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USING ICT IN PRINTING: ECONOMIC TRANSFORMATION, EVOLUTION AND PROSPECTS

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Makatora A. V., Makatora D. A., Kubanov R. A. Using ICT in Printing: Economic Transformation, Evolution and Prospects

The purpose of the study is to determine the peculiarities of the use of information and communication technologies in the printing industry; to substantiate the feasibility of technological transformation in terms of the prospects for economic development of the selected industry. Processing of primary data to provide the user with the necessary information is the main task of using information technology in the printing industry. Three main blocks – knowledge base, decision-making and intellectual interface – make up the structure of an intelligent printing system. In terms of decision-making, an intelligent printing system is defined as an information and computer system with artificial intelligence that solves problems without human intervention, in contrast to an intelligent system where the operator is involved in the decision-making process. The following types of intelligent systems are identified: intelligent information systems, expert printing systems, computational and logical systems, hybrid intelligent systems, reflex intelligent systems. It is noted that taking into account market trends, adapting to the environment and quickly adjusting their development strategy to occupy their niche in the market is important for the successful functioning of publishing and printing companies. According to the authors, this is possible based on using ICT in printing. Integrating modern technologies into the printing industry can positively influence efficiency and competitiveness. Adopting digital technologies will allow printing companies to be more flexible and respond quickly to changing market conditions, which is important for its development. In conclusion, it can be said that information and communication technologies have a great potential for the transformation of the printing industry in Ukraine. Companies will be able to automate and optimise production processes, reduce costs and improve product quality through the introduction of modern technologies. In addition, by introducing new print formats and creating specialised products for the digital market, the development of information technology will expand the range of services. According to the authors, this approach will help Ukrainian companies to compete internationally and take their products to new markets, helping to develop the whole industry. In addition, there will be a stimulus for innovation and the development of new services, which in turn will contribute to the growth of the industry as a whole.

Keywords: printing industry, information and communication technology, smart printing, artificial intelligence, digital economy, economic development, competition.

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Макатьора А. В., Макатьора Д. А., Кубанов Р. А. Використання ІКТ у поліграфічній галузі: економічна трансформація, розвиток, перспективи
Мета дослідження – визначити особливості використання інформаційно-комунікаційних технологій у поліграфічній галузі; обґрунтувати доцільність технологічної трансформації з точки зору перспектив економічного розвитку обраної галузі. Доведено, що основне завдання використання інформаційної технології в поліграфії полягає в обробці первинної інформації з метою надання користувачеві потрібної інформації. Структура інтелектуальної системи поліграфії складається з трьох основних блоків: бази знань, рішення та інтелектуального інтерфейсу. У сферах прийняття рішень інтелектуальна система поліграфії визначається як інформаційно-обчислювальна система з підтримкою штучного інтелекту, яка вирішує задачі без участі людини, – на відміну від інтелектуалізованої системи, де оператор бере участь у процесі прийняття рішень. Розрізняють такі види інтелектуальних систем: інтелектуальні інформаційні системи; експертні системи поліграфії; розрахунково-логічні системи; гібридні інтелектуальні системи; рефлексорні інтелектуальні системи. Визначено, що для успішного функціонування суб'єктам видавничо-поліграфічної галузі важливо враховувати тенденції ринку, адаптуватися до умов зовнішнього середовища та швидко коригувати свою стратегію розвитку, щоб зайняти свою нішу на ринку. На думку авторів, це можна зробити, спираючись на використання інформаційно-комунікаційних технологій у поліграфічній галузі. Інтеграція сучасних технологій у виробництво поліграфії може позитивно впливати на ефективність і конкурентоспроможність цієї галузі. Впровадження цифрових технологій дозволить підприємствам поліграфічної галузі бути більш гнучкими та швидко реагувати на зміни в ринкових умовах, що важливо для їхнього розвитку. Зроблено висновок, що інформаційно-комунікаційні технології мають великий потенціал для трансформації поліграфічної галузі в Україні. Впровадження сучасних технологій дозволить підприємствам авто-

мативувати й оптимізувати виробничі процеси, зменшити витрати та підвищити якість продукції. Крім того, розвиток інформаційних технологій дозволить розширити асортимент послуг, запроваджуючи нові формати друку та створюючи спеціалізовані продукти для цифрового ринку. На думку авторів, такий підхід допоможе українським підприємствам конкурувати на міжнародному рівні та виводити свою продукцію на нові ринки збуту, сприяючи загальному розвитку галузі. Крім того, це стимулюватиме інновації та розвиток нових послуг, що сприятиме зростанню галузі загалом.

Ключові слова: поліграфічна галузь, інформаційно-комунікаційні технології, інтелектуальна система поліграфії, штучний інтелект, цифровий ринок, економічний розвиток, конкуренція.

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In the course of history, mankind has not come up with a better means for the development of consciousness and the formation of spirituality than the book. Today, book publishing determines the spiritual and ideological spheres of society, and the book acts as an object of cultural and social information. It is the main component of the subsystem of information flows and a means of information provision and protection against information influences. Despite the active development of information technologies, which have become an integral part of the formation of the country's information space, the importance of book publishing has not diminished. On the contrary, it has increased.

On the other hand, the various advances in information and communication technologies have an impact on their implementation in various fields of science and production in order to increase their efficiency. There has been a year-on-year increase in the number of companies and government agencies adopting information and computer technologies for the automation of their operations. Technological and production processes can be accelerated and time-consuming paperwork can be avoided through the competent use of advanced technologies.

Specialists who can work effectively with these tools are required for the significant commercialisation of information and its means of creation and use. New types of intelligent manufacturing in the high-tech sector can create significant added value without the need for additional resources. They can solve many of the problems of traditional manufacturing. This has the potential to create a significant number of jobs and to satisfy do-

mestic demand. However, this domestic demand has not yet been fully exploited.

In the works of Ukrainian and foreign scientists various aspects of this problem have been studied and presented, e. g. Ya. V. Kotliarevskiy [1]; V. Bazyliuk [2]; L. A. Shvaika, V. M. Senkivskiy, O. V. Melnykov [3]; A. V. Kvasko, O. A. Sukhorukova [4]; Yu. P. Vorzhakova, A. O. Amelkina [5]; V. I. Shpak [6]; H. V. Reviakin [7]; L. M. Pronko, T. P. Sobitniuk [8]; I. L. Lytovchenko [9]; S. O. Gutkevych, L. P. Shenderivska [10]; O. I. Pushkar [11]; Yu. O. Gavrysh, A. D. Kukharuk [12]; I. V. Kriuchkova [14]; I. Ya. Ippolitova [15]; I. V. Ogirko et al. [16]; O. O. Zelinsky, T. V. Sichko [17].

The purpose of the study is to determine the characteristics of using Information and Communication Technologies (hereinafter referred to as ICT) in the printing industry; to substantiate the feasibility of technological transformation regarding the prospects of economic development of the selected industry.

Information technology creates information products on the basis of resources and uses computer and software tools for the processing, storage, protection and transmission of data in order to create information resources. In order to obtain a new quality of information about an object, process or phenomenon, information and communication technology of printing uses tools and methods for collecting, processing and transmitting data [16, p. 201]. Data stored on computers are processed through sequential operations and levels of complexity.

Processing primary information to provide the user with the necessary information is the main purpose of using information technology in the printing industry. The structure of a smart printing system consists of three main modules: a knowledge base, a decision-making and an intellectual interface [17, p. 149]. In the area of decision-making, an intelligent printing system is defined as an information and computer system supported by artificial intelligence that solves problems without human intervention. This is in contrast to an intelligent system where the operator participates in the decision-making process.

There are different types of intelligent system: intelligent information system, expert printing system, computational and logical system, hybrid intelligent system, reflective intelligent system [16; 17].

Intelligent information systems in the printing industry are a set of software, linguistic, logical and mathematical tools designed to support human activity and search for information in an active dialogue mode based on natural language. The automation and improvement of work processes can be significantly enhanced by the introduction of intelligent information systems in the printing industry. These systems can include components like speech recognition and synthesis systems, text processing systems, data analysis and more. For example, character recognition systems can automatically recognise text from scanned or photographed documents, greatly increasing productivity and speed. For example, the layout of printed materials can be automated using such systems. Deep data analysis can be used to identify patterns and dependencies in large amounts of information, helping to make informed decisions about production and marketing processes. Such systems can help with the identification of effective distribution channels, the forecasting of demand for specific products and the identification of the most appropriate development strategies.

Expert systems in the printing industry are computer systems that are partially a substitute for a knowledgeable specialist in the solution of problem situations. In computer science, expert systems, together with knowledge bases, are considered to be models of expert behaviour in a particular area of knowledge, using logical reasoning and decision-making procedures. Knowledge bases are a set of facts and rules of logical reasoning in a chosen subject area, and *computational and logical systems* include systems that can solve management and design tasks in the field of printing with a declarative description of conditions. These systems are capable of automatically building a mathematical model of the problem and synthesising computational algorithms to formulate the printing problem. A knowledge base in the form of a functional semantic network and inference and planning components are used to solve these tasks.

Expert systems in the printing industry make it possible to automate the decision-making process for solving problematic situations in the printing industry. They are

based on knowledge bases that are a compilation of various facts and rules related to printing activities. Expert systems can analyse problems and make recommendations on how to solve them using logical reasoning and decision making. A knowledge base is one of the main components of an expert system. It contains information about various aspects of printing, such as printing technologies, types of paper, types of ink, rules for marking, etc. A problem is analysed and the best solution is found using the knowledge base. Inference and planning components are also part of expert systems. They are used to automatically build a mathematical model of the problem and synthesise computational algorithms for its solution. These help the system to draw conclusions based on available knowledge and to recommend the best way to proceed. Expert systems for printing can be used in various areas related to printing, including designing, producing and checking the quality of printed materials. They help to improve productivity and efficiency, reduce the risk of errors and ensure high quality printed products.

A *hybrid intelligent printing system* is one that employs multiple ways of modelling human intellectual activities. It is a combination of analytical models, expert systems, artificial neural networks, fuzzy systems, genetic algorithms and statistical simulation models. Hybrid intelligent printing systems are the result of a collaboration between scientists and printing professionals who are exploring the possibility of using several methods of different classes to solve problems related to managing and designing.

For solving complex problems such as production process management, production planning, demand forecasting, product quality analysis and many others, the hybrid intelligent printing system has great potential. To achieve more accurate and efficient results, it combines various methods and algorithms. For example, the efficiency and optimisation of various production processes can be analysed in detail using analytical models. They allow us to assess the impact of various factors on production results and are based on mathematical models and statistical methods. Expert systems make use of the knowledge and experience of print professionals. They can take into account various options and conditions and make decisions based on an extensive knowledge base. Artificial neural networks model the way neurons in the brain work. They can be used for image recognition, text analysis and other information processing tasks. Uncertainty and fuzziness in decisions can be modelled using fuzzy systems. Fuzzy systems are systems that have a set of variables that can have different degrees of membership in certain categories. To solve optimisation problems, genetic algorithms are used. They are based on the natural principles of evolving and selecting the most appropriate solutions. Statistical simulation models, based on statistical data and simulations, make it possible to model and predict production processes.

To achieve optimal results in the printing industry, a hybrid intelligent printing system combines these different methods and algorithms. It combines and complements the strengths of each.

A *reflex system* is a system that responds to different combinations of input actions by using certain algorithms. These algorithms determine the most likely response of the intelligent printing system. These algorithms take into account the probabilities of the choice of a response to each input action as well as to certain combinations of input actions. A system that applies artificial intelligence methods to the management tasks of the printing industry should provide situational support in the decision-making process. It should automate the search for management decisions based on the accumulated knowledge of the printing industry.

A reflex system is an important component of the intelligent printing system. Its purpose is to analyse incoming data and make decisions on the basis of pre-defined algorithms. In the printing industry, a reflex system can perform a variety of tasks. For example, it can react to combinations of input actions to determine the most likely system response. The reflex system's algorithms take into account the probabilities of responding to each input, as well as to combinations of multiple inputs. Such a system can help printers manage production processes and make decisions on the basis of accumulated knowledge. It automates the search for optimal management solutions and provides situational decision support.

Thus, intelligent printing technologies are developing methods and tools to create systems that analyse data, identify relationships and patterns, support decision making under uncertainty, detect situations, and ensure the integrity and security of information in databases [18]. Such systems, by extracting, synthesising and assimilating print knowledge, can also extend the use of the gained knowledge to support strategic decision management, not just operational management.

In our opinion, the accelerating introduction of information technologies, which are becoming an important element in the process of publishing and distributing books, as well as the active distribution of e-books, which are not yet able to fully compete with traditional books in all areas, but are becoming popular and winning market share, stimulate further modification of the model of the publishing and printing economy, taking into account all these aspects. Identifying and understanding the mechanism of market transformation of the publishing and printing industry makes it possible not only to revise the conceptual apparatus, but also to return to a systematic approach at the level of solving problems of State regulation of publishing (in the broad sense) in Ukraine and at the level of management of each element of the publishing and printing industry: publishing structures, printing houses, and sales organisations. This will create a new approach to the task of modernising the publishing and printing industry [1, p. 30].

Publishing and printing is a basic sector for building the information society. It provides access to knowledge and information and forms the cultural and educational base of society. Therefore, the State should create favourable conditions for the development of the publishing sector, including supporting the production of printed and electronic publications, creating and supporting local bookshops and libraries and related services.

In developing their business, companies, including printers, have realistic goals of increasing production, sales and profits. However, in the current economic environment in Ukraine, increasing sales and profits is limited by various factors, such as:

- 1) breaking old business ties, which requires finding new suppliers and markets;
- 2) market saturation with products of a certain type;
- 3) competition with manufacturers of similar products for the same market. Neutralising the effects of these factors requires solving a number of secondary problems.

These include:

- 1) expansion of the product range to stimulate additional demand or to expand the customer base;
- 2) entry into new geographical markets with the same products;
- 3) development of new products for existing or new markets;
- 4) use of the latest production technologies for new products;
- 5) use of other companies' technologies to expand the product range [2, p. 224].

A serious obstacle to economic development is the growing competition from foreign producers of publishing and printing products and services. The increase in the import of products and the performance of part of the printing work by foreign companies slows down the development of the domestic industry, because the extant needs can be covered by external supplies [3, p. 98].

Among other trends in the commercial printing market, the following should be mentioned:

1. Digital printing, considered part of "smart printing", is becoming increasingly popular. This type of printing allows products to be personalised, changes and images to be added, and has a high degree of automation of technological processes, reducing the need for human intervention.
2. The transition to electronic formats has reduced the volume and circulation of publishing products such as newspapers and magazines. This has led to shorter operating cycles, lower costs and a wider range of access to information.
3. There has been a significant increase in the volume of printed advertising. This is an important tool for promoting goods and services and for creating a company's image.

4. Packaging production is undergoing significant development, which is linked to the expanding market and demand for such services. This is partly due to the desire to make products more attractive and informative through creative design and gamification. On the other hand, there is a need to ensure product safety through “active” packaging and to be concerned about ecology and the environment through the choice of packaging materials such as paper and cardboard that can be safely recycled [4; 5].

There are several trends in the global printing market that are shared by both leading and local players. These trends can be expected to have an impact on national and local markets, in particular:

1. The growing role of digital marketing, becoming a new way of communicating with customers and potential consumers, combining print with an online audience.
2. Using all the possibilities of the Internet to change the way new customers are acquired.
3. The provision of design services, where even small print shops have their own design department to assist customers in the creation of the look and feel of the products, with an individual approach to each customer.
4. More precise cutting, regardless of the product material, through the use of laser cutting technology. With some companies trying to reduce waste, this process is also environmentally friendly.
5. Demand for printing photos from mobile devices such as smartphones and tablets is also growing. Companies in this sector are also in the process of reformatting their activities to include other types of printing [6; 7].

To operate successfully, it is important for the publishing and printing industry to consider market trends, to adapt to the environment and to adapt its development strategy to occupy its niche in the market.

We believe this can be achieved by using ICT in the printing industry. The modern information environment is a complex, fast-changing and diverse world of information. It has been created by the development of technologies and means of communication. It is of great importance to society, as it affects our perception and understanding of the world, as well as the way we make decisions on the basis of information. This area is constantly in flux and requires people to be able to think critically and to have a good level of digital literacy [8].

Using ICT can play a key role in developing the printing industry. The efficiency and competitiveness of the industry can be positively affected by the integration of modern technologies into print production. Adopting digital technologies will allow printing companies to be more flexible and respond quickly to changing market

conditions, which is important for its development [10, p. 146].

Automation of production processes is one of the main areas of ICT use in the printing industry. The introduction of specialised software for print shop management, layout processing and production process management can help to increase productivity and print quality [11, p. 22].

The use of ICT in printing also contributes to the development of electronic communication and remote working. Order volumes can be increased and the geography of service extended by the ability to order and interact with customers remotely via the Internet and to manage the production process remotely. Reflecting current trends in the industry, these conveniences and opportunities offered by information and communication technologies in the printing industry allow companies to be more flexible and efficient in managing production, making decisions and serving customers. The expansion of remote working opportunities also contributes to the attraction and retention of skilled workers regardless of their location [12, p. 172].

Effective production management, optimisation of resources and maintenance of high product quality can be achieved through the use of specialised production planning and inventory management software. In this way, enterprises can avoid unnecessary costs and maintain an optimal level of stocks, which contributes to a high level of production efficiency [14; 15].

In addition, you can increase your customer base and brand awareness in the marketplace by implementing online marketing, creating a website and using social media to promote your products. Businesses can attract new customers, raise awareness of their products and services, and strengthen relationships with existing customers using tools such as digital marketing, e-commerce and social media. In the era of digital transformation, these tools are essential for staying competitive in the marketplace. They also enable companies to respond more quickly to changes and market needs by promoting the brand and communicating with consumers in real time. Thus, an appropriate level of ICT development, access to sources of necessary information and efficient use of information resources are essential elements for developing a modern enterprise [13, p. 95].

Given these opportunities, Ukrainian printing companies are interested in implementing ICT to improve production efficiency, expand the range of services, and enter new sales markets. This type of technology is already widely known and used in many countries around the world. Successful examples of its implementation can be found in countries such as the USA, Germany and China. Ukraine has already made some progress in this direction. However, much remains to be done to fully implement ICT in the printing industry. On the one hand, Ukrainian companies need to be prepared to invest in

the hardware and software that will allow them to make use of the new technologies. Qualified personnel who can work effectively with these technologies must also be made available. Ukraine also needs governmental support to help develop the printing industry. There should be incentives for investment in the sector, special benefits and support for companies that actively use information and communication technologies. It is also necessary to work on creating favourable conditions for exporting printed products, facilitating their entry into new markets and developing cooperation with other countries.

Furthermore, it can be concluded from the results that as a key issue of information security and a basic sector for the formation of the information society, the State has important tasks in relation to the publishing and printing industry. Supporting all components of this sector and controlling their activities should be among the priorities.

In this way, the obtained results point to the important tasks that the State has set itself in the field of publishing and printing. Since this sector stores and disseminates a wide range of information, including data that is important for citizens and public authorities, it is a key issue for information security. It is also a fundamental sector for building the information society, based on access to quality and reliable information.

All components of this sector, including publishers, printers, booksellers and other institutions, should be supported by the State as a matter of priority. It is important to provide them with financial support, to create the necessary conditions for them to develop and modernise, and to help them to compete on both domestic and foreign markets.

It is also necessary for the State to control activities in this area, in particular to ensure respect for copyright, combat piracy and illegal distribution of copied content. It is important to put in place an effective system of licensing and quality control of the products that are produced in this market.

It is clear that, depending on social needs, technological changes, etc., the priorities in this area may change. However, in the context of the development of the information society, the national Ukrainian publishing and printing industry needs to be supported and developed. This will ensure conditions for its competitiveness and expansion of the market.

CONCLUSIONS

There is a great potential for the transformation of the printing industry in Ukraine through information and communication technologies. Companies will be able to automate and optimise production processes, reduce costs and improve product quality through the introduction of modern technologies. In addition, by introducing new print formats and creating specialised products for the digital market, the development of information technology will expand the range of services.

At present, the ability of Ukrainian printers to compete with foreign producers is limited by their tendency to use outdated equipment and technologies. However, new opportunities are opening up for the printing industry with the development of information technology. Automating production processes will allow companies to reduce their dependence on manual labour and increase productivity. For example, the use of digital technologies makes it possible to produce printed materials directly from a computer, simplifying and speeding up the job creation process. Optimisation of production processes can also be a way for companies to reduce material and resource costs. For example, using advanced printing methods can save ink, and implementing a quality management system can help reduce deviations from standards and product returns. In addition, printers can expand their services and introduce new print formats through the development of information technology. For example, high-volume personalisation of printed materials is possible through the production of variable data postcards. In addition, a new area of development for Ukrainian companies could be the production of specialised products for the digital market, such as e-books or advertising materials.

This approach will contribute to the overall development of the industry by helping Ukrainian companies to compete internationally and expand their products into new markets. Moreover, it will stimulate innovation and the development of new services, which will contribute to the growth of the entire industry. ■

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