# THE ANALYSIS OF PRINTING EQUIPMENT MANUFACTURING

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Abstract: Printed materials, including books, illustrated magazines, advertising materials, posters, and consumer product packaging, are an integral part of today's global economy, science, and culture. Modern printing equipment, supplies, and new technologies allow the creation of a wide assortment of printed products – from exclusive printed, electronic or combined editions, high-quality advertising posters, or brochures to creative packaging with a complex design. Originality, exclusivity, and prestige can be given to printed products using hybrid and ultraviolet technologies, elaborate engraving, metallic color treatment, coloring with traditional, matte, and shimmering varnishes, etc. The efficient functioning of printing equipment companies is a fundamental component of global economic development. Therefore, it deserves thorough research to optimize the development of printing equipment manufacturers. This article aims to analyze the features of manufacturing and the main trends in the printing machines production in the world. During the research, we used the bibliographic method to study the scientific literature on the use and manufacture of printing equipment, as well as general scientific methods (analysis, synthesis, deduction, induction, generalization) for helpful clarification of individual aspects of manufacturing equipment for the printing industry. According to the study results, we achieved the following tasks: – identified the most well-known manufacturers of printing equipment; – outlined production trends in the printing industry; – considered the location of publishing industry enterprises in the world countries; – assessed the distribution of printing equipment production by types of machines and the demand for offset printing machines in different countries.

Keywords: Printing machines, publishing industry, printing equipment manufacturing, digital equipment, offset equipment, publishing and printing industry.

## 1 Introduction

Today the publishing and printing sector in the world counts, by various estimates, more than 1000 book publishers and publishing houses, 3000 printed media, and more than 2000 printing companies (Balan, Berculescu, Răcheru & Piţigoi, 2021).

New technological processes have radically changed the nature of the printing industry. Over the past decade, printing equipment and technology have undergone significant qualitative changes. The everyday use of computing technology, the improvement of existing and the emergence of fundamentally new devices and materials, and as a consequence, the progress of technological manufacturing processes have greatly expanded the possibilities of producing high-quality goods and significantly increased labor productivity (Liu, Liu & Wang, 2021).

The manufacturing of printing machines is a sphere of knowledge-intensive production and one of the most powerful economic sectors. The experience of developed countries, as well as the practice of many regions that previously did not use printing equipment, and now this industry is one of the foundations of their economic development (China, India, Korea, Indonesia, etc.), prove this convincingly.

Undoubtedly, a large market and developed printing industry, as well as an experience in the development and manufacturing of printing equipment, the latest developments in this field, and the significant scientific and production potential of the country – all create conditions for the successful development of printing equipment and the economy as a whole. In current conditions, the country's development of knowledge-intensive printing technologies actively influences the result of many related industries and is, of course, a matter of national importance (Šproch, Schindlerová & Šajdlerová, 2020).

In recent years, leading printing companies in many world countries have devoted significant resources to developing fundamentally new pre-press equipment and introducing digital and laser technologies in the printing industry. Today, the main challenge for most printing machines is the development of homogeneous and low-noise automation based on electronics and microprocessor technology (Pilat, 2022).

The theoretical part of this study offers an assessment of existing technologies and an evaluation of the current state of the art in printing, outlining the main aspects of the most famous printing equipment manufacturers.

The practical aspect includes:

- an overview of the publishing industry location worldwide;
- an assessment of the printing equipment production distribution by equipment type and demand for offset printing machines.

According to the study results, we determined the state and the main trends in the world's printing equipment development.

## 2 Literature review

Today, the specialized scientific literature pays due attention to the study of the current situation in the publishing and printing industry, namely the territorial location of printing enterprises, and analyzes their sales volumes. Furthermore, it considers the regional aspects of the publishing houses' development; defines the role of publishing and printing houses in the development of the national economy development; outlines important trends in the development of the publishing and printing industry development; analyzes the scientists' views on the economic growth and development problems (Kutsynska & Kutsynskyi, 2018).

The study of the printing industry's problems is described in work by such scientists as C. Horvath, L. Koltai, K. Manurova, E. Balan, L. Berculescu, R. Răcheru, D. Piţigoi, and many others. However, due to the industry's importance and the change dynamics, it is vital to constantly monitor and evaluate the performance of individual printing companies and the industry as a whole (Horvath, Koltai & Manurova, 2020), (Balan, Berculescu, Răcheru & Piţigoi, 2021).

Recently, there has been a tendency for small printing companies to expand their product range and strive for versatility (Gomaa, Jabi, Soebarto & Xie, 2022).

Nowadays, the analysis makes it possible to state that most companies have substantial development reserves both for expanding the product portfolio and increasing their competence. Therefore, movement in these areas will allow companies to increase their competitiveness in the printing market.

According to X. Cao, S. Yu, H. Cui, and Z. Li, due to the society's globalization and expansion of production possibilities, price competition, and technology selection processes, the current state of the printing industry is characterized by: smaller print runs, shorter lead times, improved product quality, increased product complexity following individual customer orders. It can be achieved by increasing the level of production automatization and integrating different production areas into a single production process (Cao, Yu, Cui & Li, 2022).

As per D. Eidukynas, over the last few years, the most well-known printing equipment and systems manufacturers have increasingly opted to use standardized digital print production processes due to the established international cooperation within a single information production environment (Eidukynas, 2022).

This tendency is confirmed by R. Răcheru, A. Lucia, D. Piţigoi, and E. Balan, who pointed out that the development of science and technology makes it possible to constantly improve printing technologies per the market needs to create favorable conditions

for printing globalization and internationalization (Răcheru, Lucia, Piţigoi & Balan, 2021).

Improvements in printing processes depend on industries such as computer science, cybernetics, physics, chemistry, mechanical engineering, and others. The first step in the development of printing automatization was the interconnection of several workstations and output devices into a unified network. The preconditions for this were the complete digitization of the production process and the appearance of powerful computing equipment and special software. The use of networking technologies makes it possible to develop and implement the new production standard CIP3 (Cooperation for Integration of Prepress, Press, and Postpress), which is the result of the Frankfurt Institute and Heidelberg – the world's leading manufacturer of printing equipment and supplies (Fratello & Rael, 2020).

According to A. Gerosa, the current feature is the reduction of print runs while the number of printed products increases. For today's devices to be in demand and paid for, they must have minimal set-up time for changing print runs so that productivity does not decrease with low mileage (Gerosa, 2018).

This opinion is supported by A. Sidorov and I. Iljin, who emphasize that all printing market segments are experiencing trends toward shorter runs, higher requirements for speed of order fulfillment, and production quality. Therefore, printing companies need to turn to integrated production systems that integrate prepress, postprocessing, and control to meet these demands in the best possible way. Printing machine manufacturers are already offering such systems. Overall, we must state that choosing a manufacturing system is a risky fundamental decision where one has to choose between systems with an open or closed structure (Sidorov & Iljin, 2022).

For W. Urban and K. Łukaszewicz, software based on a computer format makes it possible to define the parameters of post-press operation by collecting all job data into a single array containing information about the printing devices, cutting, folding and other functions. Furthermore, each machine in computer-assisted production is equipped with a personal computer and can execute current jobs as JDF files that are automatically customized (Urban & Łukaszewicz 2021).

The market's saturation with the latest devices, equipment, tools, and processes for manufacturing a variety of printed products requires a thorough systematization to identify and display printing technologies in the modern publishing and printing complex worldwide. Moreover, identifying tendencies in the publishing and printing market seems relevant since, over the last years, only a few industry journals have summarized information on the installation of printing equipment and consumables supply without detailed analysis and comparison with the world trends.

The current printing market conditions are characterized by an increasing number of unprofitable printing companies, a steady decrease in the volume of printed products, and a change in the printing market structure due to increased competition from the system printing houses (Ardolino, Rapaccini, Saccani, Gaiardelli, Crespi & Ruggeri, 2018).

The literature review on the research topic showed that the situation in the global printing equipment market is not stable at the moment. Significant changes in the economic sphere associated with digital platforms increasingly affect not only the production and use of printed products but also the entire manufacturing infrastructure related to this area (equipment and supplies manufacturing, paper and cardboard printing, wholesale trade organization, and equipment maintenance).

**3 Aims**

This study aims to determine the features of the current state and tendencies in the area of printing equipment manufacturing.

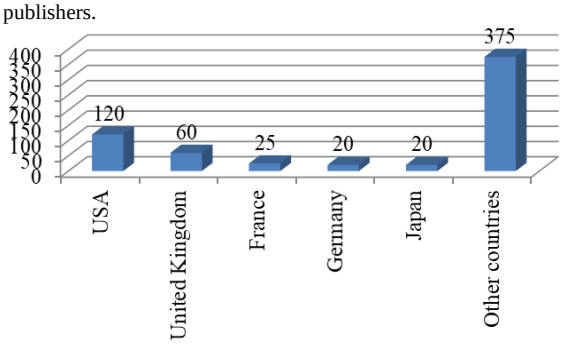
**4 Materials and methods**

We used bibliographic-semantic and analytical methods for this study to investigate the question posed.

**5 Results and Discussion**

According to V. Shpak, about 500,000 publishing houses are in the global printing business. About a quarter of all publishing houses listed in the International Handbook (Publishing house K. G. Saur (Germany) by the International ISBN Agency) are in the United States (120,000). The UK (about 60,000), France (over 25,000), Germany (about 20,000), Japan (over 20,000) etc., have strong publishing systems (Figure 1) (Shpak, 2017).

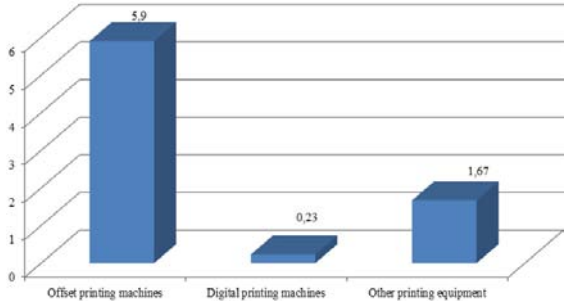
Figure 1: Worldwide location of publishing houses, thousands of publishers.




Source: built by the authors based on data from (Shpak, 2017).

Worldwide, about EUR 7,8 billion worth of printing equipment is produced yearly (not including spare parts, additional equipment, and maintenance costs). The main part of this money (more than EUR 5,9 billion) goes for offset printing machines. More than half of this amount, in turn, is spent on the purchase of sheet-fed offset presses. Currently, the digital printing equipment sales are about 3 % of the total of this kind of equipment (Figure 2).

Figure 2: Worldwide manufacturing of printing equipment by type of equipment, EUR billion.



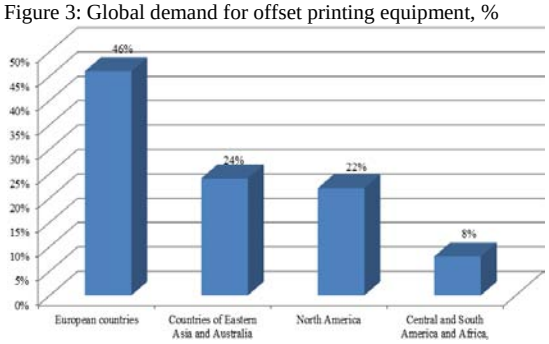

Source: built by the authors based on data from (Shpak, 2017).

The most significant demand for offset printing machines is in the European market (46 %), followed by East Asian and Australian markets (24 % in total) and North American markets (22 %). Central and South America, Africa, and the Middle East come next in terms of sales. If we compare each country, the first place goes to the USA and the second to Japan (Figure 3).

The market for pre-press equipment (including input devices, workstations, software, and output devices) is worth about EUR 10 billion, and the market for after-sales services is worth about EUR 1,5 billion.

A significant tendency in industrial information system development today is the intellectualization of production management processes in all phases of the product lifecycle (Kapitan, 2017).

Figure 3: Global demand for offset printing equipment, %




Source: built by the authors based on data from (Shpak, 2017).

One of the main problems of the printing equipment manufacturing sector is the constant growth of labor intensity of production equipment, which inevitably entails the complication of design and preparation for manufacturing. Another problem is the need to constantly reduce the amount of information about the current state of production equipment to a level that needs a decision-maker according to the current ergonomic constraints. A third problem is the lack of time to make and agree on management decisions. Finally, another critical issue of production intellectualization, including printing, is the need for constant acquisition, preservation, and dissemination of experienced manufacturers' knowledge accumulated over many years of work, including positive and negative experiences in solving operational problems (Kapitan, 2017).

Thus, modern printing manufacturing is a complex, highly computerized technological process in which printing machines are equipped with electronic, mainly digital control systems.

A study by Ye. Hrabovskyi confirmed that the most common printing process is flat offset printing. Therefore, increasing the share of digital printing next to inkjet printing and decreasing the percentage of letterpress printing were also anticipated. The advantages of the digital method and various products' increasing proportion in the 1 to 500-copy range put it at the top of the list. However, the share of gravure printing, according to global forecasts, reaches up to 15 % and is typical for manufacturing soft packaging from flexible polymer films. However, it is not reflected in the results of the vast majority of studies in this area (Hrabovskyi, 2017).

The intensive development of printing technologies and technological printing systems over the past century has influenced the improvement of new technology design methods in this area and, on their basis, gave birth to several new high-performance companies operating today on the global economic stage. The technological design of publishing houses and printing companies has historically evolved from the systematization of practical experience to the creation of a scientific basis for developing new projects in this field. For this reason, many companies today need to re-equip, improve technology and the manufacturing organization, and therefore ahead of the competition, there are many questions about the definition of advanced equipment, training, quality, and effective work (Stavropoulos & Foteinopoulos, 2018).

The fact of combining high technology with mobility and process complexity has become undeniable in today's globalizing production, so the development of new technologies and the unprecedented rate of their introduction into the printing process, as well as the appearance and improvement of advanced supplies, have led to an increase in the structural complexity and artistic brilliance of printed products.

We can note that despite the decrease in circulation, the total volume, and an assortment of editions, the level of printed products design worldwide is steadily increasing today. In addition, there is a diversity of formats, increased uniqueness, and quality of printed products, and expanded artistic and technical decoration possibilities. Furthermore, the globalization of production and the growth dynamics of the market encourage industrial enterprises to be continuously innovative, re-structuring their production, and adapt to the changing market conditions, especially to the increased use of information in electronic form and the use of various interactive means (Zheng, Zhang, Baca & Ahmad, 2021).

Considering those mentioned earlier, the problems related to technology design are not long-term but require an urgent solution and urgent implementation. Therefore, scientific management of design processes has become indispensable in modern conditions (Hrabovskyi, 2017).

Analysis of the current level of production automatization and quality management of printed products shows that in recent years, thanks to the rapid development of networked information technology, computer and laser technology, software, and the like, printing has undergone revolutionary changes. As a result, the external and internal structure of manufacturing and the market for printed products have changed, and automation and digital production management systems are constantly being improved. In addition, regional and global information networks have emerged, allowing for more efficient interaction between remote organizations and manufacturing sites (Shpak, 2017).

All of this is undoubtedly reflected in the pace and direction of printing equipment manufacturers, reflecting the main tendencies of the printing industry's future related to the development of information technology. Nowadays, there is a mass automatization of not only production itself but also its management with the introduction of artificial intelligence, direct interaction of production with the customers for the goods produced, and adaptation of equipment to customer requirements in the field of printing equipment production. In printing, this tendency makes it possible to personalize not only digital printing technologies but also all printing processes, including the most complex computer-aided processing.

Such tendencies have become a key trend in printing and a guideline for the future for all printing devices, technologies, and software developers. Digital control is now widespread in the printing industry. Internet-based control systems include important structures for managing digital devices and generating and transmitting information, e.g., via the Internet. Such systems also ensure full "transparency" of manufacturing, i.e., they enable the customer to follow their order through all stages of the printing process.

**6 Conclusions**

The scientific and practical interest in analyzing world markets grows with the increasing tendencies of internationalization and globalization of the market economy and the development of economic relations. The world market of printed products is considered one of the best indicators of economic processes. Its dynamics, problems, and prospects are the key indicators of national economic development.

In today's environment, the innovative development of the state economy is determined by the factor of society's information support, which can and must be promoted by the publishing and printing sector. The publishing and industrial complex is one of the most knowledge-intensive industries. The strategic importance of the complex for the developed country's economy consists primarily in the fact that it concentrates on a highly skilled workforce of the both humanitarian, scientific, and technical profiles, and publishing as an intellectual product is one of the cornerstones of the country's cultural, educational and scientific-information potential. The development and creation of complex enterprises, regardless of their size and ownership form, are influenced by factors in the external and internal environment. From the perspective of forecasting trends in the development of the printing industry as a component of the global industrial complex, the study of the current level of printing equipment manufacturing as the most critical factor in the development of this sphere becomes relevant.

At the same time, we should emphasize that the downward production tendency is still beyond the critical level for the printing market development. Although a process of capacity reduction and the closure of publishing spectrum companies already exist. At the same time, according to analytics, the decline in the volume of printed products in the next few years will be slightly slower, primarily due to the high cost of purchasing additional electronic tools, as well as due to psychological barriers and publishers' incomplete adaptation to the electronic distribution of the media. Another typical feature of the further development of this industry will be the use of outsourcing services by printing houses, which will open up new opportunities for expanding their services with publishing services, such as color scanning, electronic image retouching, and electronic column layout, digital printing, etc.

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