue of restoring key information is also related to the third element of key management – key distribution. Key distribution is the most responsible process in key management. It has two requirements:

1. Efficiency and accuracy of distribution.

2. Secrecy of distributed keys.

Recently, there has been a noticeable shift towards the use of public-key cryptosystems, which eliminate the problem of key distribution. The key distribution between users is implemented using two different approaches:

1. *By creating one or more key distribution centers*. The disadvantage of this approach is that the distribution center knows to whom and which keys are assigned, and this allows reading all messages circulating in the IS. Possible abuses significantly affect protection.

2. *Direct exchange of keys* between IS users. In this case, the challenge is to reliably authenticate the subjects.

In both cases, the validity of the communication session must be guaranteed. This can be ensured in two ways:

1) *a request-response mechanism* consisting of the following. If user A wants to be sure that the messages he receives from B are not erroneous, he includes an unexpected element (query) in the message sent to B. When responding, user B must perform a certain operation on this element (for example,

add 1). This cannot be done in advance because it is not known what random number will come in the query. After receiving a response with the results of the actions, user A can be sure that the session is genuine. The disadvantage of this method is the possibility of establishing, albeit difficult, regularity between the request and the response;

2) *time estimation mechanism* ("timestamp"). It involves fixing the time for each message. In this case, each IS user can know how "old" the received message is.

In both cases, encryption should be used to ensure that the response is not sent by an attacker and that the timestamp has not been altered. When using time estimates, there is the problem of an acceptable delay time interval for validating a session. After all, a message with a "timestamp" cannot, in principle, be transmitted instantly. In addition, the recipient's and sender's computer clocks cannot be completely synchronized. What lateness of the "stamp" is considered suspicious?

Therefore, in real IS, for example, credit card payment systems, the second mechanism of establishing validity and protection against counterfeiting is used. The used interval is from one to several minutes. A large number of known methods of electronic money theft are based on "wedging" this gap with fake requests to withdraw money. As a generalization of what was said about key distribution, it is worth emphasizing that the task of key management is reduced to finding such a key distribution protocol that would ensure:

– the possibility of opting out of the key distribution center;

– mutual confirmation of the authenticity of the session participants;

– confirmation of the probability of the session by the request-response mechanism, using software or hardware tools for this purpose;

– use the minimum number of messages when exchanging keys.

One of the important practical problems is the encryption of large messages and data streams. This problem appeared relatively recently with the advent of

multimedia devices and high-bandwidth networks that provide multimedia data transmission. So far we have talked about the protection of messages. At the same time, they meant rather some textual or symbolic information. However, modern IS uses technologies that require the transmission of significantly large volumes of data. Such technologies include:

– fax, video, and voice communication;

– voice mail;

– video conferencing systems.

If we compare the volume of transmitted information of different types, we can say that the volume of text information is the smallest, the volume of audio information is 2–3 times larger, the volume of graphic information is an order of magnitude larger, and the volume of video information is almost two orders of magnitude larger.

Since the transmission of digitized sound, graphic, and video information in many cases requires confidentiality, the problem of encryption of huge information arrays arises. For interactive systems such as teleconferences, conducting audio or video communication, such encryption should be carried out in real-time and, if possible, be “transparent” for users. This is unthinkable without the use of modern encryption technologies. The most common is stream data encryption. If in the previously described cryptosystems it was assumed that there is a certain final message at the input, to which the cryptographic algorithm is applied, then in systems with stream encryption the principle is different.

The security system does not wait for the transmitted message to end but immediately encrypts and transmits it. The most obvious is the bitwise addition of the input sequence (message) with some infinite or periodic key obtained, for example, from a PRN generator.

Another, sometimes more effective method of stream encryption is block encryption. That is, a fixed amount of information (a block) is accumulated, and then transformed by some cryptographic method and transmitted to the

communication channel. As has been repeatedly noted, the problem of key distribution is most acute in large IS. Part of this problem is solved (or rather, removed) due to the use of public keys. But the most reliable cryptosystems with a public key are quite time-consuming, and for encryption of multimedia data, they are not suitable at all.

Original solutions to the problem of “stray keys” are being actively developed by specialists. these systems are somewhat of a compromise between public-key systems and conventional algorithms that require the sender and receiver to have the same key.

The idea of the method is quite simple. After a key is used in one session, it is replaced by another one by some rule. This rule must be known to both the sender and the recipient. Knowing the rule, after receiving the next message, the recipient also changes the key. If the rule of changing the keys is carefully followed by both the sender and the recipient, then they have the same key at each moment. Constantly changing the key makes it difficult for an attacker to disclose information.

The main task in the implementation of this method is the selection of an effective key change rule. The easiest way is to generate a random list of keys. The keys are changed in the order of the list. However, the list will have to be transmitted somehow.

Another option is the use of mathematical algorithms based on so-called sorting sequences. On a set of keys, by the same operation on an element, we get another element. The sequence of these operations allows you to move from one element to another until the entire set is traversed.

Another possibility is the combination of encryption algorithms and information compression. The task of compression is to transform a message within the same alphabet in such a way that its length (the number of letters of the alphabet) becomes smaller, but at the same time, the message can be reconstructed without using any additional information.

In any case, the chosen complex cryptographic methods should combine both convenience, flexibility, and promptness of use, as well as reliable protection against intruders of the information circulating in the IS.

Questions for self-control:

1. Name the main types of technical channels and sources of information leakage.
2. What methods can be used to eavesdrop on conversations on the premises?
3. Name the main principles of information protection from NSD.
4. The structure of the request monitor.
5. Main characteristics of the Hartson model?
6. Main characteristics of the Bella-La Padula model.
7. Name the methods of authentication based on the unique physiological characteristics of a person.
8. Define the terms “cryptography“, ”cryptology“, ”steganography“, “ciphertext”, “cryptographer”, “cryptanalysis”, “key”, “cryptoresistance”.
9. What is the difference between symmetric and asymmetric cryptographic systems?
10. Define the concepts of “electronic digital signature”, “hash function”.

7.3. Methods of safe use of cloud storage and technologies

Recently, we have increasingly used cloud technologies and cloud data storage in our daily and professional lives. However, the basic rules of safe use of such services and technologies should be followed.

Cloud technologies are a new type of service that allows the user to use space for data storage, computing resources, and software for their processing

separately (via an Internet connection).

Cloud Computing is a model of convenient use of shared computing resources available through an Internet connection to perform data processing and storage tasks that can be configured and can be released and quickly provided to the user with minimal management costs and calls to the provider.

The architecture of "cloud" computing includes many "cloud" components (Fig. 7.11) that interact with each other through web services – Application Program Interface (API) [24–25].

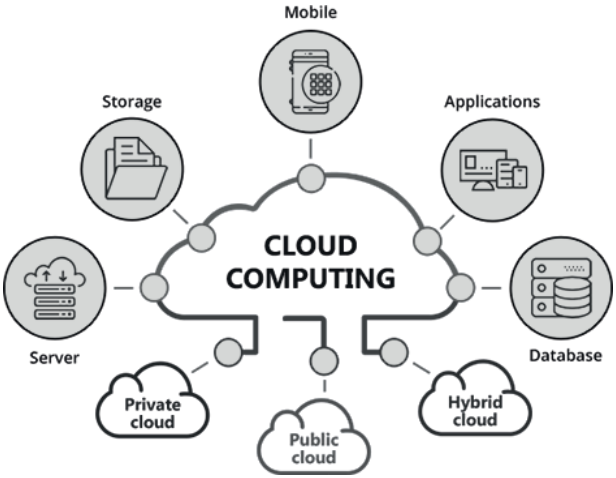

Fig. 7.11 – The architecture of "cloud" computing

Cloud technologies have two components – "Front-end" (the outer part of the cloud) and "Back-end" (the inner part of the cloud). With the help of the Front-end, the user interacts with the cloud (system, virtual machine, resources) from the client computer or other devices and applications used to access the cloud, and the Back-end represents resources (computers, servers, storage data, applications) that are involved in the performance of tasks set by the user, are essentially the "cloud" itself and form cloud services.

The concept of "cloud" data processing includes various models of providing IT services: PaaS, SaaS, DaaS, WaaS, CaaS, and EaaS (Table 7.3) [24–25].

Table 7.3 – **IT service delivery models**

Name of the service	Description
Platform as a service, Paas	Providing an integrated IT platform for creating, testing, deploying, and supporting applications. The client receives remote access to the software infrastructure and development tools.
Software as a service, Saas	The provider hosts the application, providing paid access to it via the Internet. Users pay only for using the program and do not pay for owning it.
Data as a service, Daas	Provision of data at the request of the user regardless of his geographical location or provider or organizational affiliation.
Infrastructure as a Service, IaaS	Provision of on-demand computing resources on which the customer can deploy and run arbitrary software, including operating systems and applications.
Workplace as a service, Waas	Provision of a virtualized workplace, a special case of IaaS.
Communication as a Service, Caas	As services, IP telephony, postal services, Unified Communications, etc. are provided.
Everything as a service, Eaas	A complex of all kinds of "cloud" services, satisfying any IT needs.

There are the following cloud deployment models:

– private cloud (Private cloud);

– public cloud (Public cloud);

– hybrid cloud (Hybrid cloud).

The choice of model depends on the scale of the organization, its structure, IT infrastructure, and specifics of data and tasks.

The private cloud ensures the placement of the virtual environment of the organization on a specific physical server, which is provided for use by one tenant. There is a possibility of placing the equipment (computing resources) in the data center (data center) alongside the equipment of other organizations (tenants), but it should be noted that this model provides for the separation of the cloud for one customer (tenant). Virtual resources are divided between internal structural departments, but they are used by one customer – one organization. The advantages of this model include:

– complete isolation of the IT infrastructure;

– the individuality of the configuration;

– increased reliability of data storage.

Therefore, this model is suitable for organizations with a complex IT

infrastructure and meets the conditions of a higher level of security and data privacy. Also, this structure is good for management and allows you to analyze and understand the needs of each structural unit of the organization, which in turn creates positive conditions of use. Private cloud tenants are quite often large companies, namely banks, mobile operators, retail enterprises, insurance companies, etc.

Disadvantages include high cost, deployment time, and limited resource pool, which does not allow for an increase in the capacity of cloud computing if necessary.

The public cloud involves the placement of virtual infrastructures of several customers at once on one physical server. It can be from two to an unlimited number. The data of one company is stored on the same physical server alongside the data of another organization. It should be noted that the data is reliably protected and isolated, including from the intervention of the cloud provider. In this case, the set of physical resources of the provider's data center is divided into several virtual data centers used by customers of cloud services. It should be noted that the physical location of an organization's data server cannot be determined precisely because, in a cluster, virtual machines are moved between servers to balance the load and improve uptime.

Advantages of public cloud:

– relatively low cost;

– flexibility;

– convenience and ease of interaction with cloud hosting;

– with a stable Internet connection, virtual machines are quite easy to expand and collapse;

– at times of peak load, it is possible to increase the computing power and decrease it if necessary.

It should be emphasized that the deployment of the public cloud model is not suitable for those companies or organizations that set special conditions for

information protection. However, if the company's equipment is outdated, and its replacement requires significant funds, then, in this case, renting a public cloud will be the best solution.

Comparative characteristics of public and private clouds are presented in Fig. 7.12.

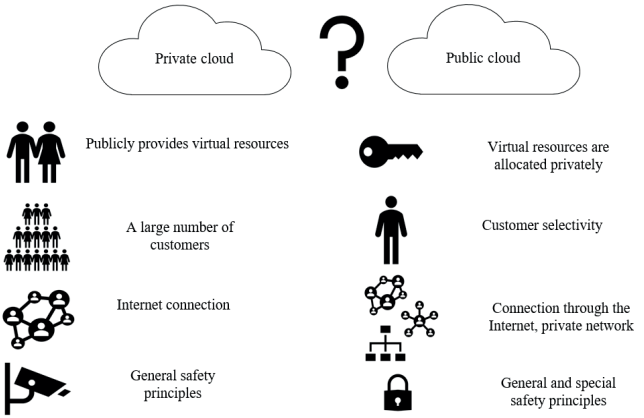

Fig. 7.12 – Comparative characteristics of public and private clouds

A hybrid cloud includes the characteristics of public and private clouds. This model is used when the customer does not have enough capacity in the private cloud, or some tasks are more convenient to perform outside the private cloud. For example, performing tasks that require significant computing resources, or performing tasks that do not require special protection of information and electronic data. Among the disadvantages, attention should also be paid to the fact that there is a possibility of data loss when transferring from a private cloud to a public one, as well as to determine the exact location of data. If it is not critical according to the organization's security policy, then this model is quite attractive for financial structures, insurance companies, and commercial enterprises.

Among the most popular SaaS products, Salesforce.com (Fig. 7.13), Google Apps (Fig. 7.14), Microsoft Office 365 (Fig. 7.15) should be noted.

Fig. 7.13 – Salesforce.com Services

Notable platforms include Microsoft Azure Platform, Google Cloud Platform, and Amazon Elastic Compute Cloud. The Microsoft Azure Platform is a full-featured combination of managed and unmanaged services that allow you to build, deploy, and manage applications in any way you want to achieve incredible performance.

Azure supports all operating systems, languages, tools, and platforms: from Windows to Linux, from SQL Server to Oracle, and from C# to Java. Azure offers enterprise data storage solutions for private, hybrid, and cloud environments with advanced capabilities.

Microsoft is an industry leader and expert in the security of personal data in the cloud.

Fig. 7.14 – Google Apps services

Microsoft's privacy policy prohibits the use and provision of data to third parties for advertising and operational audit purposes. Databases and sites of any complexity can be stored on the Azure platform. For organizations and companies, Microsoft Azure provides the opportunity to use cloud services. This option is very convenient and profitable for enterprises, as the costs of server maintenance are reduced.

Fig. 7.15 – Microsoft Office 365 services

Azure's core mission is to develop support services for computing, storage, networking, and application support that enable you to grow quickly and achieve more while minimizing costs.

Google Cloud Platform is a cloud-based data storage platform that offers to

host and supporting infrastructure. Allows you to quickly develop and deploy your applications without worrying about system administration. Cloud-hosted applications can automatically scale to meet the most demanding workloads and scale down when traffic slows down. The cloud platform offers both fully managed platforms and flexible virtual machines, allowing you to choose the scheme that will suit your needs.

Amazon Elastic Compute Cloud is a virtual computing environment that allows you to use web service interfaces.

When using ready-made software products or solutions, you are immediately offered a protection package, in particular when using Google, Amazon, and Microsoft products. The use of social networks, personal PCs, the use of social networks with a professional and personal identity requires that each user adheres to the general rules of safe operation. Let's focus on the main ones.

First of all, you need to find out what information is already available on the Internet about you and the company you work for. For this, you should use OSINT methods and the most common Internet search engines, including Google, Bing, Yahoo, or DuckDuckGo [23]. Advanced search operators should be used. Personal data include:

– your surname and first name;

– date of birth;

– e-mail;

– personal and corporate phone numbers;

– address;

– profiles in social networks;

– passwords.

Restricted information includes:

– intellectual property;

– business research;

– financial information;

– information about customers;

– information about employees;

– access passwords to resources;

– IP, MAC addresses of workstations.

Advanced search operators [23]:

– inurl: username – allows you to see all pages with the specified username in the URL;

– [your name] intext: [personal information, such as phone number, ID card, or address] – will report pages where personal information about a person is found, depending on the request;

– site:docs.google.com "company name" – will show Google Docs documents that it finds in public access, in which the name of the company is indicated;

– "companyname.com" – will show resources that link to the page of this company;

– password filetype:docx site:companyname.com – will output files in .docx format from the company website containing the word "password".

Google Images, Bing Images, and Tineye services are used to search for images. To check publicly available information about accounts and passwords, you should use the following services: Haveibeenpwned, Google Passwords, Spy Cloud, Ghost Project.

Basic safety rules:

1. **Separate accounts.** Separate your professional activities and personal life. When creating accounts, if possible, do not use your name and other personal data – generate an account without linking to personal data. To carry out financial operations, work with your bank cards, and create separate accounts that do not repeat professional and personal accounts.

2. **Use complex and different passwords**. Do not use the same passwords, it is better to use complex passwords, at least 8 characters (using letters, numbers,

special characters, upper and lower case letters). Generate multiple passwords for each online service. For added protection, use two-factor authentication.

3. **Remove metadata and hide geolocation.** Many services ask for access to geolocation. Provide access to such data only in extreme cases, when it is vitally necessary. Turn off geolocation and use a VPN. The EXIF metadata will show the camera model, time and date of the shooting, and course the coordinates of the shooting location (geographical coordinates).

4. **Take photos carefully.** We quite often like to display our photos, post selfies of others, and make corporate photo reports. The most popular social networks have taken care of privacy and automatically remove all EXIF metadata before publishing. But you should pay attention to the clues contained in the photos themselves, in particular, they can be the names of institutions, advertising signs, silhouettes of buildings that are often reflected in mirrors, and papers on the table often with confidential data of both the organization and personal information. Such seemingly insignificant details can lead to the disclosure of confidential information. Therefore, when taking a photo, analyze the place, the area, and everything nearby. Do not post photos that compromise you and do not allow others to take such photos, or simply control their deletion without the possibility of recovery. DO NOT take photos of others without their consent and ask permission to display such photos. Remember that the details of your personal life are a collection of information about you, your life, and your relatives.

5. **Minimize content.** Any comments and other content posted on the network are a threat to the confidentiality of information. When commenting on the quality of photos, or stories, especially during emotional outbursts, an unstable psychological state (a lot of content is precisely designed for such a reaction of a person, posting distorted information, or lies), control the content of the information you share.

6. **Carefully fill out the account with personal data.** All responsibility rests with the user. If you are a public person and want to share the real events of your

life, put your family, relationships, and other events of your life on display, then your own decision is yours and you are responsible for such behavior. Many people are forced to be "famous" on the Internet due to the positions they hold and their professional activities. In such cases, professional activity and personal life should be separated by accounts with the impossibility of tracing the relationship. From the security point of view, it is strongly recommended to fill in the account with false data, so that it is not possible to draw an analogy between the account and a person. Distortion of information will preserve a friendly image, obscure goals, and send competitors down the wrong path. It is recommended not to use the real date of birth (your relatives and friends know this information), enter a random value, do not enter the full name, or use a fictitious one, it is different for each account. For non-public accounts, use "avatars" or random images for the profile, but you need to make sure that this photo is unique and that no one else is already using it.

7. **Create trap files.** Such files may contain information of interest to the attacker, such as passwords, financial statements, and personal data that do not correspond to reality, that is, they are bait. With the help of the Canary Tokens service, you can receive a message when you try to open such a file and track the attacker's IP address and DNS server. A service like IP Logger will generate a link to place inside the trap file to track the hacker's IP address and location.

It is impossible to delete all information about yourself from the Internet because there are many open state registers in which you appear (real estate, court cases, vehicles, and others), so the only thing left is to delete accounts that you do not use, as well as exclusion from brokerage databases, an attempt to send requests to remove publications on social networks and other sites.

To delete accounts, you can use the directory of direct links (*https://backgroundchecks.org/justdeleteme/*). Account blocking or deactivation will technically keep your account online and searchable. To be removed from the brokerage database, it is necessary to directly contact the administrators with a

request for exclusion. On many sites, an online exclusion request form is available. To exclude your data and information compromising you, it is also necessary to contact the owners of accounts and sites. If you receive a refusal, you can file a complaint with the administration of Facebook, Instagram, LinkedIn, YouTube, and Google.

The issue of security is a continuous process that is dynamically developing. Therefore, it is necessary to constantly update your knowledge in this matter or use the services of security specialists.

Questions for self-control:

1. Define the term “cloud technologies”.
2. What IT service delivery models do cloud technologies provide?
3. Name the cloud deployment models.
4. Compare the characteristics of public and private clouds.
5. What Google services do you know?
6. List Microsoft Office 365 services.
7. What information is classified as restricted-access information?
8. Name the basic safety rules.

7.4. Blockchain

Today, humanity is constantly transforming into a digital society. The development of information technologies leads to the emergence of new technologies and their introduction into everyday life. Blockchain technologies are rapidly developing and expanding the possibilities of their use. The emergence of cryptocurrency has opened up new opportunities for society’s transition to digital finance. The cryptocurrency market is constantly expanding, they have certain fluctuations just like ordinary money. The basis of any cryptocurrency is

the blockchain, which is a global ledger created based on combining separate blocks of transaction data. Blockchain technology is based on the use of hash functions.

A hash function is a function that reorganizes an input of letters and numbers into an encrypted output of a fixed length. A hash is created using cryptographic algorithms and is necessary to manage the chain of blocks in cryptocurrency.

Features of the hash function:

– a function that meets the encryption requirements necessary for the blockchain;

– has a fixed length, which is very difficult to guess when trying to break it;

– the hash is calculated based on the information contained in the name of the blocks.

Among the properties of the hash function, it should be noted:

1. Speed – the computation speed of the hash function should be as fast as possible for any input data.

2. Unidirectionality – there should be no way to compute the input data from the hash.

3. The presence of an avalanche effect – the slightest change in the raw data should drastically change the hash, without any reference to the previous hash.

4. Resistance to collisions.

5. Resistance to attacks.

Today, the cryptocurrency market is quite large and has thousands of types. Of course, Bitcoin took the clear lead, and it maintains its leadership. However, the emergence of new altcoins (alternative coins) is primarily aimed at improving the classic bitcoin. It should be noted that each type of altcoin differs from the other and solves the problems inherent in bitcoin in its way. Weaknesses of Bitcoin cryptocurrency include:

– limited functionality;

– insufficient anonymity;

– long transaction time;

– complex and energy-consuming mining.

As a result of the improvement, cryptocurrency projects appeared with additional encryption (Monero (XMR)), minimization of transaction confirmation cycles (Ripple (XRP)), and an increase in the number of transactions in a block, simpler mining models. Ethereum (ETH) altcoin deserves special attention, which is the second largest after Bitcoin. Work on this project led to the emergence of a smart contract that expands the possibilities of using blockchain technology. Today, thanks to smart contracts, blockchain technologies are used in various spheres of human activity, including trade, service provision, and the financial sphere. The essence of smart contracts is the creation of a computer program containing the terms of the contract signed between the parties.

The terms of the contract included in the smart contract are fulfilled if the conditions written in them are fulfilled. It is not possible to affect the execution of a smart contract after it is uploaded to the blockchain, as it is executed automatically when the terms of the contract are met. Blockchain technologies are used from one-click purchases of goods using cryptocurrency to complex functions such as decentralized financing (DeFi) of loans, savings, and liquidity pools.

Blockchain is a decentralized digital ledger (a continuously growing list of electronic records) of transactions that are stored over a long period and protected using encryption. Blockchain registry data is distributed across a network of computers. Its users can independently, and directly interact with the stored data in real-time, without intermediaries to confirm the authenticity of the transaction. Blockchain technologies provide an independent, tamper-proof, and transparent platform for all participants, which allows for the safe storage, transmission, and processing of confidential information.

Main properties of blockchain:

– decentralization;

– equality;

– protection from external influences;

– synchronization by agreement;

– there is no need for verification by a third party;

– all transactions are visible to all participants of the corresponding blockchain.

Decentralized applications (dApps) are applications or programs that are based on blockchain technology and run on a decentralized computer system or P2P network. Their main advantages are open source code and high resistance to possible attacks.

Decentralized applications never stop working due to the absence of a central server. Data in them is distributed between nodes, while all nodes operate independently: if one of them stops, the others will continue working in the network. Examples of decentralized databases that use this feature are the Interplanetary File System, BitTorrent, and independent DHT tables.

Three categories of dApps can be distinguished depending on the blockchain model they use:

1. **Type I.** Programs run on their blockchain (Ethereum platform).

2. **Type II.** DApps that function based on an already existing blockchain (the MakerDAO protocol).

3. **Type III.** These applications are based on Type II dApp protocols, but they require two components to work: a blockchain and an application running on that blockchain (the Augur application).

The limited number of tokens and placement in the network of scarce resources gives profit. The constant growth of the network and the increase in the number of users with a constant number of tokens contribute to the increase in the value of the coins. Owners of computing power (scarce resources), miners, charge a fee for each transaction.

Among the areas of application of blockchain technologies, the game

business should be noted. The creation of blockchain games was facilitated by the popularity of cryptocurrency and the transparency of operations, i.e. the impossibility of economic manipulation by game companies, the minimization of payment problems, and the avoidance of disconnection or imbalance of the game process. The core ideas and principles of blockchain technology create a distributed and transparent open-source network for player participation, real-world asset ownership, consensus-based updates, decentralized markets, optimized tokens, and more. The most popular games were CryptoKitties, Alien Worlds, Axie Infinity, Cartesi, and The Sandbox.

The use of smart contracts in the field of real estate made it possible to get rid of such problems as slow transactions, mistrust between buyers, sellers, and intermediaries, administrative disputes, and inheritance registration. The introduction of blockchain technologies allowed for the automation of routine processes, transparent registration, and tracking of data, which led to a reduction in costs and an improvement in the quality of service provision. The use of smart contracts has enabled the implementation of such business models for real estate as fractional ownership of hard-to-share assets, encrypted contracts to speed up transactions, and crowdfunding of real estate through monetization.

The use of smart contracts in insurance has some positive trends, in particular, the reduction of fraud, and the increase of trust in policyholders due to the transparency of paperwork and quick payments in the event of an insurance event. For example, we purchased an insurance policy for flight delays, in the event of such an event, you automatically receive payments immediately to the card. That is, upon the occurrence of an insurance event, which is prescribed in the smart contract, you instantly receive the payments due to you. Also, the use of blockchain technologies allows offering complex versions of insurance products on microinsurance products. Most insurance companies already have this kind of offer for their customers.

The emergence of blockchain technologies did not bypass art. NFTs (non-

fungible tokens) have gained widespread use in the art world. Using this technology, works of art are created and sold at auctions at quite high prices, they are authentic and unique. The development of NFTs contributed to the emergence of crypto-art and digital collecting. The use of this technology is also possible for the authenticity of documents for real assets, such as works of art, jewelry, musical and literary works, and poetry. You can access, view, buy, and research works created using NFT technology through the Binance NFT Marketplace. You must have a Binance account to carry out transactions.

Blockchain technologies can provide security from individual accounts to the management of entire states. Recently, the use of blockchain technologies in conducting elections, managing enterprises, holding meetings, and voting on various scales is becoming more and more popular [3]. With an individual level of protection using blockchain technologies, self-sovereign identity is ensured (individual users can control personal information, ensure secure transmission of data, messages, and the necessary level of protection of Internet of Things devices).

Countries such as Malta, China, and Australia are using blockchain technology for government-level security. Blockchain technologies are widely used to prevent denial-of-service attacks at individual vulnerable points.

The use of blockchain technologies in the medical field to protect medical data, reduce fraud, and create a single medical information center for citizens of the country is considered promising [4].

Questions for self-control:

1. Define the term “blockchain”.
2. Define the term “hash function”.
3. Name the properties of the hash function.
4. Describe decentralized applications.
5. What are smart contracts used for?

6. Where are blockchain technologies used?
7. What are the prospects for using blockchain?
8. What difficulties may arise when using blockchain?

7.5. IoT and protection methods

The last few years have seen widespread development and implementation of IoT systems. In connection with the development of IoT technologies, experts in the field of information security express concern [12–14]. In their opinion, the huge number of poorly protected Internet devices provides new opportunities for cybercriminals, who have already managed to hack some IoT systems. This task is especially relevant when using these tools at critical infrastructure facilities.

As a rule, an IoT system includes physical devices, a controller, or other processing and decision-making device that communicate with computers or other devices via the Internet. For example, these can be sensors for protecting the perimeter of your house, video cameras that transmit data to the controller, and the controller transmits all information via the Internet to the specified location (phone, server, PC). When any security sensor (vibration, movement, reed switch) is activated, the signal is transmitted to the controller, and then, depending on the program, for example, a sound siren is activated, a message is sent to the security service, and the owner of the house (Fig. 7.16).

But the use of IoT systems is so wide that they can include the management of the entire city, monitor the health of people and inform about deviations from the established indicators, control the load on athletes during training, carry out remote monitoring and control of the functioning of certain objects, carry out automatic checking the condition of a wide range of devices, sensors that can be used in smart homes and cars, when managing the city and the state as a whole. IoT technology can be used individually and collectively.

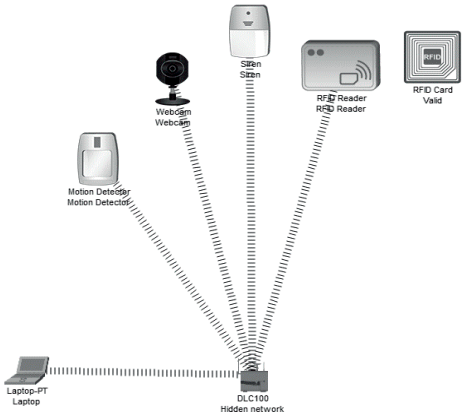

Fig. 7.16 – Protection zone cluster

The introduction of such technologies can solve the problems of improving the living conditions and quality of life of the elderly and people with special needs (management of climate control systems, lighting, food purchases, food, health monitoring, medication reminders, use of real-time sensors, transfer data to relatives or persons caring for such people).

This technology is widely used in industry and commercial activities. The use of a wide range of sensors makes it possible to control and manage a wide range of technological equipment used in the industry and municipal services of the city (management of water bodies, technological lines, machines, engines, pumps, switching of traffic lights depending on road congestion, notification of the presence free places in parking lots near supermarkets). Another direction is the use of farms to monitor the availability of water and food for animals.

The use of IoT has reached such a scale that today the issue of Internet bandwidth for transferring large amounts of information, connecting, and monitoring a large number of sensors arises. It is necessary to state the transition of humanity to the use of INDUSTRY 4.0.

In the work [7], the author testifies that at the beginning of the introduction of IoT, sensors sent data to the cloud, where they were processed, analyzed, and

stored, and management decisions were made. With the exponential increase in the number of devices, the load on both data transmission channels and the volume of the cloud for storage (trillions of gigabytes) has increased, so the use of edge computing has become a necessity, not a wish. The author notes that the use of edge computing and cloud technologies together is possible, and in some cases necessary, especially in industry. Edge computing is the most important component of IoT, which helps to reduce latency and increase the reliability of deployed systems [7]. In [21], models of IoT architecture are presented, the need for IoT protection is determined, the results of research on the construction of an information protection system for IoT devices, in particular, separated and centralized, and simulation modeling of the load depending on the number of devices is carried out.

The issue of security is quite relevant and is aimed at the comprehensive protection of information. For example, work [11] focuses on the complexity of IoT protection and provides eight key security technologies: network security, authentication, encryption, attack on the security side, security analytics and threat prediction, interface protection, and delivery mechanisms.

Prospects of implementation and threats facing IoT systems are presented in [1; 5–6; 17; 19; 22]. The analysis of these works confirms the relevance of security issues, directions of protection, and basic conceptual approaches to the implementation of security. High-profile cyberattacks have occurred more than once, and the number of hacker attacks is increasing [2; 8; 16]. The relevance of the problem is emphasized by incidents, the capital losses from which are measured in billions of dollars.

The largest number of attacks falls on portable devices, the use of wireless communication technologies between system elements creates the prerequisites for a cyber attack on the system. According to [1; 5–6; 17; 19; 22], NSD is most often carried out by hackers through entry (access) points to the corporate network or is used to launch a DDoS attack. Considering the large number of sensors

connected to the system, the use of wireless networks, cloud services, etc. does not allow to ensure a reliable cyber protection perimeter of the object. Another direction is the theft of confidential data of users (companies). Machine learning technologies and the use of artificial intelligence systems have a powerful potential for cyber threats due to their dual purpose (the algorithms used can both counter cyber attacks and create them). New technologies create new cyber threats that can only be countered with the use of new information technologies.

Modeling of systems made it possible to determine that the main areas requiring attention from the side of cyber protection are [13–15]:

– communication security;

– protection of the devices themselves;

– control over the operation of devices;

– control of interaction in the network.

As a result of the research and analysis of the most likely attacks on simulated systems, the following classification of attacks is proposed (Fig. 7.17):

Denial-of-Service (DoS) (D):

1) physical level (H):

– attack of setting an obstacle (H_1);

– attack of intervention in the IoT system (H_2);

2) channel level (C):

– collision attack (C_1);

3) attacks on routing protocols (R):

– "Black hole" attack (R_1);

– selective forwarding attack (R_2);

– attack "Rapid Onslaught" (R_3);

– "Funnel" attack (R_4);

– "Sybil" attack (R_5);

– "Wormhole" attack (R_6);

– flood attack ((R_7));

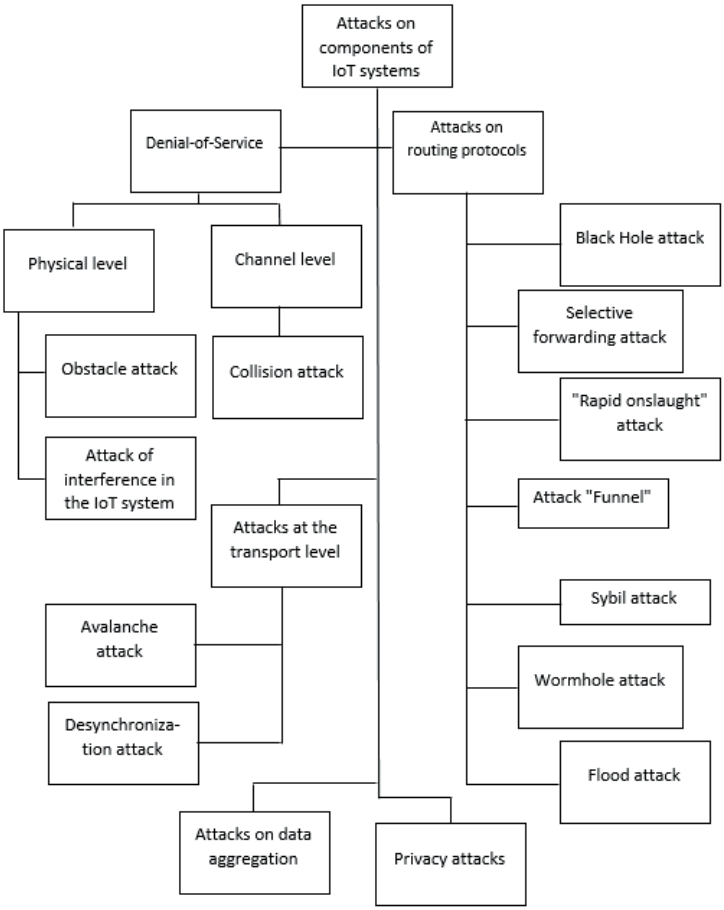

Fig. 7.17 – Attacks on IoT system components

4) attacks at the transport level (T):

– avalanche mailing attack (T_1);

– desynchronization attack (T_2);

– data aggregation attacks (G);

– privacy attacks (P).

Attacks can be presented in the form of open classification groups:

$D = H \cup C$ – multiple attacks leading to a denial of service, it includes combining multiple physical and channel layer attacks. The set of attacks leading to denials

of service at the physical level (formula 7.7):

$$H = \bigcup_{i=1}^{n} H_i. \tag{7.7}$$

The set of attacks leading to denials of service at the channel level (formula 7.8):

$$C = \bigcup_{k=1}^{z} C_k. \tag{7.8}$$

A set of attacks on routing protocols (formula 7.9):

$$R = \bigcup_{v=1}^{s} R_v. \tag{7.9}$$

The open classification grouping of transport-level attacks is presented in the form of a set (formula 7.10):

$$T = \bigcup_{\alpha=1}^{l} T_\alpha \tag{7.10}$$

The set of attacks on data aggregation is represented by the following form (formula 7.11):

$$G = \bigcup_{j=1}^{m} G_j. \tag{7.11}$$

Multiple privacy attacks (formula 7.12):

$$P = \bigcup_{\gamma=1}^{\delta} P_\gamma. \tag{7.12}$$

In general, attacks can be represented as a combination of all classification groups (formula 7.13):

$$A = D \cup R \cup T \cup G \cup P. \tag{7.13}$$

We will analyze each attack included in the classification group.

DoS attack at the physical level. A DoS attack is characterized by an adversary's attempt to stop the operation of a network or destroy a network

security service. In the IoT system, a DoS attack can occur at different levels of the protocol stack, can affect several levels at the same time, and use the interaction between them. A DoS attack at the physical level can be carried out by interfering with the radio frequencies on which the system operates. With such an attack, one attacking node can disable the entire network or some part of it (for example, blocking data transmission).

The attack of interfering with the operation of the IoT system when detecting a sensor (in our case, a sensor / camera on the perimeter of the security object) and trying to gain physical access to it is of critical importance for our system. In this case, an attacker can destroy the device, try to change data, gain access to confidential information (in particular, cryptographic keys), and use the device to enter the network.

Channel-level DoS attack. DoS attack of collisions at the channel level is directed, as a rule, to exhaustion of node resources. This attack affects the packet transmission process by causing exponential delay and packet retransmission procedures in some MAC protocols. Thus, when a large number of bits in a packet are damaged, the node will try to use error correction codes to restore the damaged bits, thereby wasting limited energy resources. Another example of such an attack is a “collision” at the end of a frame, which causes the entire packet to be retransmitted. Another variant of attacks inherent in the IEEE 802.11 protocols can be the generation of an RTS message to the base station or a neighboring node, which will lead to the processing of this message and the generation of a CTS message, then waiting for the reception of the signal, and all other nodes stop transmitting data to the receivers node for the time specified in the RTS message. Flowering methods can also be implemented.

We will analyze attacks on routing protocols. The well-known Black Hole attack is aimed at using a routing protocol to redirect packets going from or to a target node through a specific node. This attack can be used for packet dropping or “man-in-the-middle” (a method of compromising a communication channel, in

which an attacker, after joining a channel between counterparties, interferes with the transmission protocol by deleting or changing information). Another type of attack is the selective forwarding attack, which is similar to the Black Hole attack, but in this attack, packets that meet certain criteria will be dropped, not all.

When implementing the "Swift Onslaught" attack, the route opening procedure is used at the request of routing protocols. A malicious node generates and broadcasts a route request to its neighbors, and as a result, the node has an increased probability of being part of the chosen route between the source and the destination.

A "Funnel" attack is characterized by the fact that the attacker tries to place a compromised node or his own in the path of as many networks flows as possible, and then begins to act as a funnel – collecting all the traffic of the sensor network. In protocols using broadcast broadcasting, the attacker listens to the channel and informs the neighbors that he "knows" the shortest route to the base station. Once he managed to get between the broadcasting sensor node and the base station, he can do whatever he wants with the data packets coming to him.

The "Sybil" attack is characterized by the fact that the attacker tries to compromise an operating node, or connect his own using several pseudo-identifiers and thus pretending to be several nodes at the same time. In this way, neighboring nodes can perceive it as "theirs". This kind of attack is used to break the distributed storage mechanism, routing mechanisms, data aggregation mechanisms, and voting mechanisms in the network.

A wormhole attack poses a serious threat to the security of sensor networks because it does not require the compromise of a sensor node. So, for example, an attacker listens to a channel and receives a broadcast of a route request message from a base station and forwards it to the nearest neighbor. The node that received this message will consider it as its parent, that is, the one that is closest to it, although this is not the case at all. The action of the attack is based on creating a special path between two or more network nodes for the transmission of

intercepted packets, and the nodes will think that they are transmitting packets via the shortest path.

One type of attack is a flood attack (HELLO flood attack). The peculiarity of this attack is an attempt to transmit a mass of optional messages to the network, which will deprive the network of various resources (computing power, channel capacity, energy resources). Having a high-frequency radio transmitter with sufficient computing power, the attacker sends Hello packets to many sensor network nodes. After receiving this message, the nodes perceive the compromised node as a neighbor and include the received address of the sender in the mailing. In this way, the attacker gains access to the data sent from the nodes.

The functions of the transport layer include the delivery of packets (TCP) and datagrams (UDP) from the sender to the recipient. Attacks at the transport level are aimed at analyzing traffic regularity and sending parallel duplicate messages on other paths used at this level. Given the fact that most transport protocols support sensitive information and are therefore vulnerable to memory exhaustion, an avalanche attack (the attacker makes new connection requests each time increasing the amount of sensitive information in the attacking node, gradually leading to the fact that the node becomes faulty (rejection of the node from further connections) due to resource exhaustion) and exploits this flaw.

Another characteristic attack of this level is a desynchronization attack, as a result of which an attacker tries to destroy the connection between two working nodes in the network by repeatedly forging messages to them. In particular, transport layer protocols can use sequence numbers to track successfully received packets, identify packet loss, and detect duplicates. Attacker-generated packets can use these sequence numbers to convince a node that packets have been lost and trigger retransmissions, which can have the already known consequences of resource exhaustion and channel congestion when valid information does not arrive at the base or does arrive late.

Attacks on data aggregation are aimed at changing network behavior. Data

aggregation and fusion procedures are used in networks where the placement of typical sensors is close to each other. Such procedures are used to combine multiple data to eliminate redundant information. Save resources, is positive, but it is dangerous from the point of view of cyber security. Thus, the calculation of simple mathematical functions (minimum, maximum, average value, sum) used during aggregation in the case of the presence of one malicious node or replacement of real data from sensors can change the behavior of the network partially or as a whole.

Attacks on privacy are aimed at capturing information collected by sensors and can be implemented through network eavesdropping, traffic analysis, and/or node hijacking. This is especially relevant for those networks that do not use data encryption.

Recommendations for countering attacks on IoT system components. Defense against physical level DoS attacks. Using IEEE 802.11 (broadband) standards use frequency hopping. In this case, the interference transmitter must "know" the sequence of hopping motion or create interference of a larger frequency band. It is suggested to use spread spectrum technology to protect against such attacks. The transmission of such a signal will be similar to noise, which will reduce the risks of intentional interference with the information signal.

In addition, when the signal disappears from any part of the network or node, or network element, the DSS (Decision Support System) must generate an alarm for the unit. Nodes that detect an interference attack must transmit a short message to their "neighbors" and the base station about the attack on the network. In this case, if the message "does not reach" the base station from the attacked node, there is a possibility of receiving an emergency message from the node that was not attacked.

To counter attacks of interference in the operation of the IoT system, each sensor used in the system must be equipped with a tamper (a miniature button on the board of the device that is pressed when the case is opened or it is disconnected

from the attachment point). When the tamper is triggered, the hub sends all users of the security system push messages and SMS (if such types of messages are available in the devices that will be used), as well as transmission of the message to the base station. In addition, it is desirable to provide programmatically that when the tamper is triggered during “arming”, all data stored on the device will be destroyed automatically. To avoid detection of sensors, they should be placed in hidden places, but suitable for their installation, and materials resistant to external influences should be used. Sensors and cameras have their range, so when placing such devices, this indicator should be taken into account and installed with an overlap to avoid a zone of insensitivity. If installed correctly, the sensor will detect the danger and send an alarm signal to the base station before the attacker gets close to it.

To counter a link-level DoS attack, there is authentication to verify that the node generating the message is authorized on the network in combination with encryption. In our case, we use the WPA2-PSK authentication standard with the AES encryption type. Considering the limit of energy resources, the use of asymmetric encryption becomes impossible in such systems. The main disadvantage of using symmetric encryption is the problem of key distribution. When using a symmetric cryptographic scheme, shared cryptographic keys must be reliably and securely established between two nodes before they can exchange data. Key installation and management techniques must be suitable for use with hundreds and thousands of nodes.

Another way to improve protection is to install an RFID tag on all network devices and carry out a combined (two-factor) node authentication procedure.

It is proposed to use blockchain technology to protect against interference in the program code and changes in sensor indicators. This technology is a distributed database that is potentially accessible to everyone. Thanks to the use of blockchain technology, it is possible to combat fraud, manage the identification, and transactions, verify the status of elements of various systems,

and ensure data integrity. Combining blockchain and Internet of Things technologies can solve some security problems, namely: tracking sensor data measurements and preventing duplication by any other malicious data; authentication, and secure data transfer.

The use of cryptography is suggested to meet the needs for protection against eavesdropping, injection, and packet modification. To counter aggregation attacks, it is proposed to use methods of delaying aggregation and authentication. To prevent routing attacks, we use channel-level encryption and authentication using a global public key. Sybil attacks can be prevented by verifying the identity of sensor nodes (using a shared symmetric key from a trusted base station) and limiting the number of neighbors a node can have. Thus, a compromised node will be able to communicate only with verified neighbors. The “Funnel” attack can be countered by using a geographic routing protocol, in which traffic “naturally” directed to the physical location of the base station is difficult to redirect to create a funnel.

Edge computing in information protection systems can be used to counter several considered attacks and is the subject of further research. The use of clusters of protection systems, IoT clusters in combination with edge computing creates new approaches to technologies for building protected IoT with decentralized data processing.

In the economic direction, many Internet of Things systems will depend on microtransactions between digital objects and this will require a machine-to-machine (M2M) economy connection that will ensure the exchange of money between non-human devices. In this case, there is a need for an IoT-compatible currency, that is, the use of cryptocurrencies can be a solution. Many blockchain projects are working on scaling to provide adequate transaction-per-second performance, such as Bitcoin Lightning Network and Ethereum Plasma.

Over time, IoT will undoubtedly improve our daily lives and increase the efficiency of management and control, and automation in various industries. The

combination of cryptocurrency and IoT will create the prerequisites for the digital economy of states, cryptocurrency will become digital money for microtransactions and the M2M economy.

Questions for self-control:

1. What is included in the IoT system?
2. Name the areas of use of IoT.
3. What are the prospects for the implementation and threats of IoT systems?
4. Name the attacks inherent in IoT systems.
5. List the methods and measures to counter attacks on the IoT system.
6. How can channel layer attacks be countered?
7. How to prevent eavesdropping?
8. What is a microtransaction?

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UDC 004.330.1

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Chapter 8
DESIGN THINKING FOR DIGITAL TRANSFORMATION

Content

8.1. The concept of design thinking: principles, process, empathy: understanding human needs and shortcomings

In user experience design, it's crucial to develop and refine skills to understand and address rapid changes in users' environments and behaviors. The world has become increasingly interconnected and complex since cognitive scientist and Nobel Prize laureate Herbert A. Simon first mentioned design thinking in his 1969 book, The Sciences of the Artificial, and then contributed many ideas to its principles. Professionals from a variety of fields, including

architecture and engineering, subsequently advanced this highly creative process to address human needs in the modern age. Twenty-first-century organizations from a wide range of industries find design thinking a valuable means to problem-solve for the users of their products and services. Design teams use design thinking to tackle ill-defined/unknown problems (aka wicked problems) because they can reframe these in human-centric ways and focus on what's most important for users. Of all design processes, design thinking is almost certainly the best for "thinking outside the box". With it, teams can do better user experience research, prototyping and usability testing to uncover new ways to meet users' needs.

Design thinking's value as a world-improving, driving force in business (global heavyweights such as Google, Apple and Airbnb have wielded it to notable effect) matches its status as a popular subject at leading international universities. With design thinking, teams have the freedom to generate ground-breaking solutions. Using it, your team can get behind hard-to-access insights and apply a collection of hands-on methods to help find innovative answers.

In essence, design thinking:

1. Revolves around a deep interest to understand the people for whom we design products and services.

2. Helps us observe and develop empathy with the target users.

3. Enhances our ability to question: in design thinking you question the problem, the assumptions and the implications.

4. Proves extremely useful when you tackle problems that are ill-defined or unknown.

5. Involves ongoing experimentation through sketches, prototypes, testing and trials of new concepts and ideas.

Large enterprises and corporations, representatives of private small and medium-sized businesses, academic and government institutions and organizations are faced with the need to create innovative products and services to satisfy existing stakeholders in the relevant field of activity. The key to the

successful implementation of innovations is a high-quality justification of the chosen strategy and an effective system of monitoring its implementation.

At the core of the design-thinking methodology are interdisciplinary approaches to stimulating innovative processes aimed at improving existing products, services and processes. According to scientist Michael Luchs, design thinking is a systematized method of collective work to identify and creatively solve a problem.

A comprehensive approach to design thinking as a tool for finding ways to satisfy stakeholders based on involvement allows you to expand the possibilities of applying tactics used in the fields of art, architecture, engineering and technology, which are characterized by the use of design methods. Design Thinking Theory and Practice has been gaining popularity and has been increasingly used in management and business administration academia over the past few decades.

The goal of design thinking is to solve the most complex, multifaceted and unresolved problems with systemic impact (Roberts, 2000; Churchman, 1967; Rittel & Webber, 1973).

Organizations in this section act as social units or a collective of individuals, which was created purposefully to achieve specific goals, with the aim of solving a problem by creating a new product or service (Etzioni, 1964, p. 3).

Design thinking is seen as the use of methods and research practices to solve problems outside the boundaries of architecture or engineering. **Design thinking** is a method of developing products, services, and services oriented to the consumer (user), which is based, first of all, on consumer demand, and secondly, on the possibilities of technical implementation and economic possibilities.

Characteristic features of design thinking are:

– immersion in the consumer experience;

– detached approach to defining the problem;

– focusing on personal scenarios of behavior and actions.

In order to solve the problem and determine an effective solution, it is necessary to conduct research, focus on the "pain points" of stakeholders, generate an alternative set of ideas, choose the best alternative, create a prototype and test it. The constructive-thinking method describes the tactics of performing these stages and the tools necessary for each of them.

Hasso Plattner and David M. Kelley, who are the founders of the Hasso Plattner Institute of Design (a design school that combines management and business practices with traditional engineering techniques), systematized the methods of design thinking. They investigated the stages of the creative process, the center of which is the consumer, and substantiated the approaches to using design thinking in business.

In 1969, Herbert A. Simon in his book "Sciences of the Artificial" defined design thinking as the process of transforming existing conditions into desired ones. Thus, design thinking is a process that is always focused on creating a better future and finding new tools for solving complex problems in a variety of areas, focused on the target group of users.

Since the 1990s, thousands of people have studied design thinking individually and in groups. Among the notable initiators of this trend are the design and consulting firm IDEO and the Hasso Plattner Institute for Design Thinking at Stanford University. Design thinking was depicted in various schemes: as an open spiral, a curved loop, a double rhombus or a series of rings. Regardless of which diagram to draw this process, in design thinking methodologies we constantly come across two central ideas or principles.

There was a certain development of the theory and practice of design thinking, given in the form of a chronology in the Table 8.1.

Table 8.1 **– The development chronology of the design thinking theory and practice**

Period	Characteristic
1	*2*
By the 1960s	The origins of design thinking lie in part in the process of creative techniques of the 1950s.

Continuation of Table 8.1

1	*2*
1960s	The first known books on the methods of creativity were published by William J.J. Gordon (1961) and Alex Faickney Osborn (1963). The 1962 conference on systematic and intuitive methods in mechanical engineering, industrial production, architecture and communications, London, Great Britain, aroused interest in the study of design processes and the development of new design methods. Books on methods and theories of design in various fields are published by Maurice Asimou (1962) (engineering), Christopher Alexander (1964) (architecture), L. Bruce Archer (1965) (industrial design) and John Chris Jones (1970) (product and system design).
1970s	Don Koberg and Jim Bagnall, in their book The Universal Traveler, were the first to develop "soft systems" to solve the problems of "everyday life". Horst W.J. Rittel and Melvin M. Webber publishes "Dilemmas in a General Theory of Planning", which show that the problems of design and planning are evil problems, in contrast to the "manual", individual disciplinary problems of science. L. Bruce Archer expands the study of design ways of knowing, arguing: "There is a constructive way of thinking and communicating that is different from scientific and scientific methods of thinking and communication and is as powerful as scientific and scientific research methods when applied to his own types of problems".
1980s	The development of design, human-centered, and the growth of design-oriented business management. Donald Shen publishes a "reflective practitioner", in which he seeks to establish the epistemology of practice embedded in the artistic, intuitive processes that [design and other] practices bring to situations of uncertainty, instability, uniqueness and conflict of values.
1990s	The first symposium on research in the field of design thinking is held at Delft University, the Netherlands, in 1991. IDEO consulting agency for design thinking is formed by combining three industrial designs of the company. They are one of the first design companies to demonstrate their design process based on design methods and design thinking.
2000s	Beginning of the 21st century, brings a significant increase in interest in design thinking, as the term becomes popular in the business press. Books on how to create a more design-oriented workplace where innovation can thrive have been written for the business sector, including Richard Florida (2002), Daniel Susan (2006), Roger Martin (2007), Tim Brown (2009), Thomas Lockwood (2010), Vijay Kumar (2012). The design approach is also expanding and adapting to solve service design problems, marking the beginning of the service design movement. In 2005, Stanford University's School of D. School began teaching design thinking as a universal approach to technical and social innovation.
2010s	2018 – In Harvard Business Review, Jan Lidtke argues that "design thinking works" in business.

Design thinking has certain characteristics. First, design thinking is human-centered. First of all, it takes into account the needs and desires of people, not the

proposals of companies or artistic ideas. Human-centered design thinking involves observation, conversation, research, and collaboration.

Secondly, design thinking is based on a creative worldview, openly exploring certain issues, rather than looking for a specific path to these results. During this creative process, you need to ask questions, visualize ideas, create material prototypes and tell stories about people, ideas and results.

These key principles are people-centeredness and creative worldview and support a lively and changing process of design thinking.

For each stage of the process, design and thinking is characterized by the passage of two phases:

– divergent comprehension;

– convergent processing.

The divergent phase (from the Latin divergere – diverge) consists in finding a set of solutions to the same problem.

The convergent phase (from the Latin convergere – converge) consists in the exact use of instructions for solving the problem.

Characteristics of the design thinking process and the main stages

Innovation is seen as the embodiment of the process to be updated in the organization and designed to create new products and services (Bessant, Lamming, Noke, & Phillips, 2005), is a mechanism for solving key problems. To effectively innovate, strengthen competitiveness, organizations in recent decades have increasingly turned to the use of design thinking as a product development process (Lockwood, 2010; Johansson-Sköldberg et al., 2013). Design problem solving is a powerful method of creating innovative products and services that can solve existing problems of various industries.

Sydney A. Gregory, in The Design Method (1966), states that design thinking is “a method of designing a model of behavior used to create things that do not yet exist. The science is analytical, and the design science is constructive”. In this context, design is used as an engine of a product, system, creation of services that

meets the needs and challenges of the client or end user.

The idea of the fundamental, practice-oriented method of design thinking is the ability to adapt the existing experience of solving the problem, taking into account the achievements of socio-scientific research, various groups of the population and existing trends.

Tim Brown defines the process of design thinking based on three elements that are not consistent, but intersect: inspiration, idea and realization. He noted this position in the work "Change by Design" (2009). This definition of design thinking is based on the work of Lawson (1980), Rowe (1987), Archer (1979) and Cross (1991, 2001). This design approach notes three **key elements** that can be repeated, may overlap, and may not be consistent (Brown & Wyatt, 2010):

– inspiration;

– idea;

– implementation.

The first key element is the creation of ideas with participation and empathy on the part of designers for relevant stakeholders. This empathic process can find out which stakeholders are relevant, which are not mentioned, and what system dynamics are in question. In addition, interaction with stakeholders (whether they are the end user) leads to more innovative results (Holmlid, 2009). This element aims to define a need (Faste, 1987), in which the designer studies the explicit and implicit desires and requests of the client, creates a user solution that meets these requests. A search exercise file is required throughout the design process; however, in terms of the inspiration of the IDEO process (Brown, 2009; IDEO, 2011), is a central function that allows you to create ideas, solutions and approaches to solving a client's problem.

The second key element is one form or another of prototyping, iteration and verification. This can be described as a period of quick, gradual testing of ideas that can be quickly tested and analyzed. This element can be described as reasoning (Brown, 2009), with a clear emphasis on the transformation of ideas

into specific products, services or systems. The stage of an idea in design thinking can be repeated endlessly since ideas are repeatedly comprehended and transformed by the physical in different forms to verify and evaluate their compliance with the desired goal.

The third element is implementation, which is also reflective and repetitive, which consists of studying each idea, testing and affirming the success or failure of an idea in order to continue and create better, more sophisticated goods or services. This process consists of experience-based learning can be described as reflective (Schön, 1988) and serves as a driver of the process of design thinking. Reflective practice (Schön, 1988, 1983) links elements of inspiration, ideas and implementation (Brown, 2009) design thinking in the context of stakeholder needs, with an emphasis on reflection, improvement and empathy.

Theoretically, the design process is split into three main phases, but in practice you can start with any and move as you like.

Step one is to observe. You need to look, listen, ask questions and collect data. Observation requires patience, care, and humility. Conversations with users develop empathy and give insights. Workshops push to develop design together with stakeholders whose views may diverge. Researching the lifestyle of a particular community deepens knowledge about it. The foundation of these methods are the values of human-centered design.

The next step is to imagine. At this stage, it is necessary to generate many ideas, sort them into groups, look for connections and analogies and decide how to move on. In this way, human-centered research is combined with creative thinking, opening our perception to unexpected concepts.

The third step is to create. Here creative action comes to the fore. Creation is a direct and physical process. Through prototypes, you can show how the product will work. Storyboards (storyboards) give users an idea of how they will be able to interact with the device. Role-playing embodies a service or process in social and physical aspects. Each creative method begins with the question: how

a design solution or insight can help real people. Each prototype or narrative serves as a tool to communicate with users and stakeholders.

At the heart of design thinking is the search for ideas. Creative methods in design play the role of a set of defined actions that the team performs to search for an idea.

The Stanford School of Design divided the process of design thinking into several stages (Fig. 8.1):

1. *Empathy* – immersion in the problem issue and user experience.

2. *Focusing* – the formulation of a specific, significant task that can be solved.

3. *Idea generation* – generating ideas and choosing a solution.

4. *Prototyping* – creating a model for testing certain solutions.

5. *Testing* – receiving feedback and determining the best solution.

Fig. 8.1 – Algorithm design thinking

The presented method of design thinking consists of five stages, each of which refers to a divergent or convergent phase. Divergence consists in expanding the angle of view, collecting all the finds and ideas. Convergence involves narrowing the focus and choosing a priority idea to be tested, worked out in the following stages.

The process of design thinking is iterative, that is, the developed idea is immediately subject to verification, the result obtained is used as an experience to find the best solution.

As a result, we note that the term design and related words are used in the text with the meaning – design, engineering, development and reproduction. The reorientation of cognitive processes in professional activity from analytical methods to a creative approach faces various kinds of problems, the main of which is cognitive distortions of human consciousness.

Questions for self-control:

1. Explain what the essence of design thinking is?
2. Describe the main goal of applying design thinking.
3. What are the key features inherent in design thinking?
4. What is the essence of the divergent phase of design thinking?
5. What is the essence of the convergent phase of design thinking?
6. How are elements such as inspiration, idea, realization related?
7. What stages of the design thinking process are selected by experts?
8. What is the essence of empathy in the process of design thinking?
9. What is the purpose of creating empathy maps?
10. Explain what the essence of empathy is?

8.2. Cognitive distortions and their effects of human activity

The effect of cognitive distortions on human consciousness

Design thinking is a creative process of a person's professional activity, because of any process of information processing, he encounters certain features of consciousness. Most often these are cognitive distortions.

Cognitive (the process of information processing by our consciousness) distortions are understood as systematic errors in thinking or pattern deviations that arise on the basis of dysfunctional (incorrect) beliefs embedded in cognitive schemes and are easily detected when analyzing automatic thoughts. The existence of most cognitive distortions has been described by scientists, and many have been proven in psychological experiments. Cognitive distortions are an example of evolutionarily formed behavior. Some of them perform an adaptive function since they contribute to more effective actions or faster decision-making. Others apparently come from a lack of appropriate thinking skills or from the inappropriate application of skills that have been adaptive in other settings.

Cognitive distortions can occur due to various causes, in particular:

– "failures" in the processing of information (heuristics – a scientific branch that studies the specifics of creative activity);

– "mental noise" – talking to oneself;

– limited brain ability to process information;

– emotional and moral reasons;

– social impact.

Distortions associated with behavior and decision-making unnecessary concern for success.

Amplification – investing more effort in achieving the goal than necessary, an attempt to "kill a fly with a sledgehammer". Option – excessively detailed planning in the absence of sufficient source data and the presence of strongly influencing the result of uncertain or random factors.

Acceleration – performing work at a speed greater than necessary or even acceptable. In the latter embodiment, literally and figuratively: running through a minefield.

Advancement is an unreasonably early start of action to achieve the goal. Bias towards the search for information is the tendency to look for information even when it does not affect the actions or the result.

Exaggeration of the probability of individual cases.

Generalization of individual cases – groundless transfer of characteristics of private or even isolated cases to their large sets. There are many types of this cognitive distortion, the classic version is a conspiracy theory.

The effect of contrast is the amplification or underestimation of the value of one object when it is compared with the contrast object just discovered. For example, a person is happy that he bought something inexpensively in a store, but ceases to rejoice after he discovers another, little-known store in which the same thing is 2 times cheaper.

The Baader-Meinhof phenomenon or the illusion of frequency – newly

recognized information that appears again after a short period of time, is perceived as extremely often repeated.

Reassessment of the significance of individual cases.

Deviations in the direction of the result – the tendency to judge decisions by their results, instead of assessing the quality of decisions by the circumstances of the moment in time when they were made ("winners are not judged" by the "judgment of the survivor").

Reassessment of influence – the tendency of people to transfer the duration or intensity of the impact of an event on their future experiences.

The focusing effect is an error in predictions that occurs when people pay too much attention to any one aspect of a phenomenon; causes errors in the correct prediction of the usefulness of the future result. For example, focusing on who is to blame for a possible nuclear war distracts attention from the fact that everything in it will suffer.

Reassessment of their capabilities.

The effect over confidence is the tendency to overestimate their own abilities. The illusion of control is the tendency of people to believe that they can control or at least influence the outcome of events that they cannot really influence [4].

The advantage of zero risk is the advantage of a controlled, but potentially more harmful (due to its more frequent occurrence) situation over the opposite due to the reassessment of the possibility of control. That is, the person, for his part, believes that he completely gets rid of the risk (in fact, without having full control), while on the part of statistics this is a reduction of only one, not the greatest risk to zero. For example, most people would prefer to reduce the likelihood of terrorist acts to zero instead of reducing accidents on the roads, even if the second effect gave more saved lives [5]. Another common example is iatrophobia: many people are more afraid of complications of medical interventions than diseases and deaths because of these diseases arising from lack

of treatment (for example, anti-vaccination).

The Dunning-Kruger effect – people who have a low level of qualification, draw erroneous conclusions, make unsuccessful decisions and at the same time are not able to realize their mistakes due to the low level of their qualifications. In the mid-1990s, in the city of Pittsburgh, a well-dressed man in the middle of the day and without hiding his face robbed a bank. When he was caught (and it only took one day to do so), he couldn't hide his surprise. "How was I identified?" – Asked. "After all, I generously smeared my face with citrine!" although it looks like a joke, it is true: two friends of that mister, whose name was Wheeler, assured him that citrine would help hide his facial features, making him invisible. To prove that it is, they smeared it with lemon juice, then took a photo of him, erased his features from it – and that Wheeler calmly went to business, thinking that no one would recognize him.

The news then received wide publicity and served to ensure that Cornell University social psychology professors David Dunning and Justin Kruger became interested in the case and asked themselves the following question: is it possible that a person's incompetence does not allow him to see that he is incompetent? Professors Dunning and Kruger conducted an experiment in which they asked several volunteers to assess their level of competence in the following areas: grammar, argumentation, logic and humor. So, they found that the stupider a person was, the less aware they were of their gaps. And vice versa: competent people tended to underestimate themselves very much. Dunning and Kruger also noticed that there is a connection between incompetence and quackery, and proved that fools rate themselves so highly that they always consider themselves surprisingly intelligent. Something similar happens with knowledge.

The more ignorant a person is, the more it seems to her that he knows everything, and with a lot more strongly opposed to learning something new. This is what some call the "arrogance of ignorance". Or, as popular wisdom says, the fool of the sea is knee-deep. So, when wisdom is prudence, restraint, and doubt,

ignorance is the insolence of antonyms: it is reckless, reckless, intolerant. When I was young, I was often confused by the fact that that fools are absolutely certain of themselves. For the chronically insecure person who your submissive servant is, the one to whom everything was clear was synonymous with the leader. And the big problem is that in fact it is. Many fools are born leaders, you just need to give a look at the world of politics: individuals with astonishing self-confidence and the same arrogance utter insubstantial nonsense. And since aplomb is very often confused with intelligence, it turns out that many people follow them.

The most interesting thing about this phenomenon is that a significant part of these people are by no means fools. They only think that if so many people follow this Gamel pied piper, then there is some reason for that. In addition, when a pied piper manages to convince a certain number of people, there is a cumulative effect – no one thinks anymore, everyone goes into no matter what abyss. And we hardly noticed that in this way, it seems, the realm of fools was established. Many of us ask ourselves how it is possible that people succumb to such incredible nonsense that we see every day: profess delusional conspiracy theories, create all sorts of internet-inspired silliness: from selfies in the mouth of a volcano to the belief that the earth is flat; and they also issue and maintain crazy laws that are contrary to basic common sense... There is not one explanation, there are many phenomena that contribute to the fact that folly is rotten among us (moreover, reinforced by the multiple and distorting mirror that it is social networks). I don't know what Dunning and Kruger will say now about the consequences of the effect named after them almost thirty years ago. If then they were surprised that the man, relying on his own folly, robbed the bank, smearing his face with lemon juice, now they would be dumbfounded, making sure that this effect, according to which "a person's incompetence does not allow him to see that he is incompetent", is no longer a hilarious exception to that Wheeler, but stands in the way of becoming the norm.

It is necessary to recognize that we are all carriers of cognitive distortions

and to use it correctly. Anyone who will avoid this recognition will lie to himself and make the same mistakes repeatedly.

Reassessment of the significance of one's own opinion / position / choice.

Distortion in the perception of the choice made – excessive perseverance, attachment to one's choice, perception of it as more correct than it really is, followed by its justification. For example, attempts to find implicit advantages in the purchase and thereby justify it in the presence of another, more suitable product that for some reason was not purchased.

The effect of acquaintance with the object is the tendency of people to express unreasonable sympathy for an object only because they are familiar with it (patriotism, the effect of involvement in the creation of the object).

Irrational escalation – the tendency to remember your choice as more correct than it really was.

Blindspot on distortions – easier detection of deficiencies in other people than in yourself. In this case, a person is inclined to protect his thoughts. Methods of protecting one's opinion in such distortions are usually:

– selection or adjustment of the hypothesis to the measurement results;

– the tendency to seek or interpret information in such a way as to confirm previous concepts;

– unconscious manipulation of the course of research to identify the expected result;

– considering only those facts that are consistent with expectations.

– the tendency to assert oneself in one's rightness contrary to testimony, which is contrary to a person's initial stable beliefs. Because of this effect, which has acquired the name of the *opposite result*, it can be difficult to convince the interlocutor of the dispute, even if you provide him with strong evidence that refutes his position.

Other types of cognitive distortions.

The effect of authority is the tendency to attribute a higher appreciation to

the opinion of an authoritative figure and to a greater extent depend on this opinion. *Man is used to relying on the truth of authority than the authority of truth.*

Decorating the past – the tendency to evaluate past events more positively than they were perceived now when they actually happened.

The "curse of knowledge" is the difficulty for more informed people when trying to view any problem from the point of view of people less informed.

Professional deformation is a psychological disorientation of the individual during professional activity. The tendency to look at things according to the rules generally accepted for one's profession, rejecting a more general point of view.

The effect of ownership is the overestimation of the value of the purchase immediately after its acquisition. Its consequence – the rejection of loss – the negative utility that is associated with the loss of an object turns out to be more than the utility associated with acquiring it. People, knowing the benefits of the thing due to them, are more upset about its loss than they would rejoice at its finding, to which they did not think about this thing and, accordingly, did not consider its benefits.

The need to complete and the advantage of holistic subjects – the need to achieve completion in an important question, get an answer and avoid feelings of doubt and uncertainty.

Regulation is the trap of continuous orders for oneself to do something, instead of sometimes acting impulsively, spontaneously, when it is more acceptable, when looking for something new, for example, during vacation, rest.

The status quo is the tendency of people to want things to stay about the same.

Procrastination – systematic unjustified postponement, delaying the beginning of inevitable work.

Time-saving bias – human tendency to erroneously estimate the time, which can be saved (or lost) because of an increase (or decrease) in speed.

Planning error – the tendency to underestimate the time of execution of tasks,

the cost and duration of the implementation of projects, especially new, complex, large, unique. *A special case of a planning error found expression in Murphy's law: "Any job requires more time than you think"*.

Socially conditioned distortions. A large group of distortions associated with behavior and decision making. For example, distortion in their own favor:

1. *Distortion in favor of one's group* is the tendency of people to give preference to those they consider to be members of their own group.

2. *Selfish error* is the tendency to recognize greater responsibility for successes than for defeats.

3. *Fundamental attribution error* – the tendency of people to explain the behavior of other people with their personal qualities, underestimating situational factors, and at the same time overestimating the role and strength of situational influences on their own behavior, underestimating the personal aspect.

Distortions associated with probabilities and stereotypes. Many of these cognitive distortions are often studied in relation to how they affect business and how they affect experimental research. Common mistakes due to misunderstanding of the essence of accidents, for example:

1. *The primacy effect* is the tendency to overestimate initial events more than subsequent events.

2. *The recency effect (proximity aberration)* – the tendency to value recent events more than earlier events.

3. *The Hawthorne effect* is a phenomenon in which people observed in a study temporarily change their behavior or performance. Example: increasing labor productivity in a factory when a committee comes to study labor productivity in this factory.

Distortions related to memory errors, for example:

1. *The self-reference effect* is a phenomenon in which memories encoded with reference to the self are better recalled than similar information without reference to the self.

2. *Egocentric distortions* – remembering the past in a self-aggrandizing manner, for example, remembering exam grades better than they were, and the fish caught – bigger.

3. *False memory* is a memory disorder expressed in false memories.

4. *The disinformation effect* occurs when the reproduction of episodic memories becomes less accurate due to post factum information.

Hindsight bias

Regarding the importance of influencing professional decisions in the field of financial and economic activity in the conditions of digital transformation, among cognitive distortions there is an effect after knowledge or hindsight error.

Effect after knowledge, Hindsight bias – a cognitive distortion, a tendency to perceive events that have already happened or facts that have already been established as obvious and predictable, despite the lack of sufficient primary information for their prediction. An error after knowledge can lead to distortion of memory processes, in particular, processes of restoration and reproduction of past experience, leading to false theoretical conclusions. Thus, this effect can cause serious methodological problems at the stages of analysis and interpretation of the results of experimental studies. The after-knowledge effect is dangerous in forensics – it can influence the expert's conclusions along with other cognitive distortions. Other names: "I knew it from the beginning", "I knew it like that", "So I knew it!", "English I-knew-it-all-along", hindsight, retrospective determinism, retrospective distortion.

According to Hartmut Blank and his colleagues, all hindsight errors existing in the literature can be reduced to three independent processes: the effect of inevitability, the effect of predictability, and memory distortions. All three phenomena are different possible manifestations of the hindsight error, which can occur both separately and together.

The first phenomenon – the effect of inevitability – reflects a retrospective increase in the subjective probability, or perceived inevitability, of a particular

outcome. In other words, when a person learns about how the event ended, this outcome begins to seem more likely or inevitable to him than before he acquired this knowledge.

The second phenomenon is the effect of predictability: people tend to believe that they knew everything in advance or were able to predict how this or that event would end. B. Fischhoff called this effect "I-knew-it-all-along".

Finally, the third phenomenon is memory distortion. After receiving an answer to any question (for example, "What is the length of the Danube River?") or after receiving information about the outcome of an event, the knowledge in memory is distorted, adapting to the received information about the correct answer.

In the literature, the hindsight phenomenon is most often associated with the effect of predictability, followed by the effect of inevitability and processes of memory distortion. H. Blank notes that these phenomena do not reflect the same phenomenon, since, first of all, different psychological processes are at the basis of each of them. Thus, at the basis of the effect of inevitability are the processes of creation and modification of cause-and-effect models of the event. In hindsight, people construct and add new cause-and-effect relationships in such a way that the outcome seems predetermined.

The effect of predictability, in turn, is associated with processes such as a person's perception of the extent to which he was able to predict a certain outcome. For example, drunk drivers may recognize in retrospect that after six glasses of whiskey the probability of getting into a car accident is very high, but they will also be convinced that they were unable to foresee such a possibility when they were drunk. Finally, memory distortions are governed by various memory processes, especially such as binding ("fitting") memories to the actual outcome of the event and restructuring initial assumptions. Moreover, the inevitability effect may also help to cope with the disappointment of undesirable consequences ("I had no chance"). The effect of predictability, in turn, serves the

function of self-affirmation (for example, promotes the perception of oneself as an informed person, including in the eyes of others). In addition, subjective predictability (or unpredictability) performs the function of self-protection (maintenance of positive personal identity) in case of perception of a negative result for which a person can be responsible. For example, owners of stocks that have crashed in price believe that they were not able to foresee the failure in advance. Memory distortions, according to some authors, can be considered as a byproduct of knowledge updating processes and thus can indirectly affect the function of knowledge updating.

The hindsight bias is based on the same limitation of cognition. This limitation is manifested in a person's dependence on current knowledge when trying to recall or reason about available information, regardless of whether it is about one's own state or about another person's state. This is the key limitation underlying the hindsight fallacy.

The hindsight bias has similarities to other memory distortion phenomena, such as the misinformation effect and false memories in autobiographical memory. All three variants of memory distortion are the result of a three-stage process. The specifics of each process for the three cases may differ, but they all end with one or another psychological manipulation or alteration of memories.

The first stage is different for the three phenomena, but in all three cases there is some kind of event present in the first stage: the event that happened (misinformation effect); an event that did not happen (false autobiographical memories); a statement made by a person about an event he remembers (hindsight fallacy).

The second stage consists in increasing the information that a person receives after the event has occurred. In the case of a hindsight error, the new information is reliable and clearly presented to the person, while the additional information in other cases of memory distortion is false and presented to the person in an ambiguous and possibly manipulative form.

The third stage includes restoration in memory ("remembering") of primary information. A person prone to the hindsight error or misinformation effect must recall the original information, while a person with false autobiographical memories will create memories of events that did not actually occur.

Research shows that a person tends to make the hindsight error even when he is aware of the existence of this effect and has a desire to overcome it. It is impossible to completely overcome the hindsight effect, but there are ways to weaken it. One of them is consideration of possible alternative explanations of the event and openness to different points of view. The only way to reduce the effect of hindsight in experimental conditions is to force yourself to think about alternative explanations that may be correct.

Prevention of the impact of cognitive distortions

Thinking is a useful activity, necessary for solving problems, analyzing, comparing, studying, planning, etc. But very often the mind wanders where it wants, occupying attention with trivial and unimportant questions and useless thinking that wastes your time and energy. Critical thinking is an integral part of design thinking, its component.

Indeed, there is no consensus on any known definition of intelligence. The reason, perhaps, is that this word is associated with different qualities. In history, there are many examples of people unanimously recognized as intelligent in such diverse fields as science, technology, art or philosophy.

Defining intelligence as "he ability to reflect, plan, solve problems, think abstractly, grasp complex concepts, remember quickly, use accumulated experience", scientists conducted an analysis of research and concluded that people endowed with high intelligence have more chances to protect themselves from various kinds of prejudices.

To reveal a high level of intelligence, one should remember the ability of some people to abandon the established patterns of their era and act in a new way, not being satisfied with what seems obvious. Galileo, Darwin, Einstein, as well as

Kant and Descartes were such dissenters. They questioned the prevailing ideas and simplified interpretations of the world order. Intelligence in that case was accompanied by critical thinking, the ability to intellectually oppose the dominant system of concepts, an attempt at ideological processing and, in general, any form of dogmatism.

Critical thinking is often confused with intelligence, but it is not the same. Critical thinking is a set of cognitive qualities that allow us to think rationally, considering a certain goal and the readiness to apply these qualities at the right time. Critical thinkers have flexible thinking and look for evidence that supports their beliefs and recognize attempts to mislead them. Critical thinking means the ability to overcome any cognitive biases (e.g. hindsight bias, confirmation bias).

Man by his nature is irrational and this in certain aspects hinders us, creates obstacles on the path of life. Not all beliefs are stupid, absurd, or dangerous. Some of them can be constructive, such as *believing in yourself, in your abilities, in your worth, in life and in other people*.

The risk of falling under the influence of dangerous beliefs is connected with the need to find the meaning of life at any cost. If someone gives us an explanation that fits our worldview or frees us from independent search, it is easier for us to accept it. But the greatest danger of irrational beliefs is that they tend to align with our intuitive expectations. Since ancient times, people have believed in strange things, and many have tried to fight them.

Despite all his intelligence, education and critical thinking, no human being is immune to stupid prejudices – mainly because people have a hard time believing in randomness. To look for *fate, fatality, intrigue, conspiracy, good or evil intention in random events* is a universal mistake.

If it is not possible to particularly increase the level of your intelligence, you can learn to develop critical thinking.

Informing people about cognitive distortions and biases and encouraging them to avoid them is not enough to get rid of them. To avoid them, it is very

important to understand how an alternative result could have been obtained. We need confirmation – evidence, and this is achieved through obtaining information – knowledge. On the way to critical thinking, the first thing a person needs are to realize his nature and accumulate knowledge and experience.

Acquiring knowledge (acquiring experience) is a physically difficult process for our brain, so in approximately 80–85 % of people it (the brain) will resist this process. The solution is to constantly train yourself, as a person, and the brain as its main part. The first stage will be planning your day.

Questions for self-control:

1. What methods of analyzing consumer behavior are used at the stage of empathy in design thinking?
2. Expand the content of the concept of consumer profile
3. What are cognitive distortions?
4. What are the types of cognitive distortions?
5. What are the main techniques for counteracting cognitive distortions?
6. What is critical thinking?
7. Define intelligence

8.3. Idea generation: techniques and tools for conceptualizing solutions

Goal setting and motivation as elements of critical thinking

In order to achieve the set goals, tasks, or increase one's efficiency in general, a person first of all needs to understand how the brain works.

So: modern neuropsychology and psychoanalysis claim that 2 systems are responsible for the thinking process in our brain – the subconscious (unconscious state) and consciousness. They are marked by system 1 – unconsciousness and system 2 – consciousness. System 2 is our conscious thoughts, the voice in our

head, in fact it is the person we consider ourselves to be. This is a system that can carry out instructions and a sequence of actions (for example, multiply 7 by 14). System 2 is very hard to start (actually lazy) it is slow but attentive and can find a bug.

System 1 is our unconscious part (subconscious mind), an incredibly fast system that processes a huge amount of data that enters our brain, it selects the most important of them and discards the extra, and most of it. It works automatically (in the background) without us, that's why it was called the subconscious. We do not even understand the scope of her work. For example, when you see some text, it reads it even before you try to read it. It automatically adds information for completeness of perception. This is the library of our memory, and system 2 is a short-term memory that can simultaneously hold 4–5 new concepts.

Learning is essentially the formation and grouping of new information into known designations, that is, the transfer of work from system 2 to system 1. That is, in fact, it is a system of repetition.

Frequent, conscious repetition leads to the accumulation of databases of system 1. It was Sigmund Freud who popularized the idea of the unconscious. He formulated the statement that: the perception that behind our ideas, thoughts and actions there are unconscious motives beyond the control of our will. Further, Carl Gustav Jung developed this statement and concluded that people are very strongly influenced by things that are not controlled by their consciousness. This is how our brain has evolved to use our resources in a better way. For repetitive tasks, we have developed an automatic system for their execution to save the limited capabilities of system 2 for those things that really need our full attention.

How to train your mind to achieve efficiency

No one can live without a routine, if you don't have one, you can't maintain your psychological health! For example, you can choose a time to get up in the morning, any, but one thing and be sure to stick to it, it will have a positive effect

on your mood.

Setting a goal for oneself is a problem when a person sets a task for himself and does not fulfill it. Again and again he formulates the task and postpones it for later, formulates it again and postpones it again. How to solve such a problem?

First, you must agree with yourself what you want and what you will get for it. Such work must become part of your routine, otherwise it will not work, because you are not your own servant, you must negotiate with yourself. This is motivation. You have to motivate yourself to do the work through incentives. You need to start by determining the number of hours during the day wasted on meaningless activities. Make a schedule for yourself and stick to it. But consider that the main rule of the schedule is not a prison. Ask yourself about the ratio of responsibility to reward and move on. You need to make a schedule so that you get the best possible day for yourself and you are satisfied with it, and the most important thing is that you are not in a worse position compared to the beginning of the day based on the results of your work. And even if you did everything as you wanted, you will be able to fulfill your plan by no more than 50–70 %, but this is already significantly more than 0. And even if these percentages will be smaller, you should try to achieve positive growth dynamics in the following periods. This will make you efficient and you will see your own results and be amazed at your achievement.

Second, start writing. Writing is thinking, if you have an idea, put it on paper, and the first thing you will see is some flaws in the formation of the idea itself. Ideas expressed in writing allow a person to learn to think and clearly convey his thoughts. Advanced thinking allows you to be more effective.

Identifying the problem and assimilating input information

To achieve goals, a person needs 2 things – diligence and intelligence. Two complex elements that are difficult to measure and even more difficult to determine their impact on achieving results. Modern science does not provide an answer to the question of how to increase intelligence and diligence. These

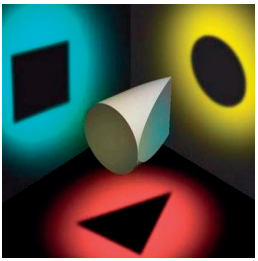
complex questions lie in the plane of a person's personality. Take IQ as an example, any attempts to develop exercises to increase it have failed. Indeed, many techniques, methods and principles of solving complex problems were developed, and people used them very effectively, but changing the problem and the situation brought everything back to the beginning. Accordingly, humanity has not achieved progress in increasing human intelligence. Therefore, each person works on the balance of these elements within the framework of his personality or personalities, which actually creates a successful adaptation of a person to the surrounding environment. It can be characterized in such a way that a person will look for such a field of activity where his specific features of perception, temperament and behavior will meet the requirements of this field (self-realization).

In any field, self-realization is the process of solving certain problems, or choosing the optimal solution or direction. The only way to choose the optimal way to solve the problem is to determine the content of the problem. After creating an empathy map, focusing is carried out – this is a transitional stage that involves processing all the collected information. An empathy map is a graphic diagram in the center of which is the consumer, surrounded by various information blocks depending on the task. The main task of creating an empathy map is to create a detailed portrait of the ideal consumer of a particular product. At the same time, the center of the empathy map can be not only the consumer, but also an idea, task or problem to be solved.

Focusing is the next stage of the design thinking process. At this stage, a clear concept of the project is revealed. All that was heard and seen is gathered together, a complete picture is formed from the received information, in which the most important is determined. At the focus stage, conclusions are drawn based on the information gathered in empathy mode, and a concept is created that will be implemented in the project.

The content of focusing consists in formulating a question that should be

related to the problem. This is a statement that focuses on the conclusions made in the process of observation, an image that is formed based on certain characteristics of various objects. The focusing mode is also called "point-of-view" (POV). The main problem of this stage is to avoid cognitive distortions of "points of view" (Fig. 8.2).



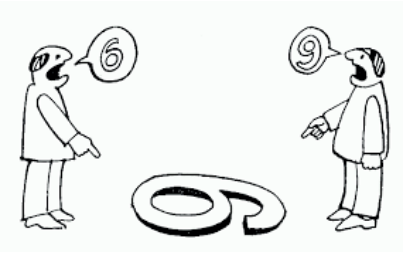


Fig. 8.2. The problem of information perception through "point of view"

Focusing is a deep understanding of what was collected in the process of observation. Focusing is critical and allows for an explicit expression of the problem that needs to be solved based on the information collected about people's lives.

The information with which we work, the samples that are available to us, do not reflect the whole picture, but only what we received and perceived. Accordingly, you need to be able to go beyond this framework, keep in mind that the data that is available is always incomplete, and this inevitably leads to various kinds of distortions.

The process of finding new ideas

The next stage is the ***generation of ideas***. At this stage, the search for a solution to the problem, which was defined earlier, is carried out. At this stage, it is important to generate the whole range of possibilities, there is no place for one correct idea. Idea generation is the development or development of new ideas that contribute to the possibility of creating new ideas. There are many ways to organize a constant search for ideas. The main components of the search for new products are the analysis of sources and the application of creative methods of

obtaining ideas.

The process of generating ideas should be aimed at expanding the possibilities of solving the problem and looks like branching into all possible concepts and results that can be applied as an alternative solution to the problem. The basis for creating a prototype and an innovative solution is the representation of participants in the design thinking process.

The use of different methods of generating ideas allows you to avoid potential complications and get benefits, namely:

– avoid obvious solutions and increase the innovative potential of the idea;

– use the collective representation and strengths of the team;

– to open entire areas that were previously left out;

– provide flow (quantity) and flexibility (diversity) of innovative solutions.

In order to generate ideas, prototyping or creating a layout based on bodystorming is used – this is a variant of "brainstorming" with an emphasis on generating ideas and creating unexpected inventions through physical research and interaction, creating intellectual maps, sketches, etc.

The creation of an idea occurs through a combination of rational thoughts and emotions based on established limits, the presentation of context and the consideration of unrelated ideas.

The search for new ideas begins with the method of "silent brainstorming". After that, ideas are discussed and developed. All formulated ideas are subject to verification of their viability by applying evaluation criteria and using filters.

Procedure for selection, sorting and structuring of basic ideas:

1. Formulation of selection criteria. If there are several criteria, then each of them must have a certain weight. The criteria allow you to preserve the innovative potential accumulated in the mode of generating ideas.

2. Selection of an idea by voting (the danger of voting may be that if the majority supports the idea, then the enthusiasm of the rest of the team may fade).

3. Prototyping and testing its functionality. To search for ideas, it is

appropriate to use brainstorming sessions, sketches, drawing up intellectual maps or building a layout. Any way is good, the main thing to remember is that the generation of ideas should be clearly separated from their evaluation. Under this condition, the presentation can be limitless.

As an effective tool for finding new ideas is Boyd's "ooda loop" or killing speed. U.S. General Charles Krulak characterized John Boyd as a high intelligence officer. A specialist who made an unsurpassed contribution to American martial art and was one of the central architects of military thought reform. It is this model of behavior that competitive decision-making on the battlefield – time compression, and its use as its ally "OODA Loop" began to be applied in civilian life due to its effectiveness and highly competitive environment.

A military mental model known as the "OODA Loop". It is also called the "Boyd Loop". It is a practical concept of rational thinking of military leaders to function effectively in confusing or chaotic situations. It helps to quickly make the right decisions in a combat situation. The abbreviation "OODA" stands for simply. Observe is to observe. Orient is to navigate, decide is to solve. Act is to act.

The word "loop" involves repeating these steps repeatedly until the situation is resolved or ended. Each repetition of one stage provides more information for the next, turning it into a feedback process.

Observe. Information alone is not enough. The observation stage requires the transformation of information into a general context. A particularly important leadership skill is the ability to determine which information is just noise and irrelevant to the decision at hand. If you want to make good decisions, you need to master the art of observing what's around you.

Orient. To navigate, it is necessary to recognize any obstacles that may interfere with other parts of the "Boyd loop" cycle. What does orientation do in this context? First, it allows to associate oneself with reality: to see the world as

it really is. As free as possible from the influence of cognitive biases and simplifications. Without unnecessary details, but not primitive either. To his colleagues, John Boyd recommended the use of the process of "deductive destruction". Pay attention to your own assumptions and biases. Then find fundamental mental models to replace them. In this way, you always learn from the mistakes made and do not continue to repeat them.

Decide. The previous two steps provide the foundation needed to make an informed decision. If there are several options at hand, you will have to use your observation and orientation to choose one. The best possible.

Act. There is a difference between making decisions and implementing them. Once you decide that it's time to act, it's worth checking your decision. The results and consequences will indicate whether your decision was correct or not. Having received information about this, you will return to the first part of the "loop" and begin to observe anew.

In sports, there is a proverb that extends quite well to war: "Speed kills". If you know how to be agile, adequately assess an ever-changing environment, and adapt quickly to it, you will always have an advantage over any adversary. Even faster than lightning.

Suppose you need to work fast. What then? You can learn something from fighter pilots. For them, any seconds of undue hesitation can cost lives. Pilots have many solutions and processes that they can juggle when they are in air battles. They move at high speed and must avoid enemies by tracking them. And also to maintain contextual knowledge of goals, terrain, fuel and other key variables.

Start applying the "Boyd loop" in your everyday decisions. Just watch what's going on! Believe me, you will notice things that you did not pay attention to before. Before you draw a conclusion from the information received – stop. Pause for a short break. Consider your mental biases, get more information, and be sure to think about the consequences.

Like any practical action, if you do something right, the more you do it – the

better you will succeed later. After a certain time, you will begin to make the best (high-quality and correct) decisions in full. You will see faster progress. And as Colonel John Boyd would say, you're going to start something "better to do in your life, not just be someone".

Like all good mental models, this knowledge works in other areas, even outside the military: it is actively used by special services, lawyers, doctors, businessmen, politicians, law enforcement agencies, marketers, coaches, etc.

Methods for generating new ideas

The method of associating ideas is based on the use of the capabilities of the senses of a person (hearing, sight, touch) and his mental abilities to form the desired ideas. Observing, listening or feeling a particular real object, a person is able to move away from his image and imagine another that has a certain similarity, but is fundamentally different from it. The associated original and valuable idea is captured and used for further study. During the observation and formation of the idea, the properties of the real and imaginary object are analyzed. Based on logical reflections and direct comparison of these properties, the necessary decisions are made. It is clear that this process involves the availability of accurate answers to a number of specific questions. It turns out, in particular, the advantages and disadvantages of the design of the product, the possibility of its use under new conditions or the implementation of a large-scale (increased, reduced) modification of the product. The possibilities of changing the external design, layout or principles of the product, replacement of materials, etc. are also studied. Answers to these questions allow you to create an image of the future object.

The method of generating ideas is based on the systematization of data on the development of a certain type of product in the past and on the logical analysis of these data to determine possible directions for product development in the future. Common means of generating are diagrams and matrices of ideas, the so-called brainstorming (brainstorming method), heuristic methods.

The method of generating with the help of a diagram of ideas involves the use of appropriate graphic material that synthesizes the past experience of the formation and development of the type of product in question. The method of generating using a matrix of ideas is associated with penetration into the morphology (composition and structure) of the product. It is considered more productive because it allows you to get more combinations of ideas, including alternative ones. The latter contributes to finding fundamentally new solutions. Morphological analysis is based on the construction of a matrix of characteristics of the object of forecasting and their possible values, followed by sorting out and evaluating the variants of combinations of these values. It is implemented based on the construction of the so-called morphological block, which was proposed by the Swiss scientist F. Zwicky in the late 50s.

The procedure of morphological analysis is a sequential sorting of possible combinations of different characteristics (in our example, physical principles and technical solutions).

The sequence of stages of morphological analysis is as follows:

– the problem is described as a whole (no solutions are offered);

– the problem is decomposed into several components (for example, the parameters of the object are determined – shape, packaging material, contents);

– for each parameter, several possible options are offered (known and those that have not yet been used in the goods on the market). In this case, a matrix is compiled, the so-called morphological box, in the first column of which all the parameters are listed, and on the right in the same row are alternative solutions;

– parameters and alternative solutions are combined (each solution consists of a set that requires one option from each parameter); the optimal solution, from the point of view of the company, is selected and implemented.

The method of morphological analysis is very useful for the design of new products, as well as for determining the possibility of patenting the main parameters in order to “block” inventions that may appear in the future, and block

competitors' path to imitation of innovation.

The brainstorming method proposed by A. Osborne in the late 30s and as a method is very simple. It assumes the following stages: preparatory; idea generation; analysis and evaluation of ideas.

There are several methods of brainstorming and its modifications:

– classic brainstorming;

– anonymous brainstorming;

– didactic brainstorming;

– destructive and constructive brainstorming;

– technique of creative cooperation.

Anonymous brainstorming. Directly brainstorming is carried out before the meeting. Participants are asked to formulate and write down all ideas related to the problem on a piece of paper and give them to the presenter. The presenter presents ideas consistently, without naming the authors, and the group develops and improves these ideas.

Didactic brainstorming (Litt technique). Before the meeting, the formulation of the problem is known only to the presenter, who leads the participants to the problem gradually during, as a rule, a series of meetings: at first they are introduced only to the general aspects of the problem, then additional information is displayed consistently, as a result of which the problem is solved completely.

Destructive and constructive brainstorming. Brainstorming is carried out in two stages. At the first stage, all the shortcomings of the existing solution to the problem are highlighted, and at the second, a search for new, better ideas is underway.

Technique of creative cooperation. With this method, group work is changed to individual. First, a group brainstorming session is held for 10–15 minutes. Then the participants individually (5–10 minutes) think about the problem, write down new ideas. Improve the proposals made during the discussion.

The conference of ideas is a modification of the brainstorming method,

which is characterized by a higher pace of meeting and involves benevolent criticism in the form of remarks and comments. All ideas are recorded in the protocol, but the authors are not indicated. A variation of this method is the Hilde Ideas Conference, Discussion 66, Method 635. *Hilde Ideas Conference*. Both employees who are aware of the problem and newcomers who are able to put forward new fresh ideas are attracted to the conference of ideas, since traditional approaches to solving it do not gravitate over them. Skeptics or specialists who believe that they know everything better than others should not be invited to a conference. The chairman, whose status during the conference is equal to others, should maintain a relaxed atmosphere, steadily moving towards the goal.

Discussion 66 (a series of buzzing voices). Participants are divided into groups of six people, each independently of the others prepares his own solution to the problem or works out a position on a specific issue. In each group, the presenter, protocolist, speaker is determined. Group work lasts approximately 6 minutes. After that, all groups gather for a plenary session, at which a new view of the problem can be selected, which is again discussed separately for a short time.

Method 635. The group, which consists of 6 participants, analyzes and clearly formulates the problem. After that, each of the participants within 5 minutes enters into the form 3 proposals for solving the problem and passes the form to his neighbor, who takes into account the proposals of the predecessor and notes three more of his own proposals. They can arise as a result of certain associations with recorded decisions or be completely new. After all participants have processed the forms, the process ends. The time given to ponder in the last phases can be extended.

The next method of generating ideas is synectics. This is a really effective method of finding ideas proposed by V. Gordon.

Synectics – search for ideas of new products based on the use of analogies from other areas of life. The basis of synectics is brainstorming, in which

specialists in various fields of activity are invited to participate. A group from one assault to another accumulates experience in solving the problem. The main techniques used in the synectic assault are based on analogy:

– direct (how tasks similar to data are solved);

– personal (try to enter the image of the object given in the task and express yourself from this position);

– symbolic (give a figurative definition of the essence of the task);

– fantastic (how this task would be solved by fairy-tale characters).

The method of control questions. This method is implemented using a list of questions developed by A. Osborne, T. Eiloar, D. Pearson, G.L. Bush and others. The list proposed by A. Osborne includes 9 groups of questions:

1. What new application can be offered for the object?

2. What another object is similar to this and what can be copied?

3. What modifications can be obtained by rotating, bending, twisting, turning, changing functions, color, shape, contour?

4. What in a technical object can be increased (size, strength, number of elements, etc.)?

5. What in a technical object can be reduced (compacted, compressed, accelerated, narrowed, crushed)?

6. What can be replaced in a technical object (element, material, drive, etc.)?

7. What can be reworked in the object (scheme, layout, order of work, etc.)?

8. What in the object can be done the other way around?

9. What new combinations of elements are possible?

The method of verbal associations. When we are looking for needs that can be met, or working to improve an existing product, form of service, ideas can suggest words. The method of verbal associations consists in methodical compilation and re-reading of a list of words and concepts until a word suggests a new idea. The source of verbal associations can be dictionaries, journals on trade problems, technical literature.

Heuristic methods are based on associative abilities, intuitive thinking and the ability of a person to control it. These methods include various rules and recommendations that help solve problems without first evaluating the results. The most common heuristic methods include methods of analogy and inversion.

Methods of analogy reflect the natural desire of a person to imitate, that is, to reproduce in the elections the characteristics of objects, processes and phenomena of the environment, as well as mental abilities and physical properties of his own organism. The desire to establish the identity and divergence of objects of wildlife and the tools created by man accompanies the individual at all stages of creative activity. They are still looking for analogies between an airplane and a bird, a manipulator and a human hand, a cybernetic device and a human brain. Taking in general, generalized heuristic methods of analogy, depending on the specifics of the object of imitation, are divided into two classes: methods of imitating objects of inanimate nature, methods of imitating objects of wildlife (man and other biological beings).

In modern practice, the *method of precedent* is widely used. It involves the use in the new product of an original and effective functional principle that was applied in previous models. For example, vending machines, cash registers.

The *method of constructive similarity (the principle of the matrix)* is the basis for the design of goods, which is a geometric (linear, plane or volumetric) analogy of existing ones. For example, a few cars built on a common structural basis, a series of electrical household products.

The *method of reintegration (the method of "Ariadne's thread")* is also used in creative activity, which contributes to the creation of a new complex product by analogy with a relatively simple one. It is known that the rocket engine of F. Bandera was developed by analogy with a blowtorch. For the development of consumer goods, the pseudomorphization method is very often used. According to this method, products are created that are similar in shape to existing ones, but have a different functional purpose. The purpose of such a product is to create a

misconception about its true function. For example, a pen in the form of a lighter-gun, a lighter-gun, a radio-wallet.

Methods related to the imitation of wildlife objects are widely used to generate ideas. For example, the paleobionics method takes the silhouettes of fossil animals (walking excavator) as prototypes for new products.

The method of biomechanics is based on the reproduction in the developed goods of the principles of the mechanics of the movement of creatures (helicopter).

The bioarchitecture method uses for new products the shapes and proportions inherent in wildlife objects (for example, heating radiators, fences and other structures). When designing products that artificially reproduce the functions inherent in man, they use the method of biocybernetics. Recently, in research practice, the methods of bionics have been widely used – a science that studies the laws and principles of the functioning of a living organism to create artificial technical systems. Automated self-learning systems, robotically technical devices, devices for pattern recognition – this is not a complete list of applications of bionic algorithms.

The logistical also includes methods of alternative search, based on the integrated use in the process of searching for ideas of new products of such techniques that form alternative pairs in the form of "reception – antireception". For example, magnification-decrease, hyperbolization-miniaturization, macroidealization-microidealization.

The method of inversion (from the Latin rearrangement) also plays an important role in finding ideas for new products. It involves the search for solutions in directions opposite to those generally recognized for similar objects. For example, the method of inversion of working materials and substances involves the replacement of their traditional types with non-traditional ones. This provides the ability for the product to perform new functions or increases its usefulness. The method of inversion of the shape of the object involves a change

in the operational properties of the product due to deviations from traditional solutions. For example, an airplane with folding wings, a hydrofoil boat. If it is necessary to take into account the contradictory requirements for structural materials at the same time, the inversion method is also used.

Gamestorming is a set of practices to facilitate innovation in the business world. The presenter directs the group towards a specific goal through play, a structured activity that allows you to think freely, even playfully. The word "gamestorming" is a neologism about the use of games for brainstorming. Games can be seen as an alternative to a standard business meeting. Most games involve 3 to 20 people and last from 15 minutes to an hour and a half. The game pauses some of the usual life protocols and replaces them with a new set of interaction rules. Games may require multiple props, such as sticky notes, poster, markers, random shots from magazines, or thoughts of provoking objects. The game's skills include asking questions (discovery, managing, experimenting, closing), structuring large diagrams, sketching ideas, merging words and drawings into visual language, and most importantly, improvising to select and conduct a suitable game or invent a new one. Gamestorming is used to explore user experience, social media marketing, innovation, product development.

Questions for self-control:

1. What is the significance of the day map element?
2. What is goal achievement analysis in the day map?
3. How motivation is realized in the critical thinking system?
4. What are the basic techniques for creating solution concepts?
5. What is the focus content?
6. What are the methods for generating new ideas?
7. What is Boyd's Loop?
8. What is the purpose of dobistorming as a prototyping tool?

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UDC 334:007:65.012:35.07

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Chapter 9
CONTEMPORARY RESTRUCTURING (RE-ENGINEERING) OF BUSINESS PROCESSES AT TRANSITION TO ELECTRONIC SERVICES RENDERING

Content

9.1. E-services in the restructuring of digital economy business processes

Electronic services provision is first of all connected with the state, therefore, while characterizing them we will focus special attention on services in the field of public administration. With the development of new technologies, a rethinking of approaches to governance and responsibility begins, relations between players change: between service providers and manufacturers; between public, private and third sectors and between authorities and citizens. New forms of governance

are emerging, reflecting the change of organizational and economic relationships, with profound implications for use by citizens and businesses.

It was digital economy development that caused the need to build online communications between business, citizens and the state. Widespread ICT and Internet enabled the emergence of electronic services.

E-services concept is quite young, it has only been used for 20 years, but there are already many definitions of it. In a general sense, an electronic service can be understood as a service provided through the Internet using ICT. Separate interpretations of "electronic services" concept are given in Table 9.1.

***Table 9.1* – The views of scientists and practitioners regarding the content of "electronic service" concept**

Author	Definition of the term "electronic service"
Beznaziuk O.	An electronic administrative service is an administrative service provided in whole or in part through online services
Borysov I.V.	Electronic services are services provided through the informational telecommunication system and do not constitute a separate type in the system of contracts for the services provision.
Kovalskyi V.	Electronic services are services provided via the Internet, automatically, with the help of information technologies and mainly without human intervention, including by installing a special application on smartphones, tablets, television receivers or other digital devices.
Matviichuk R.M., Kandziuba S.P.	An electronic service is a service created to meet the user's information needs, which has an electronic form of provision.
Tyshchenkova I.O.	Electronic services in the activity of public administration should be understood as legal relations that arise thanks to ICT regarding the subjective rights realization of a natural or legal person, mainly at their request in the process of public administration's public-authority activity.

Source: complied by the author.

Therefore, a peculiarity of electronic public services is the use of ICT and the Internet in their provision. As a type of public service, electronic services have certain characteristics:

1) legal regulation;

2) mandatory recognition and provision;

3) direct participation of public authorities and public institutions in the services' provision;

4) service continuity and its availability for everybody.

Among the main features of services in the conditions of digital technologies development, scientists single out the following:

1) the service is always expressed through the active actions of the legal relations participants;

2) the service provided by the contractor is able to satisfy the needs of the customer;

3) lack of material nature;

4) synchronicity of providing and receiving services (are consumed in the process of their provision);

5) the service must meet the requirements specified in the contract or regulatory act;

6) the possibility of remote services provision – the use of ICT in the services provision.

In Ukraine, the concept of electronic service is defined at the legislative level. The normative definition of the term "electronic services" is presented in Table 9.2.

***Table 9.2* – Normative definition of "electronic services" concept**

Legislative and normative acts	**Definition of the term "electronic service"**
1	*2*
Law of Ukraine "About electronic confidential services"	An electronic service is any service provided through an information and communication system.
Law of Ukraine "On e-commerce"	Electronic information services – paid or free services related to information processing and storage, provided remotely using information and communication systems at the individual request of their recipient.
Law of Ukraine "On the peculiarities of public (electronic public) services provision"	Electronic public service – a service provided by state authorities, local self-government bodies, enterprises, institutions, organizations that are under their management, including an administrative service (including automatic mode), which is provided using information and telecommunication systems on the basis of an application (appeal, request) submitted in electronic form using information and telecommunication systems (including using the website of the Unified State Electronic Services Portal), or without submitting such an application (appeal, request).

Continuation of Table 9.2

1	*2*
Tax Code of Ukraine	Electronic services are services provided via the Internet, automatically, with the help of information technologies and mainly without human intervention, including by installing a special application on smartphones, tablets, television receivers or other digital devices.
The Concept of Development of the a-Services System in Ukraine	Electronic service – administrative and other public service provided to the subject of the appeal in electronic form using the means of information, telecommunications, information and telecommunications systems.

Source: complied by the author.

In fact, the state established the essence of electronic services (e-services) as those provided to the consumer in electronic form with the help of ICT. The question arose: "What exactly should be considered electronic services?". The Tax Code of Ukraine defines the list of transactions that belong to electronic services and those that are not classified as such (Appendix A).

The concept of e-services includes not only administrative services provided in electronic form, but also other services that do not belong to administrative. In particular, such other e-services can be online registration in the e-queue for kindergarten or for a doctor's appointment, registration in the queue for vaccination against COVID-19, etc.

Here are generalized approaches to the electronic services classification [1]:

1) by the content of electronic services provision (informing, one-way interaction, two-way interaction, conducting transactions);

2) by the field of activity: informational services; consulting services;

3) services related to interaction between public administration subjects; assistance and support services;

4) by subject of provision: those provided by central executive authorities, regional representatives of the government, local self-government bodies and subjects of delegated powers;

5) by the place of receipt: "single window"; the official web portal of the authority;

6) by the form of receipt: fully automated and partially automated;

7) by the result they can both provide for the execution of an administrative act and not provide for its execution;

8) by consumers: electronic services for public authorities, citizens and business organizations B2B (Business-to-Business); B2C (Business-to-Citizens); G2B (Government-to-Business); G2C (Government-to-Citizens); G2G (Government-to-Government); C2C (Citizens-to-Citizens).

Scientists recognize that the goal of providing e-services is the creation of simpler conditions and more effective relations for citizens and public institutions regarding:

– information exchange (requests of citizens about the activity and work of public institutions, conducting a population census, etc);

– public services provision (at individual requests of citizens or through information systems);

– the control or introduction of restrictions, usually initiated by the state and involving the introduction of restrictions on certain behavior (for example, the imposition of penalties, the collection of taxes).

Today, the concept of "electronic services" is gradually being replaced by the term "digital services". At the same time, the very interpretation of these services is expanding, because if "electronic services" are concentrated in the field of public administration, then "digital services" cover all online services. The development of digital services and digital markets is defined as a priority of the European Union. In April 2022, the European Parliament agreed and approved the draft Digital Services Act (DSA), which will enter into force on January 1, 2024 and is aimed at establishing fundamentally new rules of the game in the online space.

The law interprets "digital services" much more broadly than "electronic services", as the DSA rules will apply to four main categories of online space participants: companies providing online intermediary services; companies providing hosting services; online platforms; very large or super large online

platforms. The main tasks of DSA, as defined by the European Commission: to improve the defense mechanism of users' rights on the Internet; to protect against unsolicited advertising; to reduce the amount of illegal content on the Internet; to expand digital services for online market participants in the EU; to prevent the abuse of "Internet power" by super large platforms that cover an audience of more than 10 % of the EU population; to contribute to the growth and expansion of competition in the online market [2].

That is, digital services include the ability to receive any service on the Internet through social networks; search engines; online market (marketplaces).

It should be noted that the Ministry of Digital Transformation of Ukraine announces the development of digital services in our country as well. The perspective development of digital Ukraine – the digitalization of the service sector is outlined in conceptual and strategic documents, in particular in the Concept of the Digital Economy Development and Society of Ukraine for 2018–2020, which provided for the introduction of measures to implement incentives for the socio-economic processes digitalization, digital competences acquisition by citizens. Currently, the main strategic document is the National Economic Strategy 2030, in which one of the strategic courses of the economic policy until 2030 is the "Digital Economy" direction.

The directions of Ukraine's regions digital transformation are defined in the State Strategy of Regional Development 2021–2027 (2019). Among the main priorities of regional development, the following are highlighted: improving the quality and ensuring the availability of administrative services for the population, developing infrastructure and digital transformation of regions. At the regional level, there is a practice of approving Digital Development Programs. Thus, the Digital Development Program 2021–2025 was approved in Khmelnytskyi at the end of 2020. The program is aimed at implementing the policy of informatization, digitization, digital development, digital innovations, e-government, e-democracy, creation of effective management mechanisms using modern ICT.

You need to have certain knowledge and skills to effectively provide and use digital services. Back in 2013, the European Commission launched a scientific project on the development of a digital competence system for citizens DigComp (DigComp – The Digital Competence Framework for Citizen). In 2016, the Digital Competence Framework for Citizen DigComp 2.0 was published, and in 2017 its format was updated – DigComp 2.1. In addition to the European Digital Competence Framework for Citizens DigComp 2.1, were adopted pan-European Digital Competence Framework: for teachers (DigCompEdu, 2017) and higher education institutions (DigCompOrg, 2015). In 2021, the Ukrainian government adopted the national Concept for the digital competences development, the main purpose of which is to define priority directions and tasks for the digital skills development and digital competences of various employees' categories, graduates of educational institutions, and citizens. Ukrainian experts adapted the DigComp 2.1 conceptual reference model of digital competences to the peculiarities of Ukraine, taking into account the recommendations of European and international institutions, and in 2021 a description of the Digital Competence Framework for Ukrainian citizens was published.

The development of electronic and digital services is greatly facilitated by the formation and deployment of digital platforms. The European Commission has defined a digital platform as an enterprise that operates in bilateral and multilateral markets and that uses the Internet to enable interaction between two or more individual, interdependent groups of users [3]. A European Parliament study proposed a broader definition, according to which a digital platform provides a technological basis for the provision or aggregation of services (content) from service providers (content) to end-users [4]. The tasks of the platforms are defined as creating value for all users of the platform, maintaining connections between its users and facilitating the exchange of information, values, products, services, works.

Four main types of platform participants are: platform owners, providers

(managers), developers and independent end-users (consumers, suppliers) [5, p. 444].

The following models of digital platforms monetization in relation to the consumer are distinguished [6, p. 59]:

1. **Free platform** – provides free services. It is worth highlighting two models of financing the operation of the platform:

1) for state platforms – at the expense of the state budget, various funds, grants, donor organizations (DIIA);

2) for commercial platforms – monetization can occur by delivering advertising content to users (Facebook).

2**. Shareware platform** – provides free services in the basic version, the user pays for the advanced format (Spotify).

3. **Charge of commission** – receiving a commission on each transaction (eBay, Uber).

4. **Access fee** – payment of information on the platform (Science Direct, paid electronic mass media).

5. **Differentiated access fee** – only a part of users who are more interested in platform services pay for access (dating sites).

The diversity of areas in which platforms arise allows you to receive an electronic or digital service of any nature: educational services (Buki, Coursera), logistic services (Lardi Trans), sale and purchase of goods (Amazon, OLX, Prom, Rozetka), courier services, performance of various tasks and services provision (kabanchik.ua), finance services (purchase of insurance through Privat24), state services (Prozorro, Diia).

Economically, a digital platform is the implementation of a multi-marketplace model, where supply and demand are coordinated, transaction costs are optimized, and a transition from unification to total aggregation of all possible goods and services is performed. There are several models of digital platforms communication (Table 9.3).

Table 9.3 – **Basic communication models for the digital platform's formation**

Subject (Manufacturer of goods and services)	Object (Consumers of goods and services)		
	Business	**Consumers (households)**	**Government**
Business	Business to business model (B2B). Electronic commercial services	Business to consumer model (B2C). Online stores (e.g.: Alibaba, Amazon)	Business to Government model (B2G). Electronic public procurements
Consumers (households)	Customer to business model (C2B). Contextual business advertising and electronic labor exchanges (e.g.: Google AdSense; Work.ua.)	Customer to Customer model (C2C). Digital platforms for joint consumption (e.g.: blablacar; Airbnb; eBay).	Customer to Government model (C2G). Digital platforms for submitting petitions
Government	Government-to Business model (G2B). Government services for business.	Government to Consumer model (G2C), State services for citizens.	Government to Government model (G2G). E-Government.

Source: [7].

Thus, platforms may have different functionality, but most of them have similar features:

1) multilateralism – the ability to coordinate different groups of users, for example, buyers and sellers;

2) the presence of network effects, which consist in increasing the value of the platform for a group of participants as its number increases;

3) the presence of a unique ecosystem (combination of companies that develop the platform);

5) the presence of applications that are the main software;

6) limited resources provision consisting of software and regulators that facilitate close cooperation of users;

7) degree of openness and availability of software interfaces and development tools [8, p. 60].

Depending on the subjects and their role in the creation and regulation of the platform, the latter are divided into public (state) – platforms created and regulated

by state bodies, the users of which can also be commercial participants; private (commercial) – founded by a private business, providing services to both private and public participants.

State (public) digital platforms, unlike private ones, are established by the state represented by state bodies. The functioning of such a platform is determined by a state regulatory legal act of the appropriate level, which establishes the order of activity and management, defines the participants of the platform, the purpose and tasks. The digital platform is managed by an authorized state body (platform operator). The activity of state digital platforms is limited by the territory of the state.

The state digital platform, unlike private ones, does not aim to make a profit, because it is created by the state with the aim of increasing the efficiency of the public services provision through the digitization of interaction processes with their consumers.

Questions for self-control:

1. Define the content of the electronic services.
2. What are the main characteristics of electronic services?
3. Characterize the Ukrainian legislative base of the regulation of electronic services.
4. Generalize approaches to the electronic services classification.
5. What is the difference between the terms “electronic services” and “digital services”?
6. Distinguish the models of digital platforms monetization concerning the consumer.
7. Describe the basic communication models for the digital platform’s formation.

9.2. World experience in the introduction of e-services

Let's consider several case studies on the introduction of e-services and features of digital business processes development in different countries.

Case 1. One of the leading places in the world and the EU in the provision of electronic business services is occupied by *Estonia*. It has invested heavily in its own developers and gained significant experience that can already be capitalized. Currently, Estonia is a powerful digital state with high GDP per capita.

The country has succeeded in introducing e-government and citizens receiving individual ID cards in 2002, which provide an opportunity to use state-administrative, medical, financial, educational services, public transport and libraries, get insurance, travel and vote online. Due to the ID card, Estonia saves 2 % of GDP and allows providing services in a convenient format for citizens. Currently, Estonians use the Mobile-ID identity card (personal identification through a SIM card).

The most important event in the development of electronic interaction in Estonia was the X-Road program, which manages requests between unrelated computing environments and is an integrated data exchange system [9]. Due to it, almost all administrative services are provided online in Estonia. As of 2022, almost 67 % of Estonian citizens use an ID card regularly, also 99 % of administrative services are presented online and 2,773 services are subject to the X-Road system.

There is also an eTaxBoard system in Estonia, which helps citizens fill a tax return, refund VAT and monitor its return [10]. In 2014, the Estonian government launched the e-residency digital project, due to which every EU citizen residing outside Estonia can open a company in this country. Since every digital transaction is taxed, the government has revenue from it.

Estonia became the first European country to hold electronic parliamentary elections in 2007 ("eGovernment Award" Best Practice Label) [11].

Unemployed citizens can search for vacancies through national and regional employment services remotely. Social benefits and vehicles are made and registered online as well (Estonian Motor Vehicle Registration Centre).

One of the results of electronic business effective provision services was the formation of a startup ecosystem. There is a Startup Estonia platform, which continuously reboots the startup ecosystem. The country has the largest number of "unicorns" per capita in Europe: Pipedrive.com, Zego.com, ID.me, Skype.com, Playtech.com, Wise.com, Bolt. Let's consider the basis, factors, goals of the formation and provision of electronic services in Estonia (Fig. 9.1).

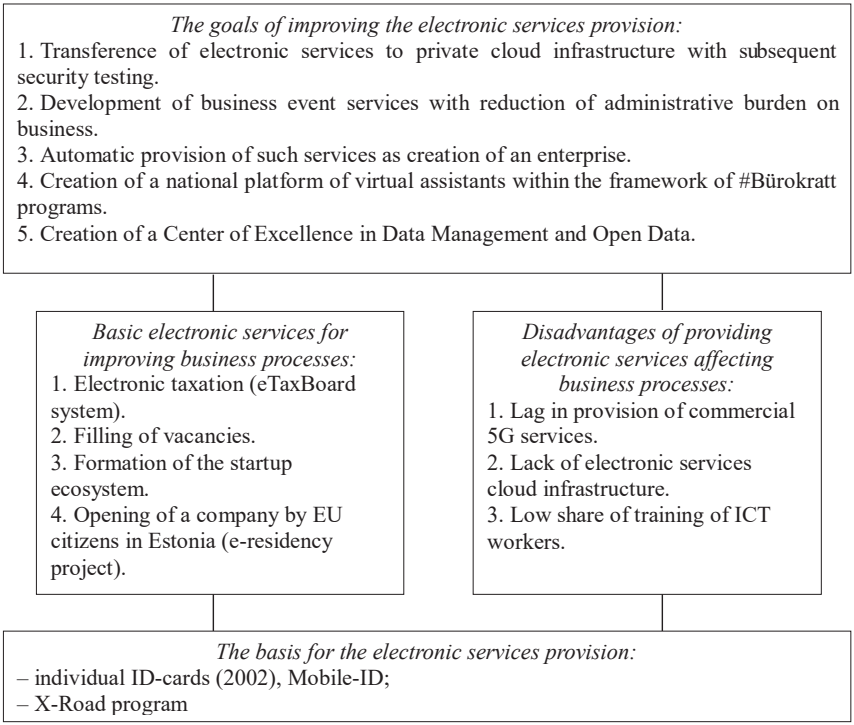


Fig. 9.1 – Peculiarities of electronic services provision in Estonia

Source: [10].

Estonia's new digital strategy until 2030 has been adopted. It is based on large-scale goals in the field of digital services, connectivity and cyber security.

The state plans to train an additional 7,000 specialists in the field of ICT, by 2027. To date, Estonia lags behind in the provision of commercial 5G services, but there is a goal to cover large cities by 2023, and to create transport corridors by 2025. 47 % of all actions to support digital transformation in the Strategy will be aimed at further digitalization of public services (budget of 97,43 million euros) [12].

Case 2. The formation of the electronic service provision system in *Sweden* began at the end of the 20th century, when the Swedish government launched the Government eLink project, which consisted in the secure information exchange between government institutions and customers of their services [13].

Later, the State Administration Modernization Strategy was presented. Later, the State Administration Modernization Strategy was presented. Its essence lies in a greater focus on the needs of citizens and defines information and communication technologies as the most important tool for improving public services. At the same time, the "Information Society for All" initiative was adopted, which consisted in strengthening Sweden's position as one of the leading countries in the information society and using the potential of information and communication technologies to stimulate growth, employment, regional development, democracy, fair treatment, quality of life, equality and effective public administration, which was a significant contribution to the development of Sweden's information society [14].

In 2000, the report "Agency 24/7 – Criteria for 24/7 agencies in public administration network" was published and Sweden became the first country in Europe to introduce round-the-clock provision of administrative services.

Among the principles of providing electronic services in Sweden, the following can be distinguished: confidentiality and security of information; ease of use and transparency; providing services 24/7.

Since 2017, the Swedish government has launched a new Digital Strategy, which is still in effect (Fig. 9.2). The strategy established a number of goals: digital literacy, digital security, digital innovations, digital leadership, digital

infrastructure.

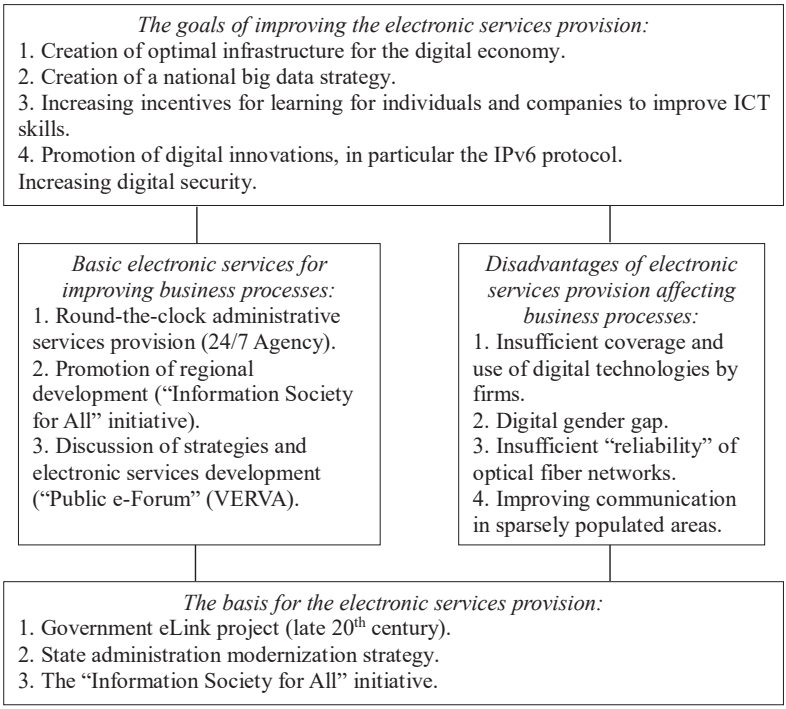


Fig. 9.2 – Peculiarities of electronic services provision in Sweden

Source: [14–15].

The coverage and use of digital technologies can be further increased by: promoting ICT courses in education; coordination of retraining activities with social partners; promoting additional investment across sectors and companies; developing complementary skills in a comprehensive digital skills strategy.

The National Cybersecurity Strategy 2017 marks a turning point towards a more holistic approach to digital security in Sweden.

Digitalization actively affects the improvement of business processes in Sweden. For example, Swedish forestry companies today are actively investing in digital technologies to improve production quality management and optimize supply chains. The application of analytics, artificial intelligence and IT process management are becoming strategically important tools affecting sustainable

forest exploitation and timber trade.

Case 3. *Singapore* is the founder and chair of the Global Governance Group, an informal bloc of 30 small and medium-sized countries that seeks to strengthen engagement between the G-20 and the rest of the world to support multilateral cooperation and collaboration. The G-20 community is promoting e-government as part of the UN's Sustainable Development Goals: "industry, innovation and infrastructure". In 2017, the leaders of the bloc have committed to reduce the gap in the development of digital infrastructure between countries with more technological resources and low-income countries by 2025, as well as to promote international digitalization standards in accordance with the principles of openness, transparency and consensus.

In the case of Singapore, the government began to promote the computerization of the civil service in the early 1980s. The government's understanding of IT's primary role in modern world led to the creation of strategic program:

1. The program of the state civil service computerization (1981).
2. National plan for information technologies (1986).
3. IT plan 2000 (Intelligent Island) (1991).
4. Creation of a nationwide broadband network for the provision of multimedia interactive services Singapore ONE (One Network for Everyone) – "One Network for Everyone" (1996).
5. "Basic ICT plan 21" (2001).
6. The first national IT-literacy program (2001).

Accelerated construction of advanced information infrastructure has reduced time of services provision and ensured secure virtual access in times of crisis such as the COVID-19 pandemic [16].

In 2007, the government launched the Singapore Government Enterprise Architecture (SGEA) program. The Singapore Government Enterprise Architecture was developed by the Ministry of Finance and the Infocomm

Development Authority (IDA):

– Business Reference Model (BRM);

– Data Reference Model (DRM);

– Technical Reference Model (TRM);

– Solutions Reference Model (SRM).

Singapore's electronic networks are used by enterprise to improve business processes. This is the trade network TradeNet (the process ofdocuments passing takes 3 minutes), marine network – MarineNet, port network – PortNet and the electronic system for judicial documents accounting – Electronic Filling System.

For business entities, the e-Citizen portal provides access to electronic forms of tax and other payments, to the system of electronic public procurement. Here you can register a trademark or a patent, get information about various government programs for business support and development, preferential credit schemes, consulting and training, especially those related to small and medium-sized enterprises. Such a unified approach significantly increases the efficiency of business processes. In the field of trade, the government has already created the legal system and regulatory mechanisms necessary for e-commerce.

Singapore was the first in the world to implement the idea of a government portal [17] – the "Electronic Government" program operates on a single government website *(http://www.egov.gov.sg/)*. The server supports several sections:

– business;

– defense;

– education;

– employment;

– health;

– law and order, etc.

Public e-help centers have been created; e-lifestyle is being formed: e-learning, e-entertainment, e-communication, e-interaction (Fig. 9.3).

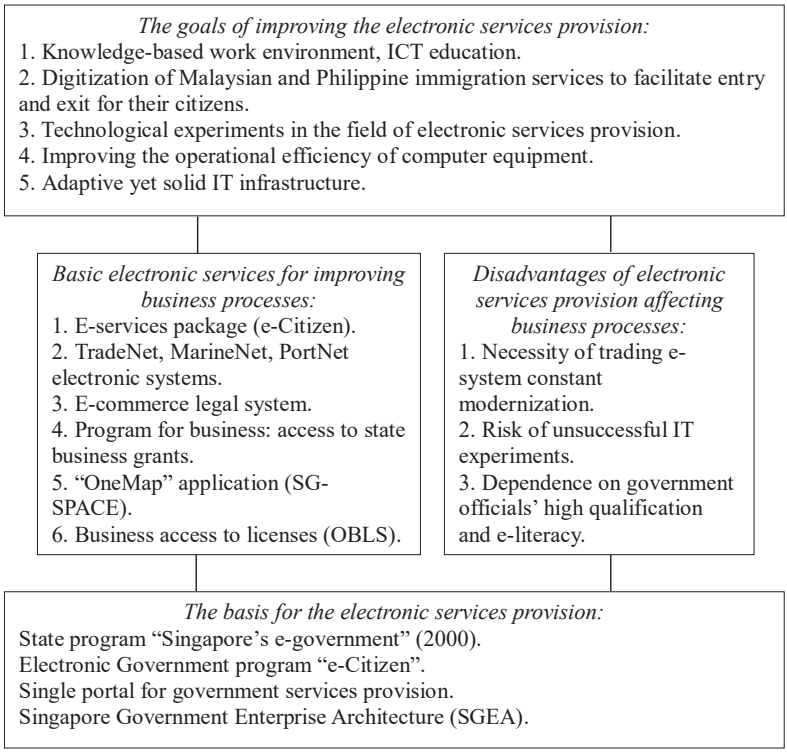


Fig. 9.3. Peculiarities of electronic services provision in Singapore

Source: [18].

Therefore, the large-scale implementation of the general service technological architecture allowed to improve the electronic services provision according to the following steps (Fig. 9.4):

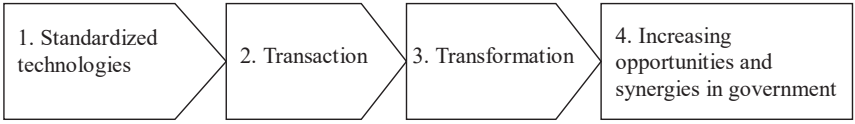


Fig. 9.4 – Steps to implementation of the general service technological architecture of electronic services provision in Singapore

Source: [16].

Since 2015, the government has not developed official strategic plans for the development of eGov, considering there are already built-in stabilizers in the

digitalization policy and electronic services provision. At the same time, IDA (Infocomm Development Authority of Singapore) is the senior technology and information assistant of the Singapore government [18].

Case 4. *The United States of America* launched a digital services program in the 1990s. In 2003–2010, according to the Electronic Government Development Index, the country was among the top ten in the world. In 2000–2008, the share of US government websites providing electronic services increased from 22 % to 89 %. At the same time, Internet penetration doubled.

In the USA, the E-government Act was signed in 2002, the Open Government Directive was signed in 2009, and the initiative "Creating electronic government of the 21st century" was introduced in 2012. Digital services were planned to be improved by using data more efficiently, so the US Digital Service (USDS) was formed. In 2021, a second decree was signed to improve service to electronic services users – "Improving Federal Customer Service and Service Delivery to Restore Trust in Government" [19].

The US is a federal democracy, so digital transformation is happening simultaneously at the federal, local and state levels. The US are innovating with respect to specific digital services. There is an extensive system of agencies and institutions that facilitate electronic services provision. In the USA, the following institutions are engaged in the creation and provision of electronic services:

– US Digital Service (USDS);

– Technology transformation service;

– 18F;

– Presidential Innovation Society;

– Centers of excellence in IT modernization;

– Office of scientific and technical policy.

It is advisable to delegate most of the functions to a centralized body to define a digital transformation strategy that would contribute to a more effective restructuring of business processes (Fig. 9.5).

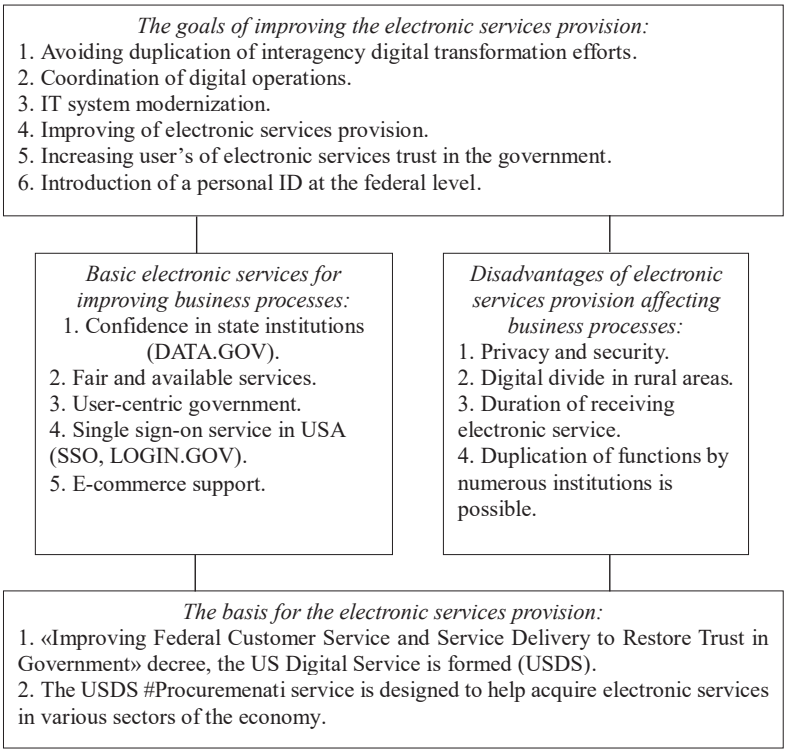


Fig. 9.5 – Peculiarities of electronic services provision in the USA

Source: [20].

During the vaccination fixation period of citizens against COVID-19, the United States did not introduce digital IDs at the federal level. At the same time, the leadership of the United States became more active. 30 states plan to introduce digital driver's licenses, and 6 states are already offering them.

The modernization of electronic services provision in the USA is aimed mainly at migration policy, social services and e-commerce between government organizations and ministries.

The main difference of modern economy models and the traditional (industrial) ones is the mechanism of interaction between subjects of economic activity. Its formation was preceded by the process of technological business processes transformation, both within companies and between them. Digital

technologies were designed to reduce production costs. Nowadays, this opportunity is increasing in the conditions of well-coordinated mechanism for electronic services provision and digital automation of production.

Taking into account the experience of other countries on the way to digitization will help Ukraine to avoid typical mistakes and use the most successful cases in its own practice. State authorities and enterprises need established two-way communication, obtaining the necessary information, conducting consultations on the e-services provision for the effective restructuring of business processes.

Questions for self-control:

1. Describe Estonia's case study on the introduction of e-services and features of digital business process development.
2. Define the peculiarities of electronic services provision in Estonia.
3. Describe the electronic service provision system in Sweden.
4. What are the peculiarities of electronic services provision in Sweden?
5. Characterize Singapore's case study on the introduction of e-services and features of digital business process development.
6. What are the peculiarities of electronic services provision in Singapore?
7. What are the steps to implementation of the general service technological architecture of electronic services provision in Singapore?
8. Describe the peculiarities of electronic services provided in the USA.

9.3. Applied aspects of e-services in Ukraine

A key condition for building a digital society and a digital economy for the development of state, business and citizen communications online is the legislative regulation of such processes. Today Ukrainian regulatory legal issues

regarding the digital format of the participants activities in economic relations are defined in a number of such legislative acts as: Commercial, Civil, Tax Codes of Ukraine; laws of Ukraine: "On Information", "About the National Program of Informatization", "On Telecommunications", "On Electronic Documents and Electronic Document Circulation", "On State Registration of Legal Entities, Natural persons – Enterprises and Public Organizations", "On Access to Public Information", "On the protection of personal data", "On the permit system in the field of business activity", "On electronic commerce", "On public procurement", "On administrative services", "On the protection of information in information and telecommunication systems". Special attention should be paid to the Laws of Ukraine adopted during 2021–2022: "On electronic confidential services", "On stimulating the development of the digital economy in Ukraine", "On public electronic registers". The above-mentioned standards regulate and standardize the financial and economic activities of business entities and their cooperation with public authorities in a digital format.

The main body in the system of central executive bodies that ensures the formation and implementation of digital transformations state policy in Ukraine is the Ministry of Digital Transformation of Ukraine, which was created in September 2019. The Ministry ensures the formation and implementation of state policy: in the fields of digitization, digital development, digital economy, digital innovations, e-government and e-democracy, information society development, informatization; in the field of citizens' digital skills and digital rights development; in the fields of open data, development of national electronic information resources and interoperability, development of infrastructure for broadband access to the Internet and telecommunications, e-commerce and business; in the field of providing electronic and administrative services; in the fields of electronic trust services and electronic identification; in the field of the IT industry development, in the field of development and functioning of Diia City legal regime. The Ministry of Digital Transformation is actively developing

projects related to the digitalization of the economy and society in general, it is engaged in the automation of processes for the administrative services provision, and is creating a comprehensive system of electronic services in Ukraine – "A State in a Smartphone".

Recently, there have been many positive changes regarding the introduction of electronic services in Ukraine: various web portals and online services for the digital services provision have been created; the network of Centers for Administrative service (CASs) is developing, the list of digital services is continuously expanding, the number of web services is growing, etc.

In 2020, the Unified state web portal of electronic services was implemented – "Government services online" (https://diia.gov.ua) (Fig. 9.4), which concentrates public services that were previously placed on various portals of government bodies.

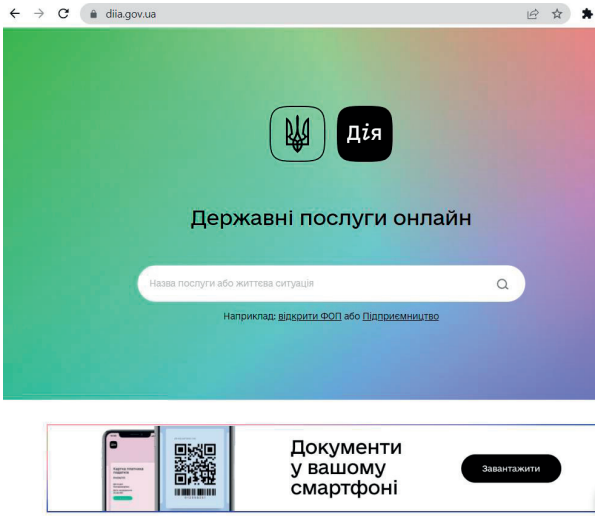


Fig. 9.4 – "Government Services Online" platform

The introduction of this project was implemented in order to ensure the rights of citizens and businesses to access digital services, information about electronic and administrative services; obtaining information from national electronic

information resources, that is necessary for providing services; appeal to public state authorities of Ukraine. The Unified state web portal of electronic services was put into exploitation by the Ministry of Digital Transformation of Ukraine without state budget funding. The Diia portal was created with the support of the USAID/UK aid project "Transparency and Accountability in Public Administration and Services / TAPAS" and the EGAP Program, which are financed by the Swiss Agency for Development and Cooperation; the USAID project "VzayemoDiia!" (SACCI) and the EGOV4UKRAINE project.

The Unified state web portal of electronic services «Diia Portal».

The "Government Services Online" portal presents services in certain areas for two categories:

1) citizens (references and extracts, transport, environment; land, construction, real estate; security and public order; licenses and permits; family; health; entrepreneurship; pensions, benefits and assistance);

2) business (land, construction, real estate; medicine and pharmaceuticals; licenses and permits; extracts and certificates; transport; business creation; Diia.City).

The full list of available electronic services can be found at *https://diia.gov.ua/services* and in Appendix B. Among the most popular public services are those related to cars, obtaining passports, pension provision, private entrepreneurship, taxation and obtaining information from public registers.

The list of services on the Diia platform is constantly growing, and existing services are being improved. In 2021, the Ministry of Digital Transformation introduced new services, such as: signing a document using an electronic signature, launching Covid-certificates, assigning and recalculating pensions, applying for subsidies. One of the main goals of the Ministry is to digitize 100 % of public services by 2024.

Communications of digital relations subjects (state authorities, local self-government bodies; legal entities and natural persons – entrepreneurs; citizens)

begin with electronic identification. The Diia platform operates an integrated electronic identification system ID.GOV.UA *(https://id.gov.ua)* for e-identification and user authentication using electronic signatures, Diia.Signature and BankID of the NBU. According to Ukrainian legislation, an electronic signature has the same legal force as a document signed personally. An electronic signature can be obtained through accredited key certification centers. The list of qualified providers of electronic trust services is posted on https://czo.gov.ua/ca-registry.

The relevant normative acts of Ukraine establish the right of citizens to use digital documents, which have the same legal force as plastic ones. The following digital documents are available in the mobile application:

– Ukrainian identity card;

– biometric foreign passport;

– taxpayer ID number (identification code);

– driver's license;

– vehicle registration certificate;

– vehicle insurance policy;

– birth certificate of the child;

– student card;

– Certificate of displaced person (IDP's certificate).

The following projects are implemented on the Diia platform:

1**. Diia. Digital education** *(https://osvita.diia.gov.ua/)* – a national digital literacy online platform that hosts over 80 educational series. Educational series on digital literacy developed by the EdEra online education studio with the support of the following companies: Google Ukraine, Microsoft Ukraine, DTEK Academy, UNDP Ukraine's Accelerator Lab, CISCO, CFC Consulting, Osvitoria, Global Teacher Prize. The project was implemented with the support of the Swiss-Ukrainian EGAP Program, financed by the Swiss Agency for Development and Cooperation and implemented by the Eastern Europe Foundation and the

Innovabridge Foundation.

The courses were developed taking into account European standards for teaching and assessing digital competence for such categories as: active citizens, civil servants, businesses and startups, entrepreneurs, schoolchildren, medical workers, military personnel, coaches, parents, beginners, etc. From September 1, 2022, all courses on Diia.Digital education provide for the accrual of 0,1–0,2 ECTS credits as part of self-education.

2**. Diia.Center** *(https://center.diia.gov.ua/)* – public service platform where:

1) citizens can receive administrative services; consultations on the organization and conduct of business, digital services; maps of Diia.Centers and information about Administrative Services Centres (ASC);

2) employees of the center (ASC) have access to the distance learning module, the library of materials and templates and sample documents.

3. **Diia.Business** *(https://business.diia.gov.ua/)* – an online platform for entrepreneurs, which contains information about starting your own business and its development. The business development and export project Diia.Business, which is a sub-brand of the Diia ecosystem, was launched by the Ministry of Digital Transformation of Ukraine in cooperation with the office for entrepreneurship and export development in 2020. Business representatives have access to: a guide for an entrepreneur, 150+ business ideas, templates of necessary legal documents for starting a business, services and support programs for business, cases of Ukrainian entrepreneurs, current news, free online and offline consultations, National online school for entrepreneurs, online exhibitions, the Diia.Business virtual center, the Diia.Business export direction, a marketplace of financial opportunities for business, an analysis of Ukrainian business' state, a platform for attracting impact investing and other initiatives.

4. **Diia City** *(https://city.diia.gov.ua)* – IT hub with a special legal and tax space for Ukrainian IT companies, where comfortable tax conditions have been created:

1) low tax rates: labor taxes: personal income tax (PIT) – 5 % (as standard in Ukraine, the rate is on the income of natural persons – 18 %), military tax – 1,5 %, unified social tax (UST) – 22 % with the minimum wage; tax on withdrawn capital: 10 % while withdrawing dividend (instead of income tax);

2) to stimulate investment: an alternative model of employment, a new form of cooperation using the GIG contract.

5. **E-Entrepreneur** – a comprehensive electronic public service, which is posted on the Diia portal with the aim of simplifying the conditions of registration and conducting business activities. Phased implementation of this experimental project is planned for 2021–2022. Through the "e-Entrepreneur" system, the following services will be provided:

– state registration of business entities of various forms of ownership;

– registration of a single tax payer, value added tax;

– issue of licenses for: the right to wholesale alcohol trade, retail trade of tobacco, fuel storage, retail trade of liquids used in electronic cigarettes;

– registration of settlement operations registrar and settlement operations software registrar, state registration of food market operators' capacities;

– registration of the declaration of the material and technical base conformity with the requirements of the legislation on labor protection;

– issuing a permit for the beginning of high-risk works and the beginning of operation (use) of machines, mechanisms, and high-risk equipment;

– opening a bank account [21].

6. **Diia. Open data** *(https://diia.data.gov.ua)* – the portal is designed to provide access to public information in the form of open data and provides access to authorities information with the possibility of its subsequent use.

Open data help to improve state services and create new digital services, monitor the work of public authorities. These data are very valuable and much of it should be available and open to businesses, startups, government officials, journalists, the public. The leader of data disclosure among state bodies is the

State Tax Service, the Antimonopoly Committee, the State Customs Service, the Office of the Prosecutor General, the Ministry of Education and Science.

In recent years, positive changes in the Ukrainian society, economy and its spheres are confirmed by the rise of Ukraine in the world rankings regarding its digital development. Leading international institutions and organizations are engaged in researching digitalization problems on a global scale: United Nations, World Bank, World Economic Forum, European Union and others.

Since 2014, the European Commission has been publishing materials on assessing progress in achieving the goals of the digital economy in the European Union and monitoring the state of digital development in individual member states, using the results of Eurostat surveys. Every year, the European Commission analyzes 34 indicators from 5 main categories (communication; human capital; use of Internet services; digital technologies integration; digital public services) and publishes a report on the progress of digital transformation in the EU, based on them. I-DESI (International Digital Economy and Society Index) was developed for comparison with countries outside the European Union.

Ukraine is not a member of the EU so its DESI index is not officially determined, also one of the reasons is the lack of relevant information (reporting), which, for its part, does not allow assessing digitalization level of the country and the possibilities of its development and competitiveness.

To assess the development of digital services, we will analyze the level of e-government development using two key indices: The UN Global E-Government Development Index (EGDI) and E-Participation Index (EPI). The E-Government Development Index is calculated by the UN Department of Economic and Social Affairs once every two years and is formed taking into account three indices: Online Service Index (OSI), Telecommunication Infrastructure Index (TII) and Human Capital Index (HCI).

According to UN 2020 data, Ukraine took 69th place in the ranking of countries with the most developed e-government, which is 13 positions higher

than in 2018. According to the data of E-Government Survey 2020, Ukraine has entered the group of countries with a high level of e-government development and became one of the 12 countries that moved to a very high level according to the E-Participation Index. The indicator of E-Government Development Index 2020 is 0,7119 [22, p. 11]. The leaders of this rating are Denmark, Korea, and Estonia (Table 9.4).

***Table 9.4* – E-Government Development Index (2014–2020)**

Country	2020		2018		2016		2014	
	Place in the rating	E-Government Development Index	Place in the rating	E-Government Development Index	Place in the rating	E-Government Development Index	Place in the rating	E-Government Development Index
Denmark	1	0,9758	1	0,9150	9	0.8510	16	0,8162
Korea	2	0,956	3	0,9010	3	0,8915	1	0,9462
Estonia	3	0,9473	16	0,8486	13	0,8334	15	0,8180
Finland	4	0,9452	6	0,8815	5	0,8817	10	0,8449
Australia	5	0,9432	2	0,9053	2	0,9143	2	0,9103
Sweden	6	0,9365	5	0,8882	6	0.8704	14	0,8225
Great Britain	7	0,9358	4	0,8999	1	0,9193	8	0,8695
New Zealand	8	0,9339	8	0,8806	8	0,8653	9	0,8644
…								
Lithuania	20	0,8665	40	0,7534	23	0,7747	29	0,7271
Kazakhstan	29	0,8375	39	0,7597	33	0,7283	28	0,7283
Russia	36	0,8244	32	0,7969	35	0,7215	27	0,7296
Belarus	40	0,8084	38	0,7641	49	0,6625	55	0,6053
….								
Ukraine	69	0,7119	82	0,6165	62	0,6076	87	0,5032
….								
Somalia	191	0,1293	193	0,0566	193	0,0270	193	0,0139

Source: [23].

Estonia deserves special attention, since in recent years, according to the UN, it has been among the twenty world leaders in terms of EGDI, and according to the 2020 indicator, it is in the top three of the e-Government Development Index rating.

A certain lagging behind the world leaders of countries with developing economic systems indicates the need for measures of effective institutional support by the state regarding the development of this direction.

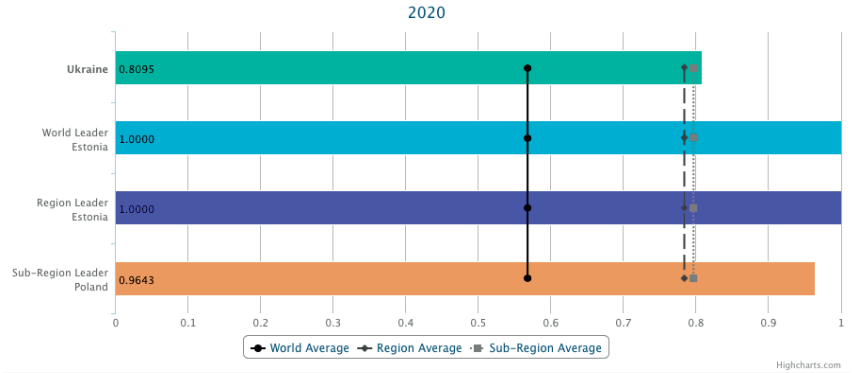
The key indicator for measuring e-government is E-Participation Index (EPI), which is evaluated by analyzing the level of national e-government portals (government platforms) development regarding information interaction with citizens. The UN E-Participation Rating measures e-Participation by indicators:

1) the use of interactive services for providing information by governments to citizens;

2) interaction and consultations with citizens;

3) citizen participation.

In the 2020 UN E-Participation rating, Ukraine took 46th place among 193 countries of the world, rising 29 positions compared to 2018. The leaders of this rating are Estonia, South Korea, the USA, Japan and New Zealand (Fig. 9.5).



E-Participation Index	2020	2018	2016	2014	2012	2010	2008	2005	2004	2003
Ukraine (Rank)	46	75	32	77	83	48	14	28	24	24
Ukraine (Value)	0.80950	0.68540	0.74576	0.43137	0.15790	0.25714	0.56818	0.36507	0.34426	0.39660

Fig. 9.5 – E-Participation Index of Ukrainian citizens [24]

In recent years, digital tools for the interaction of citizens and businesses with public authorities have been successfully implemented in Ukraine. Citizens and business representatives gained access to such services: e-appeal; e-consultations; e-petitions to the Verkhovna Rada of Ukraine, the President of Ukraine and to the Cabinet of Ministers of Ukraine, central and local executive bodies and local self-government bodies; e-contests of projects and programs of civil society institutions, e-elections of public councils members under executive

authorities, e-registration of an entrepreneur, e-payment of taxes, e-licenses.

In 2020, Ukraine for the first time participated in the Open Data Maturity Report 2020 – European open data rating, and it took 17th place among European countries in the open data maturity rating. In the Open Data Maturity 2021 rating, Ukraine rose to 6th place, the level of open data maturity was 94 % (Fig. 9.6).

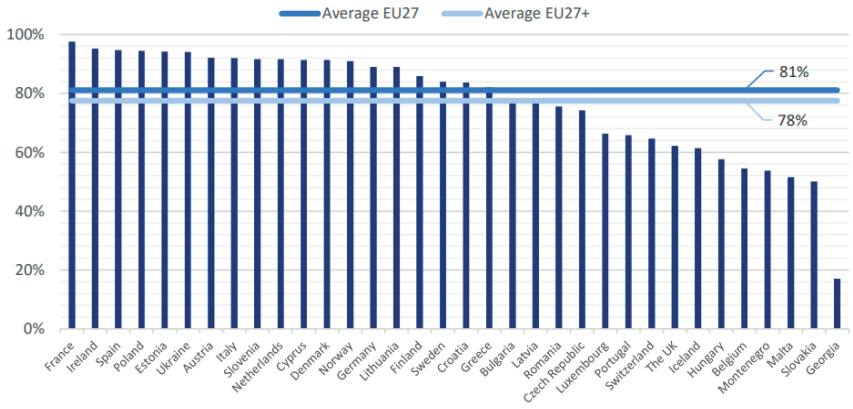


Fig. 9.6 – Overall Open Data Maturity Indicators 2021 [25, p. 5]

Fig. 9.6 illustrates the overall open data maturity indicators for all 34 European participating countries in 2021. It is obvious that Ukraine occupies a much higher position in the rating than the 21 EU countries. France has the best indicator among countries (97,5 %), it has been leading in this rating for recent years. The top five include Ireland, Spain, Poland, and Estonia (Table 9.5, Fig. 9.7).

***Table 9.5* – Open Data Maturity Development Indicator in Ukraine 2020–2021**

Open Data Maturity Development Indicator, %				
	Ukraine		The average indicator of the European Union countries	
	2020	2021	2020	2021
Overall, including:	84	94 (+10)	78	81 (+3)
Open Data policy	85	98 (+13)	85	87 (+2)
Web-portal of Open Data	88	94 (+6)	79	83 (+4)
Open Data impact	85	95 (+10)	72	77 (+5)
Open Data quality	78	89 (+11)	76	77 (+1)

Such positive dynamics are present in all points of Open Data Maturity Development assessment, where Ukraine will demonstrate a trend towards stable positive dynamics and one of the highest growth rates in Europe.

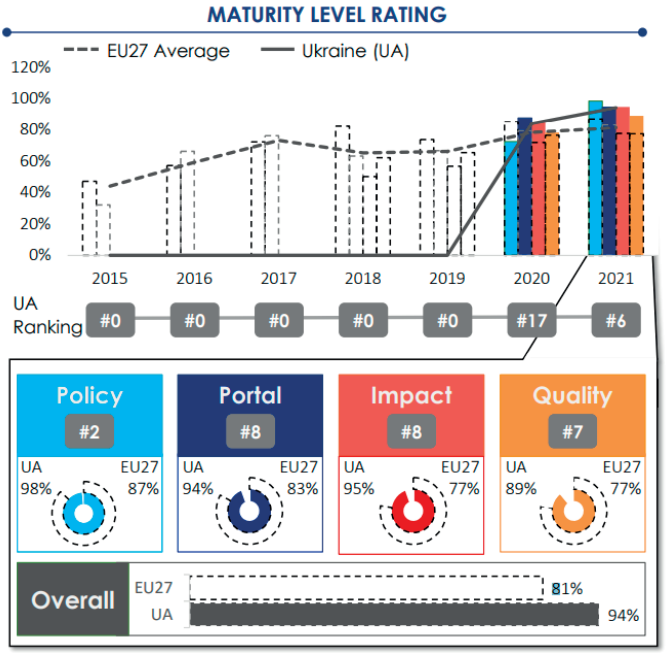


Fig. 9.7 – Open Data State of Ukraine 2021 [26]

According to all indicators, Ukraine had demonstrated higher results than the average one in Europe. The presence of Ukraine's positive dynamics in the above-mentioned world rankings in recent years reflects the gradual digitalization of society and the country's economy.

Questions for self-control:

1. Describe the areas and categories of the "Government Services Online" portal («Diia Portal»).
2. What digital documents are available in the Diia mobile application?

3. Characterize the projects, which are implemented on the Diia platform. Define their features.
4. Analyze Ukraine's position in the E-Government Development Index Ranking (2014–2020).
5. Analyze Ukraine's position in the E-Participation Index Ranking.
6. Which are Ukraine's positions in the Open Data Maturity ratings 2021–2022? Describe and analyze the indicators.

9.4. Transformation of business processes in digital economy

The digital approach is a new business philosophy that involves the presence and constant development of feedback between the entities of business relations regarding the development of economy, which is driven by innovative technologies. Paradoxically, however, digitalization does not consist in the total implementation of IT technologies, but in the deep transformation of business strategy. This is a complete renewal of the current business model, and therefore a rethinking of the mission of the activity, processes, tools and means.

In digital economy, competition is increasingly becoming a competition not of resources, but of strategies, when organizations' investments are more and more often focused on building core competencies and securing their dynamic capabilities. Innovative potential, the ability to form more effective strategies and constantly develop organizations, updating their structure and key business processes in response to the challenges of the external environment, play even greater role.

Business can choose any direction of development, guided by the mission and available tools for influencing processes. However, it is digital transformation that has the greatest potential. It is a new prototype of the reconstruction of society and economy, which is realized by implementing a flexible modular complex of

models and tools that are fully available for adaptation in traditional business models (Fig. 9.8).

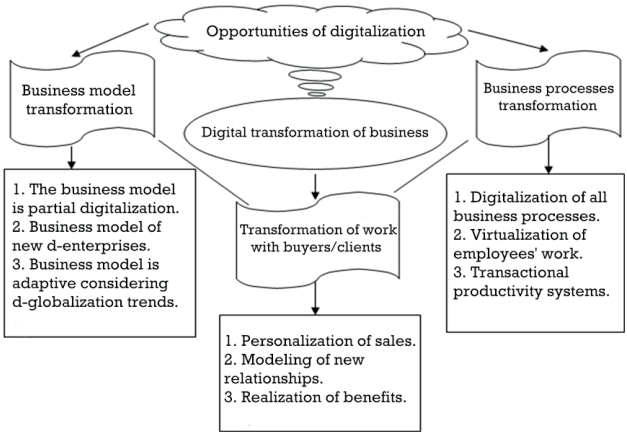


Fig. 9.8 – Model of digital business transformation

Source: [27, p. 146–148].

It is obvious that business digitalization process covers three main directions:

1) transformation of business models;

2) transformation of relations with buyers and/or clients;

3) transformation of business processes.

Let us consider the essence of mentioned directions.

Business model is a broad term used to describe the method (positions in the value chain, customer choice, products, pricing) of doing business [28]. A revenue generation model describes the process by which a business makes money and defines exactly how the firm is going to price its products and services.

Today, when defining the essence of the "business model" concept, 2 approaches are distinguished:

1) business process/role-oriented (an approach aimed at inside the enterprise);

2) value/customer-oriented (an approach aimed at the external environment of the enterprise).

The first approach is related to the consideration of the enterprise's activities from the point of view of business processes and technologies (the focus of attention is directed inside the company). The second approach, on the contrary, involves focusing on the value that an enterprise creates for external customers, as well as on the results of activities. In fact, the business model allows you to get an answer to the question: what and how should be done to achieve the desired result.

The key business model elements of any enterprise that determine its content are:

– the value for external customers that an enterprise offers based on its products and services;

– the system for creating that value, including suppliers and target customers, as well as value chains;

– assets that an enterprise uses to create value;

– the financial model of the enterprise, which determines both the structure of its costs and the methods of profit-making.

The business model turns innovations into economic value for the business (Fig. 9.9). It describes in detail how a company makes money by clearly defining its place in the value chain. A business model is built of various business components, which include entrepreneurship, strategy, economics, finance, operations, competitive strategies, marketing and sustainable growth strategies.

Fig. 9.9 – The sequence of value creation by business model [29]

The business model structure can be presented in the form of three main components:

– functional model – business processes and events that initiate these business processes, output results;

– organizational model – organizational structure of the enterprise and the roles that departments perform in the enterprise's management system;

– information model – a scheme of information flows in the control loop, built on the basis of a functional model.

The business model is necessary to form a holistic view of the following essential characteristics of the enterprise: what value and in what way is it created for the consumer; to whom and how it is provided; how resources and capabilities are used to create sustainable competitive advantage and make profit.

Comparison of business models in the conditions of classical and digital economy are presented in Table 9.6.

***Table 9.6* – Comparison of business models in the conditions of classical and digital economy**

Criteria	*Classic business model*	*Digital business model*
Strategic planning and data analysis	Finding and analysing trends	Identifying trends based on Big Data and machine learning
Production	Manufacturing products	Production optimization in accordance with customer requests
Storage	Storage of finished products	Optimizing remains in real time
Transport and logistics	Planning, delivery and control for efficient logistics	Real-time delivery control and process forecasting
Sale	Distribution of products through sales points	Direct sales to consumers

Source: [28; 30].

The introduction of digital technologies led to the formation and development of such business models categories as:

– digital platforms that provide direct interaction of participants;

– service business models based on the use of resources instead of owning them (including Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS), etc.);

– business models whose pricing is based on the achievement of results (outcome based models) and effect for the client, including those on the basis of complex products and services consumption;

– crowdsourcing models based on the involvement of external resources for the implementation of business processes;

– business models based on the monetization of clients' personal data, when free services to users sell their data at other consumer segments.

Digital transformation consists in the use of modern (disruptive) technologies to increase enterprise's productivity and value in today's conditions. The main results of such transformation can be: cost reduction, improvement of services and products quality, as well as increase productivity. KPMG research shows that in 61 % of companies, digital technologies have contributed to growth of competition in their business from new employees.

The second direction of digitalization impact on business is the *transformation of relations with buyers and/or clients*.

The most important reason why people buy a certain product is not the quality or price, but rather the feeling they get after the purchase. Due to Customer Relationship Management (CRM), companies work methodically to exceed their customers' expectations, meet their needs, and delight them. It is digitalization that significantly helps to solve this task due to:

1. A deeper understanding of clients – is realized due to the company's use of social networks in order to study client's requirements and preferences, promoting the brand, providing support to clients during the purchase and use of products, etc.

2. Revenue growth from the company's existing clients – statistical data on the purchases of its own customers are used for organization of personalized sales and full customer service, development of individual packages of proposals.

3. The search for new touchpoints with clients is implemented by creating opportunities for own customers for self-service with the help of digital technologies, or multi-channel ways of access to customers.

4. Building a successful client experience – effective implementation of the initiative turns into customer satisfaction and loyalty.

5. The possibility to use customer data to further improve their experience, satisfy their preferences, understand pain points and obtain a complete customer profile.

6. Fast, effective response and resolution of customer issues in real time.

7. Much of the digital transformation power lies in its ability to enhance level of interaction with customers. For example, promptness in responding and fulfilling customer requests increases their engagement. Moreover, digitalization allows customers to access functions, make transactions and initiate communication anytime and anywhere, which increases the convenience and speed of request execution.

8. Providing a higher level of customer service, increasing opportunities to build relationships with each customer.

An important component of digital transformation of enterprises is *digitalization of their business processes*. It should be noted that under this term, domestic scientists consider both the automation of basic and auxiliary (supporting) business processes, as well as management processes, which are carried out in order to optimize and ensure the efficiency of the enterprise and industry activity in general [30, p. 20].

According to the results of research conducted by Ernst & Young, digitalization has the greatest impact on such components of business processes as: interaction with customers, value proposition and internal infrastructure management [31].

Business processes digitalization of enterprises through the introduction of digital technologies contributes to the formation of more perfect business processes, which in turn leads to the improvement of their efficiency, flexibility, adaptability to external environment changes and formation of competitive advantages. Business processes digitalization of enterprises involves consistent implementation of several stages:

– collection of complete information about each business process, its

modelling and identification;

– identification of places of origin, further processing and consumption of information;

– information business processes modelling;

– information system modification considering the digitalization model; automated information system creation (due to the use of hardware and software);

– all business processes controlling (fixation of individual business processes parameters in the information system, drawing up plans, creating reports, etc.).

It should be noted that the methodology of business processes digitalization of enterprise is based on the supporting concepts of information systems, which in their development evolved as follows: MRP I (Material Requirements Planning) – MRP II (Manufacturing Resource Planning) – Enterprise ERP systems (Enterprise Requirements Planning) – CSRP (Customer Synchronized Resource Planning). Modern ERP system is a complex of interdependent modules (appendices) that ensure the operation of a single integrated information environment due to the automation of all business processes of the enterprise. Currently, such a domestic software product as the ERP system of IT-Enterprise corporation "Information Technologies" is becoming common among enterprises in Ukraine. This system has complex "Industry 4.0" implementation projects at industrial (metallurgy, machine-building, food, chemical, cable) and agricultural enterprises, including the introduction of production management systems, controlling, logistics, budgeting, etc.

All IT-Enterprise system modules are conventionally grouped into management circuits of such components as: production and technical re-equipment of production; implementation of projects; basic production means; business processes; document flow; personnel; logistics; budgeting and controlling. Business processes digitalization of the enterprise includes a number of elements, a brief characteristics of the main ones is given in Table 9.7.

Table 9.7 – **Characteristics of the components of business processes digitalization of the enterprise**

№ p/p	Component	Brief characteristics
1.	Realization	Ensuring the successful realization of the company's strategy requires thorough market and competitors analysis.
2.	Result	The conclusion of this stage will be an informed decision on whether to move to digital transformation or not.
3.	Analysis	A thorough analysis of what enterprises can do better with existing business processes and which business processes require immediate implementation of the latest technologies should be conducted.
4.	Recognition	Enterprises need to identify changes they can introduce to business processes to improve them. For this, it is necessary to perform many actions, in particular, the following: study current business processes; involve key stakeholders; study the latest innovative technologies; choose technologies and technical products that can be implemented in the activity of the enterprise; view and improve products, service offerings and even business models.
5.	Prioritization	Enterprises must first rethink detected changes, analyse expenses and benefits, assess possibilities, resources, budgets, etc., and then prioritize based on this.
6.	Implementation	Implementation of changes. Includes obtaining the necessary budgets, identifying responsible groups, redesigning of processes and implementation using identified technologies and technical products.
7.	Deployment	It consists in making the new system available for use. Includes developing a clear deployment plan with clearly defined functions, responsibilities and timelines.

Source: [32].

Business processes digitalization (English: digital work) involves the use of digital tools when carrying out business organization activities, and not only the digitalization of data array. First of all, there is a need for preliminary assessment of the existing information system of the enterprise, to determine the procedures and processes that need to be automated or digitized. It is also equally important to determine the interaction between business processes at the level of their implementation and consider the hierarchical structure of business processes of economic entities.

Improved business processes, in turn, change priorities in the distribution of enterprise resources. The main functional areas of the enterprise, including marketing, finance, production and personnel, are determined by the available

information systems capabilities that ensure the implementation of production and organizational activities. The decision-making process is mainly focused on the use of an integrated information base, which is formed at lower management levels, and on data flows from structures external to the enterprise, obtained with the help of new telecommunication means and services based on them. Information technologies implementation in the organization of business processes is based on electronic document flow and the transformation of information resources (data) into a means of achieving commercial goals.

The goal of digital transformation is to create the right foundation for digital business. This means creating an organization that can continue to evolve as needed to keep up with changes in technology and customer expectations. Digital strategy must be transparent enough to help the company survive the changes in the digital economy, so that it continues to deliver digital advantage to the business [33].

Therefore, business processes digitalization is aimed at optimizing the existing resource potential, working time expenditure and improving the efficiency of economic activity.

Questions for self-control:

1. What are the features of competition in conditions of digital transformations?
2. What is the digital transformation of business? Outline its main directions.
3. What is the essence of the business model?
4. What new types of business models have appeared in conditions of digitalization?
5. What are the features of the business model in digital economy?
6. Explain how digitalization affects the transformation of relations with buyers and/or clients.

7. What advantages do buyers and clients receive during digitalization implementation?

8. Describe the components of business processes digitalization of the enterprise.

9. What are the consequences of business processes digitalization for the enterprise?

10. Outline the stages of business processes digitalization.

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UDC 004.330.1

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Chapter 10
USE OF MULTIMEDIA METHODS TO VISUALIZE DATA ON THE EDUCATIONAL NEEDS OF THE PEOPLE WITH SPECIAL EDUCATIONAL NEEDS

Content

10.1. Use of "Theory of multiple intelligences" in the inclusive education

Universal Design of Education is design of the objects, environment, educational programs and services, which ensures their maximum suitability for use by all persons without the necessary adaptation or special design [4].

Structure of the universal design [1]:

– using the various methods for presenting information, easy perception and understanding of information,

– providing students with the alternative ways to act and demonstrate what they know,

– using interests of the students, offering a choice of the educational content and ways to motivate them, offering the different levels of complexity.

The main goal of the *universal design* in education is to remove barriers for gaining and acquisition of the knowledge. All barriers can be united into three groups: physical – lack of ramps, unequipped toilets, and high thresholds, etc.; informational – lack of subtitles or sign language translator, small print, etc.; mental – our prejudices and attitudes.

"Theory of Multiple Intelligences" (by Howard Gardner) contradicts the generally accepted definition of the intelligence by the standardized IQ tests. His approach is based on the individual approach to each person with the establishment of the intellectual capabilities based on his/her type of intelligence. That is why the use of "Theory of Multiple Intelligences" is becoming relevant today in building the effective inclusive design in education.

Intelligence is the ability to process information due to the biological and psychological factors, which can be activated in the certain cultural environment for solving problems or creating products (H. Gardner) [3].

Types of intelligence (or centers of competence) of the author of "Theory of Multiple Intelligences" are graphically shown in Fig. 10.1.

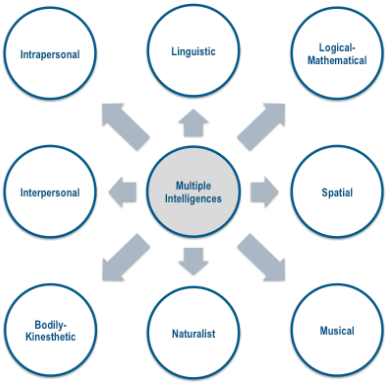

Fig. 10.1 – Types of intelligence by H. Gardner [3]

H. Gardner gives the following definitions to each of these types of the intelligences:

– *visual-spatial* – the ability to accurately perceive the visual-spatial world and change the previous images or manipulate them;

– *kinesthetic* – the ability to control the movements of one's own body and skillfully operate with the physical objects;

– *musical* – the ability to create and perceive the rhythm, pitch and timbre, as well as distinguish the forms of musical expression;

– *interpersonal* – the ability to recognize the moods, temperaments, motivations and intentions of others and respond appropriately to them;

– *intrapersonal* – the knowledge of one's own feelings, strengths and weaknesses, intentions and the ability to be guided by this knowledge to determine the own behavior;

– *logical-mathematical* – the ability to distinguish between the logical or numerical models and to understand and build the long chains of inferences;

– *verbal-linguistic* – sensitivity to the sounds, rhythms and meanings of the words; the ability to recognize different functions of language;

– *naturalistic (natural)* – the ability to distinguish between the plants, animals, stones and other phenomena of the world [3].

A person learns through what he/she feels, hears, smells, does, sees, tastes. Based on the capabilities and characteristics of each person, it is also necessary to choose the individual learning style.

Dominant learning styles [3]:

1. Kinesthetic-tactile (haptic) – it is used by people who learn better when they move, are engaged in the practical activities, explore new things, experiment, i.e. learn by touch.

2. Visual (optic) – it is used by people who learn better through drawings, diagrams, charts related to the topic of study; a smaller percentage of them prefer the printed text (i.e. learn through reading).

3. Auditory (acoustic) – it is used by people who learn better, perceiving information by ear, through conversation, lecture, often with background music.

Janet Voss proposes to use the following technique of determining a person's learning style [3].

1. According to the eye movement:

– *Visual style* – a student, grasping information, sits quietly and looks ahead, or periodically raises his/her eyes. Usually such children speak quickly;

– *Audial style* – a student, grasping information, leads the eyes in the horizontal plane (one who has an active right hand – to the left, and one who has an active left hand – to the right). Periodically, these children look down. These children speak rhythmically;

– *Kinesthetic style* – a mobile student, by grasping information, looks right and down, speaks slowly. When such a student asks questions, his/her glance slides up.

2. According to the body language:

– *Visual style* – a student sits straight and watches the person who communicates information.

– *Audial style* – a student sometimes whispers the words spoken by the teacher, nods his/her head, his/her glance is distant.

– *Kinesthetic style (tactile)* – perceiving information, a student sits freely at the desk. Listening, he/she can play with a pen, move objects on the desk, and twist a small object in the hands.

Questions for self-control:

1. Why do we use the universal design?
2. Define the "Theory of Multiple Intelligence"
3. Describe the main learning styles.

10.2. Digitalization as a part of the inclusive education

Digital Economy is the economy based on the digital computer technologies. The digital economy is sometimes called the Internet economy, new economy, or web economy. Increasingly frequently, the "digital economy" is infused with the traditional economy, making the clear demarcation more difficult. The digital economy is understood as the production, sales and supply of the products through the computer networks [7].

Digitalization of the economy leads to the effective results for business and population:

1. There are the following results for business:

– simplification of the basic business processes (calculations, logistics, reporting, etc.);

– reduction of the load on the specialists (replacement of the mechanical functions of a specialist by the machine work, elimination of the professional skills in the direction of creativity and development);

– reduction of the operating costs;

– promotion of the goods/services through the Internet platforms (expansion of the market outlets).

2. There are the following results for the population:

– improving the quality and availability of the public services;

– simplification of the everyday household tasks (payment for utilities and other services, purchase of the goods on-line, etc.);

– expanding access to the services (medical, legal, consulting, etc.);

– improving the quality of education.

Digitalization in the education, and especially in the inclusive education, is becoming a separate part. The effectiveness of the educational strategy can be assessed by the following algorithm (Fig. 10.2).

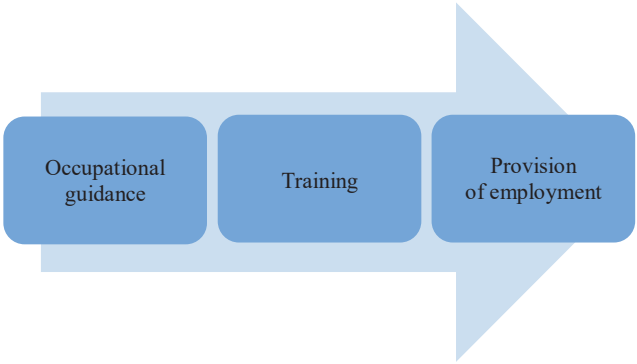

Fig. 10.2 – Algorithm for building the effective educational strategy

The sequence of execution of the algorithm shown in Fig. 10.2 reflects the effectiveness of the educational strategy. Failure to comply with one or another stage leads to the general decrease in the effectiveness of the educational strategy, the reasons for not achieving the goals of the educational strategy may include:

– lack of understanding of the basic requirements and competencies of the profession;

– inconsistency of the acquired knowledge and skills of the chosen profession;

– low applied nature of training;

– lack of communication habits;

– lack of information on the labor market;

– inability to "sell" the own knowledge and skills in the labor market.

Today we can identify the main stages in the development of education: computerization of learning, distance learning, digitalization of the society. At each stage there were certain changes in education:

1. Computerization of education:

– advanced training of the pedagogical staff;

– digitization of the data;

– increasing the amount of the information;

– acceleration of the learning process;

– increasing the level of access to education.

2. Distance learning:

– advanced training of the pedagogical staff;

– learning new Internet platforms;

– expanding the geography of education;

– cost reduction (transport, accommodation, meals);

– increasing the level of access to education.

3. Digitalization of the society:

– advanced training of the pedagogical staff;

– use of the modern learning tools;

– use of the digitalization products in the learning process;

– increasing the level of access to education.

With respect to the rapid development of the society, digitalization is becoming an integral part of the inclusive education. That is why the educational process requires the development of the additional tools and multimedia methods to visualize data on the educational needs of the people with special educational needs.

Questions for self-control:

1. Name the main results of economy digitalization.
2. Describe the algorithm for building an effective educational strategy.
3. Name and describe the main stages of education development.

10.3. Use of the modern visual teaching methods in the inclusive education

The rapid penetration of the information and communication technologies into the human life and the overload by the information flows require that the new

technologies, changes of the teaching methods, ways of presenting educational information and introduction of the new learning technologies that would be effective in the today's conditions be adopted by the modern education. The information richness of the modern world requires special preparation and some adaptation of the educational material before presenting it to the students in order to provide the students with the basic or necessary information in the visually accessible form that will be understandable, easily accessible and easily assimilated. The expediency of using visualization of the educational information is due to the need to take into account the cognitive characteristics of the current generation of the students, as well as the need for compact presentation of the educational material in the form, which is the most convenient for its perception, understanding, assimilation and memorization [1].

At the present stage of development of education, the following visual teaching methods are used [1]:

– scribing;

– book trailer;

– gifs and social networks;

– mind maps;

– interactive books and textbooks;

– interactive timelines;

– internet memes;

– lapbooks;

– clouds of words, etc.

Scribing is the latest presentation technique, the speaker's language is illustrated "on the fly" with felt-tip pen drawings on a white board (or sheet of paper), it turns out like a "parallel tracking effect" when we hear and see about the same thing, at the same time the graphic series is fixed at the key points. A specialist in this field is called scriber, and the presentation created by him/her – a scribe [6].

Types of scribing:

– "manual" scribing (example of the manual scribing – *https://www.youtube.com/watch?v=1G3Kyu_UbjQ*);

– "computer" scribing (example of the computer scribing – *https://www.youtube.com/watch?v=1OexEa4Yeyk*).

You can use PowToon and VideoScribe to create the computer scribing.

Book trailer is a short video that reproduces the story of a certain book in any form. It is created by analogy with the movie trailers. Typically, this method of work is used to increase interest in reading books. Importantly, the trailer can be made by both the teacher and the students, depending on the purpose of the work. Its most interesting feature is the specific presentation of the intriguing information [1].

According to the method of visual embodiment of the text, they are divided into following groups [5]:

– game (mini film based on a book);

– non-game (a set of slides with quotes, illustrations, book covers, thematic drawings, photographs, etc.);

– animated (cartoon based on the book).

According to the content, they are divided into following groups:

– narrative (presenting the basis of the plot of the work);

– atmospheric (conveying the main mood of the book and the expected emotions of the reader);

– conceptual (conveying the key ideas and general semantic orientation of the text).

Gifs and social networks are the original means of modernizing the images of the classics of the world and Ukrainian literature. You can create a writer's profile on social media or imaginary online correspondence between the two artists, or even develop themed gifs and emoji. It is quite simple and at the same time very interesting. Conducting lessons in this format will allow students to use

the convenient online tools while learning, as well as to discover their own creative abilities and make the outstanding personalities from the textbook a little closer [1].

Mind maps is a universal way of organizing information, adapted for the most productive perception of the brain. The technology teaches thinking in a new plane, involving both hemispheres of the brain in the active work. Opinions and conclusions are presented in the convenient format, with the arbitrary addition of the pictures and other supporting elements. The most popular scheme contains several components: keywords on the topic, graphics, arrows, combining different blocks. All this is designed to form the intuitive perception of information [1].

Programs for creating mind maps: MindMup, Simplemind, The Brain, Comapping.

Interactive books and textbooks imply modernization of the usual format of books, which has become possible thanks to the latest achievements in the field of IT. The text in the book is supplemented by 3D models, audio, video and thematic animations. Interestingly, in Ukraine such a format has existed for a long time, and is now gaining more and more popularity [1].

Interactive timelines is the dynamic way to study the chronological course of the events by visualizing it. The method does not lose its relevance in any of the subjects. Creating the timeline can be used to test knowledge and when learning a new topic [1].

Internet memes are any information presented succinctly and wittily to attract attention of the Internet users. This technique reproduces the certain attitude to the events or circumstances. The most popular are Internet memes in the image format with apt humorous textual explanation. For a long time it was believed that they are used online only for the entertainment purposes, but it has been proven that they are also quite effective in education [1].

Lapbook is a self-made interactive folder or notebook, where various informative materials on a certain topic under study are collected and brightly

designed. The main advantage of the laptop is that it is created by hand and designed to the own liking – with the addition of various moving parts, pockets, envelopes, mini-books or other elements. This allows you to structure the information, actively participate in the learning process and identify the creative abilities of the students. Due to this, the process of cognition becomes really exciting [1].

Word clouds is the visual representation of a list of words, categories, or labels in a single shared image. With the help of the word clouds, it is possible to visualize terminology on the particular topic. This facilitates the rapid memorization of the information. The word cloud can be easily generated with the own hands using the special programs [1].

Questions for self-control:

1. Define the concept of "educational information visualization".
2. Name and describe the visual learning methods.

10.4. E-Accessibility tools in the Inclusive education

All e-accessibility tools in the inclusive education can be divided into the following groups: voice-to-text tools; text-to-voice tools; screen access programs; communication programs and spatial orientation programs. Let us look at each group of the tools in more detail.

1. Voice-to-text transformation. Examples of software: Live Transcribe, Write SMS with the help of voice PRO, Speechnotes, Notta, Audio file to text.

Main functions:

– automatic speech and sound recognition;

– possibility for people with hearing impairments to read audio texts from the screen (lectures, webinars, video lessons, etc.);

– telephone communication becomes more accessible;

– notification of indoor sounds;

– people with disabilities can send e-messages using voice.

2. Text-to-voice transformation. Examples of software: LINKa. Write, RHVoice Anatol, Voice Aloud Reader, KNFB Reader, FBReade, Voice Vocalizer, UkrVox.

Main functions:

– sounding of the entered text;

– making textual information available for the visually impaired;

– helping to establish communication with people with speech disorders;

– helping to orient in the institutions;

– reading information about the goods in stores (price, ingredients, shelf life, etc.).

3. Screen access programs. Examples of software: LINKa. Press, LINKa. Paper keyboard, JAWS, Fusion Downloads, MAGic, BIG Launcher, Blind Accessibility Keyboard, Google BrailleBack.

Main functions:

– helping to enter the text for people who can press only one button (using the suggested images);

– zooming on the screen of the device;

– reading aloud the information from the device screens.

4. Communication programs. Examples of software: Digital Inclusion, Autism: Communication, Understand Me Free, LINKa. Show, Card Talk, Leeloo AAC, AutiSpark.

Main functions:

– helping people with verbal dysfunction (speech, autism, some forms of cerebral palsy, after a stroke) to communicate with the surrounding people;

– giving the possibility to express the needs, emotions, desires with the help of the images;

– sounding the images helps to develop the language.

5. Spatial orientation. Examples of software: Dostupno, Sullivan, Be My Eyes, Envision, Cash Reader, LazarilloApp GPS, Aipoly Visio, Google Lens, LetSeeApp, MCT Money Reader, Wheelmap, izi.TRAVE.

Main functions:

– helping to navigate in cities, choose the barrier-free locations for low-mobility groups (cafe, hotel, shop, library, etc.);

– working as GPS navigator on a given route;

– recognition of the objects with the help of the camera;

– color recognition;

– recognition of the banknote denominations;

– performing the functions of a guide.

It is important to consider the practical application of the digital accessibility tools in the use of the popular products of digitalization of the society in terms of the problems and ways of their solving in each area of life of the population:

1. Public services

Problems in using:

– no version for visually impaired people;

– difficulties in entering the information for people with musculoskeletal disorders.

Solutions:

– using the screen access programs;

– using the text-to-voice programs.

2. Banking

Problems in using:

– problems of use for visually impaired people;

– difficulties in entering the information for people with musculoskeletal disorders;

– communication problems for people with hearing impairments in case of

problem situations.

Solutions:

– using the screen access programs;

– using the text-to-voice programs;

– using the voice-to-text programs;

– using the banknote denomination recognition programs.

3. Medicine

Problems in using:

– problems of use for visually impaired people;

– problems in entering the information for people with musculoskeletal disorders;

– communication problems in the on-line consultations for people with hearing impairments.

Solutions:

– using the screen access programs;

– using the text-to-voice programs;

– using the voice-to-text programs;

– using the communication programs (for better consultations).

4. E-commerce and digitalization of the sales

Problems in using:

– problems of use for visually impaired people;

– problems in entering the information for people with musculoskeletal disorders;

– communication problems in on-line purchases/sales.

Solutions:

– using the screen access programs;

– using the text-to-voice programs;

– using the voice-to-text programs;

– using the communication programs.

5. On-line learning

Problems in using:

– problems of use for visually impaired people (presentations, texts);

– difficulties in entering the information for people with musculoskeletal disorders (taking tests, registration);

– problems of use for people with hearing impairment (lectures, webinars, workshops);

– communication problems (student assessments, feedback, evaluation of the learning outcomes).

Solutions:

– using the screen access programs;

– using the text-to-voice programs;

– using the voice-to-text programs;

– using the communication programs.

Questions for self-control:

1. Describe groups of electronic accessibility tools in inclusive education.
2. List the practical applications of the digital accessibility tools.

10.5. Advantages and disadvantages of visualization of learning in the inclusive educational environment

A number of the problems always accompanies modernization and development of any sphere of the society, and education is no exception. There are the following problems in the implementation of the inclusive education:

– lack of the proper training of the teachers;

– information on the benefits of inclusion did not reach the participants in the process or was unconvincing;

– lack of the resources;

– changes appeared to be very huge and therefore difficult to achieve in a short time;

– attempts to involve parents in cooperation with the university are formal or non-existent;

– established organization of the training sessions and functioning of the educational institution as a whole.

Use of the visualization tools in education of the people with special educational needs has many advantages in the learning process, but it is necessary to take into account the existing disadvantages of the learning visualization (Table 10.1).

Table 10.1

Advantages and disadvantages of the visualization of learning of the students with special educational needs

Advantages	Disadvantages
– improves the speed and quality of information assimilation; – allows to grasp large amounts of the information; – reduction of the information overload and retention of attention; – unambiguity and clarity of the derived data; availability for most nosologies; – aesthetic appeal.	– does not take into account all nosologies (visual impairment or blindness); – is a very labor-intensive process; – the need to process large amounts of information; – inconsistency of the images and essence of the data; – the need for special technical means.

Introduction of the digitalization in the educational process has many advantages, but like any progress, has a number of disadvantages:

Disadvantages of the digitalization of education are the following:

– complicates/overloads the educational process;

– outdated educational technologies;

– low quality of the digital infrastructure;

– the need to use the special equipment;

– processing of the large amounts of the information;

– constant updating of the educational materials.

Taking into account the above disadvantages in the further digitalization of education will allow enjoying all its advantages, which include the following:

– services/goods/information become more accessible;

– decreases the dependence of people with the functional disabilities on the surrounding people;

– preparing people with disabilities for future independent living;

– reduces the risk of fraud;

– always corresponds to the relevant information;

– increases the level of education of the citizens in general;

– gives a stimulus to the development of medium and small businesses;

– resets the load from the government agencies.

Questions for self-control:

1. What becomes an obstacle for modernization and development of education?
2. Describe the advantages and disadvantages of visualizing the study of students with special educational needs.
3. Name the disadvantages of digitalization of education.

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UDC 330.1:378.2:004

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Chapter 11
NEW APPROACHES OF ECONOMIC FIELD SPECIALISTS TRAINING UNDER CONDITIONS OF DIGITALIZATION ECONOMIC PROCESS

Content

11.1. Digital literacy: concepts, components and factors of digital competencies development

With the increasing pace of digital technologies development, as well as the introduction of innovative solutions in all spheres of public life there is a need to improve the quality of training of employees to create opportunities for modernization of the economy in accordance with modern requirements. The lack of conceptual foundations for the formation of state policy in the field of digital

skills and digital competencies of citizens does not allow to ensure the development of all spheres of public life in accordance with modern requirements, processes of global digitalization of the economy, spheres of society which take place in most countries. Thus, there is a need to ensure the readiness of society for such processes, mastering key combinations of knowledge, abilities, skills, ways of thinking and other personal qualities in the field of information, communication and digital technologies (digital competence).

Digital competence is a dynamic combination of knowledge, abilities, skills, ways of thinking, views, other personal qualities in the field of information and communication as well as digital technologies, which determines a person's ability to successfully socialize, conduct professional and/or further educational activities using such technologies. The meaning and place of digital competence in the system of knowledge, abilities and skills of modern specialists and modern society citizens can be summarized in Table 11.1.

Table 11.1 **– The meaning and place of digital competence**

Document Title	Approach
The Law of Ukraine "On Education" [1]	information and communication competence is recognized as one of the key competencies necessary for every modern person to succeed in life
State Strategy for Regional Development for 2021–2027 [2]	a low level of digitalization of regions and digital awareness are identified among other national challenges hindering the development of regions and the state as a whole
The State Standard of Basic Secondary Education [3]	defines information and communication competence as one that provides confident, responsible use of digital technologies for their own development and communication; ability to safely use information and communication tools in learning and other life situations, adhering to the principles of academic integrity
The Concept of Digital Economy and Ukrainian Society Development for 2018–2020 [4]	the creation and implementation of a national curriculum for general and professional digital competencies and knowledge is identified as one of the priorities on the path to accelerated development of digital economy

The experience of European countries shows the significant impact of measures taken on digital competencies of the population on economic development and competitiveness of EU countries at the international level. Thus, on May 22, 2018, the European Parliament and the Council of the EU enacted the Framework Program on Updated Key Competences for Lifelong Learning

(2018/C 189/01), which recognizes digital competence as one of the eight key competences for full life and activities of EU citizens. Given the need to ensure the implementation of the strategic course of the state to gain full membership of Ukraine in the EU also requires further adaptation of Ukrainian legislation with EU law.

Today, a significant number of educational activities are aimed at developing digital skills, but they are not systemic, provide only individual skills and don't solve the issue of the low level of digital skills in society and awareness of citizens' digital rights. By order of the Cabinet of Ministers of Ukraine from March 3, 2021 № 167 – the Concept of digital competencies development and the action plan for its implementation were approved [5]. The implementation of this Concept is planned for the period up to 2025. The main problems in the development of digital competencies that need to be solved within the Concept of digital competencies [5] are shown in Fig. 11.1.

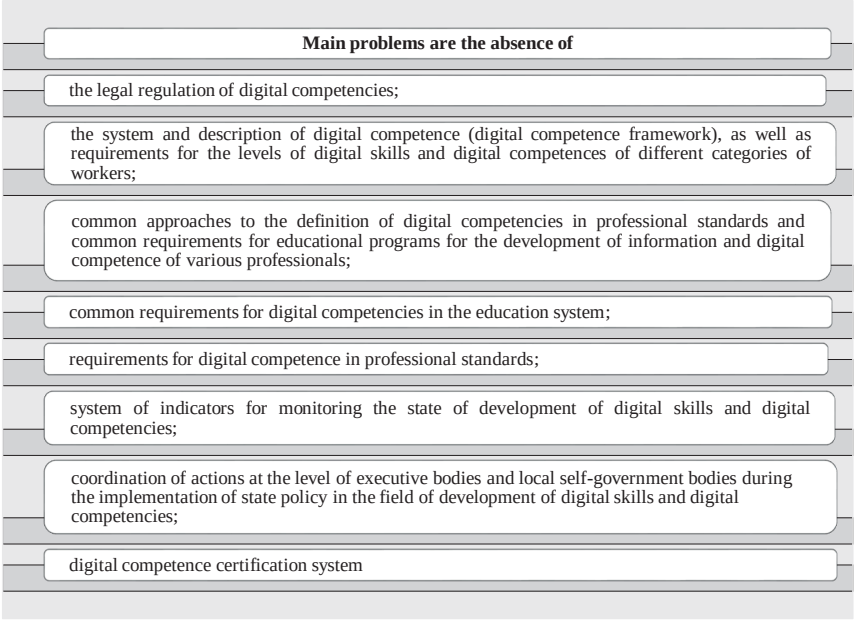

Fig. 11.1 – The main problems in the development of digital competencies

The main **purpose** of this Concept and its **objectives** are shown in Fig. 11.2.

Each of these main tasks has its own specific tools and algorithms for solving them, which need to be detailed.

In particular, the formation and development of digital skills and digital competencies in society is carried out by:

1) acquisition of digital education by a person with the use of information resources, new educational technologies and digital educational resources aimed at improving the level of digital skills and digital competencies;

2) ensuring the continuous development of professional digital competencies for specialists in the system of professional development in various fields of activity;

3) creation of the Unified state web portal of digital education "Diia. Digital Education";

4) development of measures for the introduction of digital means of conveying information (television, social networks, Internet broadcasting, etc.).

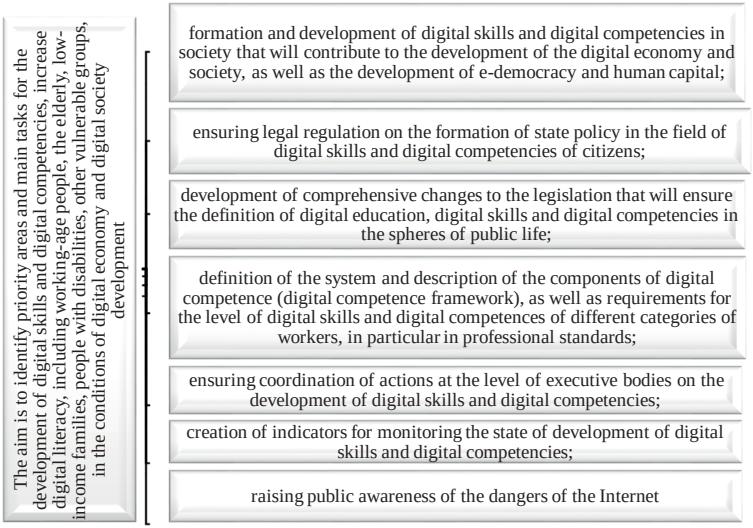

Fig. 11.2 – The main purpose of the Concept of digital competencies development and its tasks