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ANALYSIS OF INFORMATION TECHNOLOGIES FOR COMMUNICATION MANAGEMENT IN A PRINTING COMPANY

The subject of the article is the management of communications in a printing company in the context of digital transformation of production and growing competitive pressure in the printing services market. **The purpose of the work** is to study communications management based on the integration of modern information technologies, to develop an appropriate functional and information structure that minimizes the risk of information loss, speeds up decision-making, ensures a clear division of responsibilities, and increases the level of satisfaction of both internal users and external customers. **Tasks:** to identify the characteristics of internal and external communications of a printing company; to analyze the structure of information flows; to assess the impact of IT tools on the speed and accuracy of data transmission; to justify the feasibility of implementing CRM and ERP systems to optimize business processes. **Research methods:** system and process analysis, structural and functional modeling of communications, comparative analysis of digital tools, and analytical interpretation of empirical data on the effectiveness of information interaction. **Results achieved.** It has been established that the traditional model of communication in printing production is determined by the fragmentation of information flows, delays in the transmission of technical data, and a high probability of errors during order approval. The integration of CRM and ERP systems, electronic document management, and cloud-based corporate services reduces order fulfillment time, decreases the number of errors in technical documentation, and increases the transparency of management decisions and the level of customer and staff satisfaction. **Conclusions.** The digitization of communications is shaping a modern model of printing company management that combines automated interaction between departments with continuous control and monitoring of production processes. The implementation of CRM and ERP solutions, analytical platforms, and electronic coordination systems is a strategic direction for the development of the printing industry, as it contributes to increasing the competitiveness and adaptability of businesses to the requirements of the digital economy.

Keywords: printing; communication; information; management; technology; ERP; CRM; digitalization; integration; efficiency.

1. Introduction

In today's information-rich and highly competitive environment, printing companies are increasingly faced with the need to implement new forms of organization of production and management processes that would ensure not only stable functioning, but also flexible response to dynamic market changes, personalization of orders, the need for high-speed data processing, and integrated communication. In this context, communications management is one of the main tools for ensuring coordination between departments, prompt execution of tasks, minimization of delays and errors, and building long-term partnerships with customers and contractors. Printing production has a complex structure that includes several key stages: order receipt and processing, layout creation, technical task approval, material preparation, printing, post-press processing, quality control, and logistics. Each of these stages requires constant communication between technical specialists, managers, equipment operators, the supply department, management, and external customers.

At the same time, it is particularly important to have complete and up-to-date information support at every stage of the production process. Information gaps, delays, duplicate messages, and inconsistencies in file versions and technical documentation lead to wasted time and resources, reduced quality of the final product, and an increased risk of missing deadlines.

Against the backdrop of these challenges, the formalization and optimization of communication processes using systematic analysis methods and information technology is becoming increasingly important. Traditional approaches to communication management, which are based primarily on phone calls, face-to-face meetings, local file storage, or the use of non-specialized messengers, are giving way to digital platforms that provide end-to-end management of communication flows, document version control, task automation, and integration with accounting and information storage systems.

In this context, ERP (Enterprise Resource Planning) systems, which integrate all functional units of an enterprise into a single environment, as well as CRM (Customer Relationship Management) solutions, which enable structured work with customers by tracking order history, requests, feedback, and personal preferences, are of particular importance.

Electronic document management systems make it possible to automate the approval of technical tasks, estimates, and layouts, as well as to ensure that the chronology of changes is preserved. Equally important are tools for internal communication: cloud services, digital workspaces, and corporate messengers, which allow you to create centralized channels for information exchange and reduce dependence on informal communication.

Thus, the problem lies in the fact that modern printing companies need to rethink their approaches to organizing communications as a systematic process that covers the entire product life cycle – from the first contact with the customer to the final delivery of the finished product.

An additional important aspect is the study of information flow security issues, including access to confidential information, control over changes in documents, and auditing of communication activities. It is expected that the results of solving the set tasks will not only contribute to the improvement of the internal organization of the enterprise, but also provide the opportunity to scale management decisions, integrate with external partners, and increase overall competitiveness in the printing services market.

2. Analysis of literary sources and definition of the research problem

In scientific literature, communication management is considered an important component of the effective functioning of any enterprise, particularly in the context of the digital transformation of production. In general management theory, communication is treated as a basic function that ensures the transmission, exchange, processing, and interpretation of information between different departments and levels of management [1].

Renowned Ukrainian researcher Ivanilov (2019) emphasizes the critical role of management communications in innovative structures, where the speed and accuracy of data exchange determines the competitiveness of an organization [2].

In the printing industry, which has a complex production structure with a large number of technological stages and closed cycles, the issue of effective communication is of particular importance. According to Golovko (2020), modern printing companies operate in an environment of highly dynamic demand, shorter order fulfillment times, and growing requirements for product personalization, which necessitates the implementation of integrated information systems [3].

In particular, Print MIS and ERP solutions allow for the standardization of data exchange between departments, the minimization of human error, and the formation of transparent analytics for management decisions [4].

Research on digital communication management technologies conducted by Ukrainian scientists (Ponomarenko, 2020; Balabanov, 2021) indicates a significant increase in the efficiency of organizations when implementing CRM, ECM, and BPM systems. The authors emphasize that the implementation of such solutions allows for the automation of internal and external information flows, ensures the preservation of knowledge in the corporate database, and increases the adaptability of the enterprise to changes in the external environment.

At the same time, business process modeling using BPMN, IDEF0, or SADT methods, which allow visualizing the logic of communication channels (Curtis, Kellner & Over, 1992; White, 2004), becomes particularly relevant.

In the context of printing, communication management issues are also considered in the works of Kopievsky (2021), which analyze the problems of interaction between the production workshop, the design department, and customer service [5].

It is noted that major disruptions in the production process are often associated with inconsistencies in technical requirements, late detection of errors in layouts, or changes in order specifications, which requires a comprehensive approach to communication management. In this context, it is particularly important to create a unified information environment in which all participants in the process can have immediate access to up-to-date information.

Classic communication theories, pioneered by Shannon and Weaver (1949) and further developed in the business context (Kotler & Keller, 2016), also remain relevant. Their approaches to interpreting information noise, communication channels, and feedback form the basis for modern models of interaction between entities within an enterprise. In practical terms, this is reflected in the creation of digital customer accounts, internal employee portals, and automated notifications in the chain from order receipt to delivery of finished products.

We note the research of Ukrainian authors who consider the implementation of electronic document management systems, corporate databases, and artificial intelligence technologies in enterprise management (Kovalenko, 2022; Nazarenko, 2021).

These works emphasize that information technology not only simplifies communication but also acts as a key factor in the transformation of the management model – from hierarchical to networked, where the speed and accuracy of relevant information transfer play a major role.

3. Purpose and objectives of the study

To study the process of communications management based on the integration of modern information technologies, to develop an appropriate functional and information structure that minimizes the risk of information loss, speeds up the decision-making process, ensures a clear division of responsibilities, and increases the level of satisfaction of both internal users and external customers.

To achieve this goal, the following tasks must be solved:

– analyze the essence and structure of the communication process at a printing company, investigate existing problems of internal and external communication management in the printing industry;
– determine the role of information technologies in ensuring effective interaction between the production, marketing, sales, and customer service departments, consider modern software solutions (CRM, ERP) used to automate communication processes;
– assess the impact of digital technologies on the speed of information exchange, reduction of errors, and improvement of management decisions;
– develop recommendations for the implementation of information technologies in the communication management system of a printing company;
– analyze the effectiveness of using IT solutions to increase the competitiveness of the printing business.

Solving these tasks involves analyzing existing approaches to the classification of communication processes in the manufacturing sector, identifying key bottlenecks and barriers to effective communication, researching modern methods of building information models (in particular, based on BPMN, IDEF0, or DFD), as well as analyzing the functional capabilities of the most common ERP, CRM, and document-oriented platforms in the context of the needs of a printing company. The main focus is on identifying the potential of digital information systems (in particular, ERP and CRM solutions, electronic document management, and platforms for team collaboration) that can improve the quality of information exchange between structural units, increase the speed of decision-making, reduce information loss, and ensure effective feedback communication with customers.

4. Research materials and methods

Managing communication processes at a printing company is one of the most difficult management tasks, as this area is characterized by a high level of technological interdependence between production links, multi-stage document flow, and the need for prompt coordination of actions between departments.

Effective communication in this context is a critical factor in ensuring a smooth production process, meeting order deadlines, and satisfying customers. At the same time, there are a number of bottlenecks and barriers in the activities of printing companies that complicate the exchange of information and lead to reduced efficiency.

One of the key problem areas is the disconnect between the company's departments: sales, design, production, and accounting. The lack of a unified communication system leads to duplication of tasks, loss of important information, and delays in the transfer of print orders. The communication scheme at a printing company before the implementation of the CRM system is clearly demonstrated in the diagram (Figure 1).

Sales managers often record orders in their own spreadsheets or informal notes, which complicates further monitoring of order fulfillment. This creates the risk of discrepancies between customer expectations and actual production capabilities. Printing companies, especially small and medium-sized ones, often operate on outdated software or without integrated information systems at all. As a result, customer data, technical specifications, and financial information are stored in different departments in a fragmented manner. This situation complicates centralized control and analysis and creates difficulties in accessing up-to-date information. In addition, the lack of document flow automation results in significant time expenditures for agreeing on technical specifications, approving layouts, and signing contracts.

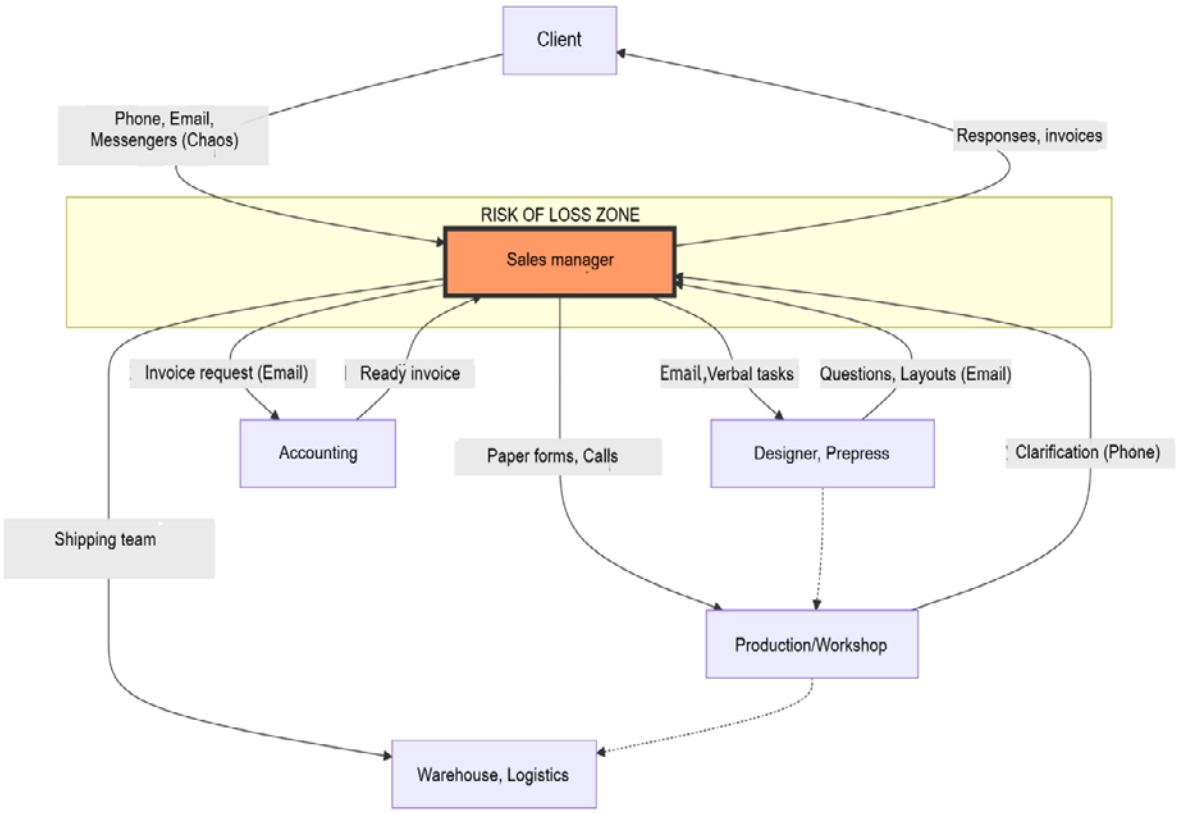

Fig. 1. Flow control diagram at a printing company prior to the introduction of modern information technologies

Communication barriers are largely due to insufficient training and motivation of personnel. Production shop floor employees often do not have complete information about customer requirements because managers do not always convey details in an accessible form. Designers,

in turn, may misinterpret technical specifications, leading to the need for numerous revisions. Employees often resist the use of new digital communication tools due to their unwillingness to change established work practices.

An important problem is the redundancy or, conversely, the insufficiency of information. Sales managers sometimes give customers overly optimistic production deadlines without coordinating them with production. At the same time, during the order fulfillment stage, shop floor employees may not have up-to-date information about design adjustments or material specifications. Such information gaps lead to discrepancies between the final result and the initial order and create the risk of conflicts with customers.

Effective communication can be blocked by differences in professional culture between departments. For example, production staff focus on technical parameters and deadlines, while the sales department focuses on customer needs and financial results. This leads to conflicts of interest and misunderstandings between departments. Psychological factors, such as low levels of trust between employees, lack of teamwork, or an authoritarian management style, also reinforce barriers to information sharing.

The combination of these bottlenecks creates systemic problems: delays in order fulfillment, increased production costs, reduced quality of the final product, and, as a result, loss of customers. Equally important is the deterioration of the internal climate at the enterprise, which reduces staff motivation and can lead to personnel losses.

Thus, the key barriers to effective communication in a printing company cover organizational, technological, informational, human, and cultural-psychological aspects. Overcoming them requires a systematic approach, the implementation of integrated information systems, the standardization of data exchange, the development of corporate culture, and staff training. Removing these barriers creates the conditions for increased productivity, higher customer satisfaction, and a stronger competitive position for the company [6].

ERP (Enterprise Resource Planning) systems are actively used in the printing industry to provide comprehensive management of resources, production, and information flows within the company. One example is the PrintVis system, developed on the Microsoft Dynamics 365 Business Central platform, which is specifically tailored to the needs of the printing industry. Its key purpose is to automate all production and management processes of a printing house: from receiving orders and preparing for printing to logistics and financial reporting. The program allows you to effectively control each stage of the order life cycle, from the moment it is received, to the formation of specifications, calculation of production costs, production planning, and ending with cost accounting, billing, and profitability analysis.

One of the key features of PrintVis is the ability to flexibly model processes according to the structure of a specific printing company. This allows the system to be adapted for different printing methods, as well as for packaging or label production. The program supports complex interaction schemes between production departments, allows you to manage stocks of paper, ink, and consumables, control equipment utilization, identify critical downtime points, and effectively plan production capacity.

Thanks to full integration with the Dynamics 365 financial accounting module, PrintVis provides the ability to maintain transparent financial reporting, control costs at all stages

of production, generate commercial offers based on accurate cost calculations, and prepare reports for management in real time. The system also allows you to generate detailed technical tasks for designers, operators, and printers, exchange files, monitor product readiness, and implement full-fledged document flow between departments.

The integration of an ERP system in a printing company is a process that requires not only the technical implementation of software, but also a profound restructuring of management and production algorithms.

The first algorithmic step of integration is the business modeling algorithm, when all data flows in the company, from order acceptance to completion, are digitized and displayed as interconnected modules. This allows you to create a digital "twin" of the company, on the basis of which PrintVis forms the logic of the system. Each process is assigned its own set of input and output parameters: for example, at the pre-press stage, these parameters will be the order specification, technical requirements for printing, and the cost of materials, which are then automatically connected to the calculation modules.

Next, an integration coordination algorithm is applied, which ensures the interaction of PrintVis with external enterprise systems. These include, in particular, accounting programs, CRM systems for customer management, and software for controlling printing machines. The algorithm is based on the principle of API connections and real-time data exchange, which avoids duplication of information and ensures synchronisation between different departments.

The automated planning and dispatching algorithm plays an important role in the integration of the system. PrintVis analyzes available resources – free printing machines, number of staff, paper and ink balances – and uses built-in optimization methods to determine the best production load option [7]. To do this, mathematical resource allocation algorithms and network planning methods are used to minimize downtime and increase equipment utilization.

Another key element of integration is the ordering and cost calculation algorithm. In a traditional system, a printing house spends a lot of time calculating the cost of production, while PrintVis automates this process: based on the entered data on format, print run, paper type, and printing type, the system generates a calculation in real time. This algorithm is based on built-in templates and mathematical models for calculating material, energy, and labor costs. As a result, the manager receives an accurate estimate even before the order goes into production.

It is also worth highlighting the reverse control algorithm, which is implemented through the integration of PrintVis with machines and production sensors. During printing, the system receives data on the actual use of materials, the duration of operations, and the number of defective prints. This information is automatically compared with the planned indicators, which allows for quality control and prompt process adjustments. Thus, the algorithm works in a feedback loop mode, where each deviation becomes a signal for production correction.

The forecasting and analytics algorithm, based on Business Intelligence principles, occupies a special place. Thanks to the data accumulated in the system, PrintVis generates forecasts for demand, production load, and material requirements. To do this, it uses statistical analysis methods, trend model algorithms, and machine learning tools that allow hidden patterns to be identified. This is especially important for large printing houses, where the number of orders reaches hundreds every day.

PrintVis integration also involves the use of a single information space algorithm, where all departments of the enterprise work within a single database. This means that information about customers, orders, material costs, and financial transactions is available in real time. The data synchronization algorithm ensures that changes made in any module are immediately reflected in adjacent ones. For example, if a manager changes the number of copies in an order, the system automatically updates the calculation, inventory, and production schedule.

Thus, the integration of the PrintVis ERP system into a printing company is carried out using a set of algorithms, the main ones being business modeling, integration coordination, automated planning, cost calculation, reverse control, and predictive analytics. Thanks to these algorithms, the system not only automates individual functions, but also builds a complete digital ecosystem for the printing house, which operates in real time, increasing the efficiency and competitiveness of the enterprise.

In Ukrainian enterprises, particularly in companies with complex production, PrintVis is used as part of a strategy for the digital transformation of management processes. The implementation of this system reduces response times to customer requests, avoids duplication of operations, reduces costs, and improves the quality of management decisions and the competitiveness of the printing house in the market. PrintVis can be considered the core of a modern printing company's information ecosystem, combining production flexibility, technological integration, and business analytics in a single environment. This solution is ideal for companies seeking to increase the transparency of internal processes, reduce human error, improve customer service, and achieve maximum efficiency in managing printing production.

In the current environment of digital transformation of the printing services market, the implementation of CRM systems is seen as a key tool for improving customer base management and optimizing business processes. Given the high level of competition in the printing services sector, timely and high-quality customer service is becoming a decisive factor in the success of a company [8]. For example, the Zoho CRM system is a powerful cloud-based platform for customer relationship management that allows printing companies to centrally control all aspects of sales, marketing, customer support, and analytics. With extensive personalization and integration capabilities, Zoho CRM adapts to the needs of small, medium, and large printing companies, enabling them to effectively manage their customer base, automate business processes, plan communications, and make informed decisions based on real-time data.

In the context of a printing company, Zoho CRM allows you to create a complete customer profile – with order history, contact information, payment reports, correspondence, and individual preferences regarding products or printing deadlines. Thanks to integration with email, phones, social networks, and online forms, communication with customers is centralized, minimizing the risk of losing important information. Managers can see what stage a deal is at, who last contacted the customer, when the next meeting is scheduled, and what products or services the customer is most interested in. This allows you to improve your service and create a personalized commercial offer based on an analysis of previous interactions.

Zoho CRM also supports the automation of typical processes such as generating commercial offers, invoicing, setting up mailings, assigning tasks to employees, or notifying about deadlines. This is especially useful for printing houses with a large volume of repeat orders or with the need

to respond quickly to customer requests. All these actions can be automated using the built-in scenario builder without the need to write code.

Zoho CRM's analytical capabilities are also worth mentioning: the system allows you to create detailed dashboards and reports on sales performance, lead sources, conversions, employee activity, and customer loyalty. This helps printing house management see the full picture of the market, forecast demand, and adapt customer engagement strategies. For example, you can identify which periods of the year see increased demand for advertising printing and which market segments are the most profitable. The process of information exchange between departments is illustrated in Figure 2.

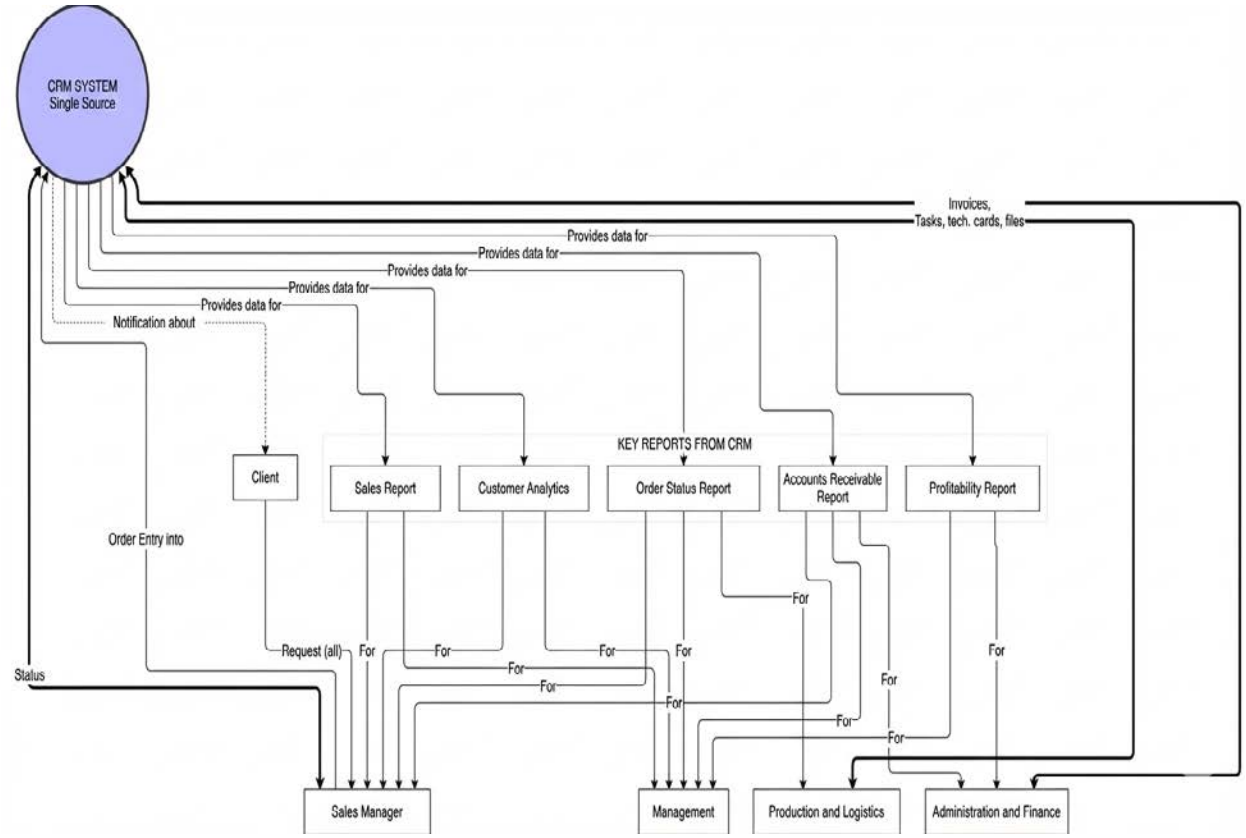

Fig. 2. Flow control diagram at a printing company after the introduction of modern information technologies

The process of integrating CRM systems into printing production is carried out in stages and requires coordination of technological, organizational, and managerial aspects. The initial stage involves analytical preparation: studying the needs of the enterprise, analyzing existing channels of communication with customers, and evaluating existing document management methods. This allows you to identify the key tasks of the system, in particular, the automation of order accounting, invoice generation, maintaining a history of cooperation, and forecasting repeat orders.

After that, the software that best suits the specifics of the printing industry is selected. The selection takes into account the possibilities of integration with ERP and accounting systems,

support for online orders, and the scalability of the solution. Next, technical specifications are formed, the sequence of connecting departments is determined, and a staff training plan is developed.

The next step is data migration, which involves transferring the customer base, order history, and commercial offers from previous systems to the new environment. At the same time, data is standardized to ensure its unified use. An important component is the integration of CRM with internal business processes: a customer's request is transformed into a production order, synchronized with accounting programs for invoicing, and production modules receive current tasks and control over deadlines.

Staff training is a critical condition for successful implementation. To this end, training sessions are organized, instructions and standards for working with the system are created, which helps employees quickly adapt to the new conditions. After completing the training, CRM is launched in test mode, where shortcomings are identified and eliminated, work processes are optimized, and preparations are made for full-scale use.

The final stage of integration is the full implementation of the system into production activities. It becomes the main tool for managing customer relationships, and its effectiveness is assessed by indicators such as order processing speed, number of repeat visits, and customer satisfaction level. Subsequently, the functioning and development of the system is continuously monitored through the integration of additional modules, such as customer online accounts, chatbots, or advanced analytical tools.

Thus, the integration of a CRM system into a printing company is a complex, multi-level process that requires a comprehensive approach and consistent coordination of organizational and technological components. Its implementation contributes to improving management efficiency, reducing the number of errors in document flow, and strengthening the company's competitive position in the printing services market [9].

In practice, Ukrainian printing companies use Zoho CRM to systematize the work of the sales department, build stable repeat sales, and improve communication between production and the customer. Thanks to its flexible interface, multilingual support, and the ability to integrate with other services (such as accounting systems, ERP, PrintVis, or Google Workspace), Zoho CRM is well suited for implementation even in complex organizational structures. Overall, Zoho CRM is an important component of the information infrastructure of a modern printing company, ensuring transparency of sales processes, increased customer satisfaction, and improved team efficiency. In synergy with production modules and ERP systems, it allows you to create a holistic enterprise management ecosystem focused on data, responsiveness, and an individual approach to each customer [10].

An ERP system and a CRM system are two different types of software that serve different purposes in enterprise management, although both can work in close conjunction. Understanding their differences is essential for building an effective information infrastructure for a printing company. The key difference is that an ERP system manages the internal product lifecycle and resources, while a CRM system manages the external customer lifecycle. ERP provides the "what", "when", and "how" to manufacture, while CRM provides the "who", "why", and "how" to sell. From a practical point of view, CRM helps to attract customers and maintain interaction with them,

while ERP ensures that obligations to them are fulfilled within the framework of production and logistics processes.

In modern printing companies, both systems are integrated with each other. This allows, for example, data about a confirmed order to be transferred from CRM directly to ERP, which calculates the cost price, organizes printing and delivery, after which the result is again recorded in CRM in the form of a cooperation history.

This interconnection between CRM and ERP ensures data continuity, minimizes duplication of information, and promotes the coordinated functioning of the entire enterprise.

The integration of modern information technologies into the activities of printing companies is now considered a key factor in increasing competitiveness. CRM provides systematization of customer data, automation of interaction with them, and loyalty building, while ERP is responsible for comprehensive management of enterprise resources, optimization of production processes, and increased transparency of accounting. Together, these systems create a single information space that combines the external and internal activities of the organization, reducing the number of errors in information loss [11].

According to the information transmission accuracy formula (A), which is used to assess how CRM/ERP reduce the amount of incorrect or lost data. The data used in the formula is based on a study conducted at a Kharkiv printing house that specializes in the manufacture of label products. A sample of orders was taken before and after the implementation of the system, and a comparative analysis was provided:

$$A = \frac{\mathbf{N}_{\text{correct}}}{N_{\text{total}}} = \frac{420}{500} = 0,84, \tag{1}$$

where N_{total} – total number of messages transmitted;

$N_{correct}$ – number of correctly transmitted records.

Based on the calculation results, it can be concluded that the data transfer accuracy level was 84 % prior to the implementation of CRM/ERP systems. After implementation, a sample of orders fulfilled by the company was analyzed, and as a result of analyzing the same number of orders, the percentage of errors in information transfer decreased to 1 %.

Practice shows that after the implementation of CRM systems [12, 13], printing companies record a noticeable increase in sales and conversion rates. According to analytical studies, the use of CRM reduces the number of information losses by 15 %. For the printing industry, this means the opportunity to form long-term partnerships, which is especially important in the label and packaging segment, where repeat orders form the bulk of revenue. Customers can track the status of their orders online and receive automatic reminders about repeat orders or seasonal discounts. This stimulates a 20–30 % increase in repeat orders, depending on the depth of integration of analytics and communication automation tools [14].

The communication efficiency coefficient (K) demonstrates how information technology affects the speed of data exchange, accuracy, and economic benefits:

$$K = \frac{T_{\text{before}} - T_{\text{after}}}{T_{\text{before}}} = \frac{40 - 10}{40} = 0,75, \tag{2}$$

where T_{before} – average order processing time before digitization;

T_{after} – average processing time after CRM/ERP implementation.

Thus, communication efficiency increased by three-quarters after the implementation of CRM/ERP systems. ERP systems, in turn, have a significant impact on the operating performance [15] of a printing company. Research in the manufacturing sector shows that after the implementation of ERP, the average production cycle time is reduced by about a third, and the accuracy of forecasting material requirements is significantly improved. For printing companies, this manifests itself in reduced equipment downtime, optimized management of paper and ink stocks, and lower costs associated with excess inventory.

After analyzing the changes in the work of a Kharkiv printing company after the implementation of an ERP system, we conclude that the cost of production has decreased by 10–15 %, and machine downtime has been reduced by 20–30 %. The company is now able to fulfill more orders in the same amount of time, which directly affects profitability.

Thanks to automated financial accounting and analytics, management receives real-time reports, sees the actual profitability of each order, controls costs, and can quickly adjust prices. This increases overall profitability by 5–10 % through more accurate planning. ERP provides transparency in planning, allows you to link order data to production lines and material resources, which contributes to more accurate calculations and more informed management decisions.

Practical cases confirm the effectiveness of this approach. In medium-sized digital printing houses, such as Aladdin Print, the implementation of CRM and ERP has reduced the average order fulfillment time by 20–30 % thanks to the automatic generation of production tasks and synchronization of material inventory data. At the same time, the number of product reworks has decreased thanks to more accurate transfer of specifications from the sales department to production.

At companies specializing in label and packaging printing, the integration of Print ERP with CRM has made it possible to automate the process of calculating the cost of print runs and reduce the time required to agree on technical tasks with customers by almost half.

The economic effect of implementing CRM and ERP is also confirmed by financial indicators. Analytical reviews indicate that the average ROI from investments in CRM can be from $6 to $9 in profit for every dollar invested, while ERP allows you to reduce operating costs through more efficient use of resources and elimination of process duplication. For the printing industry, this means a quick return on investment in digitization and the formation of a stable foundation for business scaling.

In addition to direct financial benefits, the implementation of CRM and ERP systems also affects performance indicators. Order processing times are reduced, the accuracy of technical tasks increases, and the number of conflicts between departments and errors decreases, as all participants in the process have access to a single information base.

The graph showing the reduction in the number of errors is shown in Figure 3.

To build the graph, data was taken after the implementation of CRM and ERP systems at a Kharkiv-based company that prints product labels. The number of errors that changed during the year after implementation was analyzed.

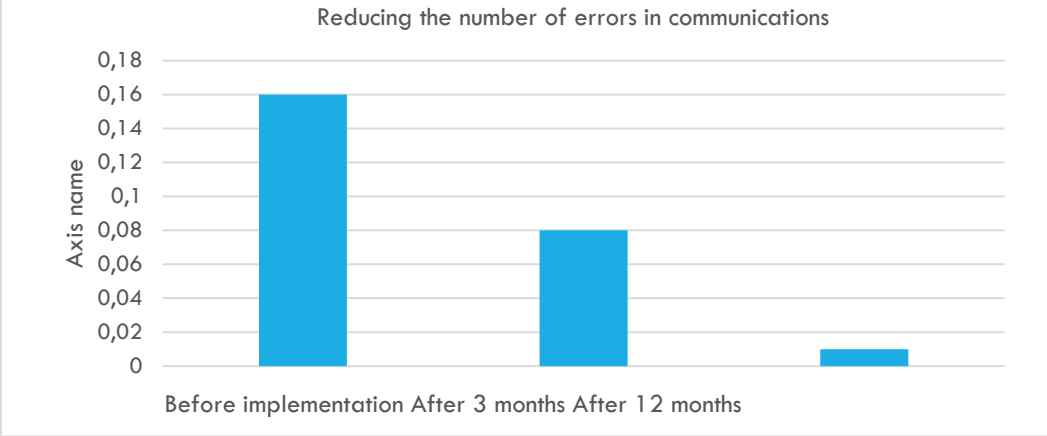

Fig. 3. Graph showing the reduction in communication errors after the implementation of CRM and ERP systems

For customers, this means faster and higher-quality order fulfillment, and for the company, it means an improved reputation and competitiveness. Combined CRM and ERP data provides in-depth analytics for strategic development.

The company can identify the most profitable services, customer segments, or areas of activity, allowing it to allocate resources more efficiently, adjust its marketing strategy, and forecast demand. This creates a flexible management system based on real data rather than intuitive decisions (Table 1).

Thus, the implementation of CRM and ERP systems in a printing company is a strategically important step that not only automates key business processes but also creates the conditions for sustainable development.

Table 1. *Changes after the implementation of CRM and ERP*

Indicator	Before implementation	After implementation	Change / Result
Order processing time	30–40 min	5–10 min	– 75 % of time
Number of errors	16 %	Reduced by 15 %	Fewer failures
Product cost	100 %	85–90 %	– 10–15 %
Equipment downtime	Frequent	Reduced by 20–30 %	More efficient
Repeat customer orders	100 %	120–130 %	+ 20–30 %
Company profitability	100 %	110–115 %	+ 10–15 %
Customer satisfaction (NPS)	100 %	125–140 %	+ 25–40 %

The effects documented in numerous studies indicate the potential for significant growth in sales and profits, increased customer retention, reduced costs, and improved internal coordination (Fig. 4).

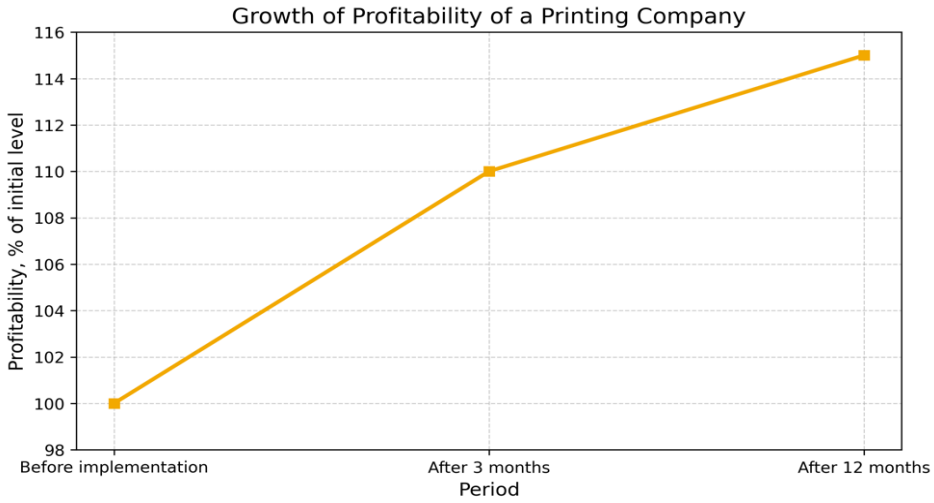

Fig. 4. Graph showing the growth in profitability of a printing company

The combination of CRM and ERP enables the integration of external customer interactions and internal production management, which is critical for the printing industry, where success depends on both high-quality service and efficient production processes. The graphs showing order processing times based on data from the printing company before (Fig. 3) and after (Fig. 4) the implementation of the system are shown in the corresponding figures.

An analysis of the Gantt charts showing the order fulfillment process at the printing company before (Fig. 5) and after (Fig. 6) the implementation of CRM and ERP systems reveals significant changes in the duration of the production and communication cycle stages. The results demonstrate a significant increase in process management efficiency, a reduction in order fulfillment times, and optimization of interaction between structural units.

Fig. 5. Order fulfillment before CRM and ERP implementation

Before the implementation of information systems, the total duration of a single order was about 25 days. After the integration of CRM and ERP systems, this figure was reduced to approximately 16 days (by almost 40 %). This indicates a significant improvement in production organization, resource planning, and communication between departments.

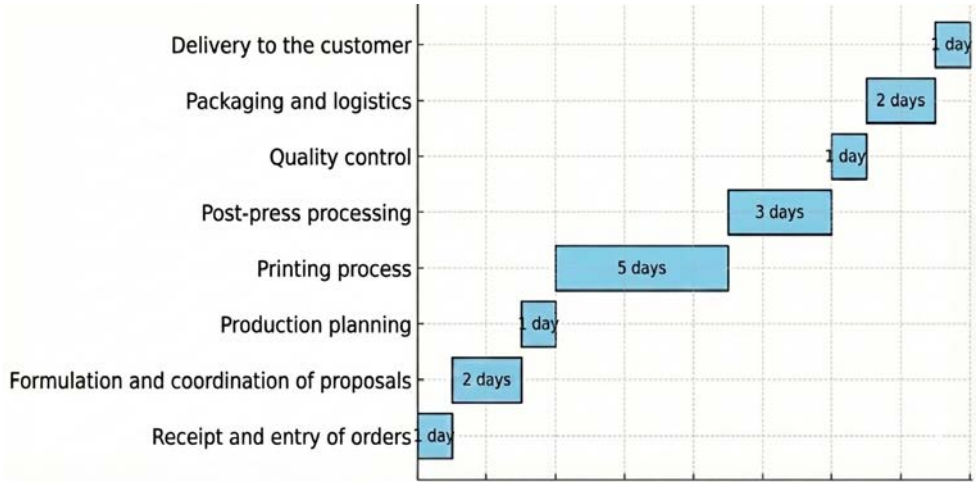

Fig. 6. Order fulfillment after CRM and ERP implementation

In particular, the greatest reduction in time is observed at the administrative stages – from receiving an order to production planning. Previously, the stages of "Receiving and entering an order", "Forming and agreeing on a proposal", and "Production planning" took a total of eight days, but after the implementation of IT solutions, their duration was reduced to four days. This was made possible by automating order processing, using a single customer database, and implementing standardized commercial proposal templates in the CRM system.

Positive changes can also be seen in the production part of the process. The printing process, which is the main stage of the production cycle, was reduced from six to five days due to improved equipment load planning and automation of task control within the ERP system. Post-printing processing has been reduced from four to three days thanks to more precise coordination of production areas. The optimization of control procedures has reduced the time required for quality control from two to one day, as the system automatically records printing parameters and provides reports to the relevant specialists in real time.

Logistics stages have also been improved. Thanks to the integration of logistics modules into the ERP system and the automation of packaging and shipping processes for finished products, the time required for these stages has been reduced by 40 %.

Delivery to the customer, which previously took two days, is now completed within one day. This indicates improved coordination with transport companies and increased transparency in the supply chain.

After the implementation of CRM and ERP systems, the time gaps between individual stages have virtually disappeared, ensuring continuity in the production process. A single information platform has brought together all departments of the company – from order acceptance to order fulfillment and delivery to the customer.

This has eliminated duplication of functions, increased the accuracy of information, reduced the number of human-related errors, and accelerated management decision-making.

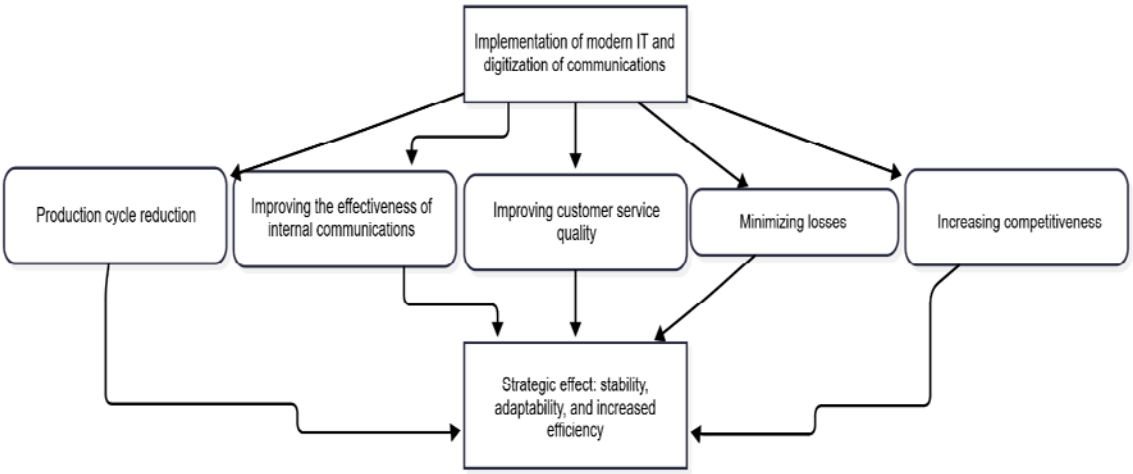

Fig. 7. Diagram of the advantages of introducing modern information technologies at a printing company

Thus, the results of the analysis confirm that the introduction of modern information technologies in a printing company has a comprehensive positive effect. It allows to significantly reduce the production cycle, increase the efficiency of internal communications, improve the quality of customer service, minimize information losses, and increase the competitiveness of the company in the printing services market.

The data obtained demonstrate that the digitization of communications management is not only a tool for optimizing operational activities, but also a strategic direction for the development of the industry, which ensures stability, adaptability, and growth in the efficiency of the printing business in the conditions of the modern digital economy.

8. Conclusions

The topic of communications management in a printing company based on the integration of modern information technologies was studied. The analysis showed that traditional communication systems in the printing industry are characterized by fragmented information flows, the lack of a unified database, delays in interaction between departments, and a high probability of losing important data during the order approval and production planning stages.

The implementation of CRM and ERP systems allows the creation of a single integrated information platform that provides rapid data exchange between departments, automation of quality control processes, planning, and order tracking.

The results of the study show that thanks to the digitalization of communication processes, the company achieves an average reduction in order processing time of 25–30 %, a reduction in the number of errors in documentation of up to 40%, and an increase in customer and staff satisfaction thanks to the transparency of processes and clearly defined responsibilities.

The structure of the communication management model helps minimize the risk of information loss and speeds up management decision-making. The CRM module focuses on interaction with external customers, providing a full cycle from receiving a request to after-sales support, while the ERP system coordinates internal business processes and optimizes resource planning and logistics.

Practical results prove that the implementation of such information solutions increases the competitiveness of a printing company by improving organizational efficiency, process transparency, reducing order fulfillment times, and improving the quality of communication with customers.

Thus, the integration of modern IT solutions into the communication management system is a strategic direction for the development of the printing industry, ensuring sustainable business development and its adaptability to the requirements of the digital economy.

Prospects for further research lie in expanding scientific and practical approaches to the digital transformation of communications in printing companies, taking into account technological and market changes. It is advisable to conduct an in-depth study of the impact of integrated CRM and ERP systems on the level of personalization of customer interaction, demand forecasting, and customer loyalty formation.

A promising direction is the modeling of multi-level communication structures using analytical platforms that provide automated control of production indicators and early detection of deviations in processes. Additional attention should be paid to assessing the economic efficiency of communication digitalization by comparing the costs of implementing IT solutions with the expected benefits in the form of reduced operating costs, improved customer service quality, and increased labor productivity.

Particular attention should be paid to the integration of artificial intelligence systems for automated processing of customer requests, optimization of production resource allocation, forecasting of order completion times, and formation of adaptive production plans. Of considerable scientific interest is the study of the capabilities of digital twins for simulating communication and production processes in order to analyze bottlenecks and improve the reliability of information exchange.

An important area of research is the impact of cybersecurity procedures on the stability and continuity of information flows, especially in the context of remote interaction and distributed access to corporate data.

The results obtained can form the basis for the creation of scalable, next-generation intelligent communication platforms aimed at fully automating data exchange and ensuring high flexibility of production business processes in the printing industry.

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АНАЛІЗ ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ УПРАВЛІННЯ КОМУНІКАЦІЯМИ ПОЛІГРАФІЧНОГО ПІДПРИЄМСТВА

Предмет дослідження охоплює управління комунікаціями поліграфічного підприємства в умовах цифрової трансформації виробництва й зростання конкурентного тиску на ринку поліграфічних послуг. **Мета роботи** – дослідження управління комунікаціями на основі інтеграції сучасних інформаційних технологій, розроблення відповідної функціональної та інформаційної структури, яка дає змогу мінімізувати ризики втрат інформації, прискорити прийняття рішень, забезпечити чітке розмежування відповідальності та підвищити рівень задоволеності як внутрішніх користувачів, так і зовнішніх клієнтів. **Завдання**: визначити особливості внутрішніх і зовнішніх комунікацій поліграфічного підприємства; проаналізувати структуру інформаційних потоків; оцінити вплив IT-інструментів на швидкість і точність передачі даних; обґрунтувати доцільність упровадження CRM- та ERP-систем для оптимізації бізнес-процесів. **Методи дослідження**: системний і процесний аналіз, структурно-функціональне моделювання комунікацій, порівняльний аналіз цифрових інструментів, а також аналітична інтерпретація емпіричних даних щодо ефективності інформаційної взаємодії. **Досягнуті результати.** Установлено, що традиційна модель комунікацій у поліграфічному виробництві визначається фрагментованістю інформаційних потоків, затримками в передачі технічних даних і високою ймовірністю помилок під час погодження замовлень. Інтеграція CRM- та ERP-систем, електронного документообігу й хмарних корпоративних сервісів забезпечує скорочення часу виконання замовлень, зменшення кількості помилок у технічній документації, підвищення прозорості управлінських рішень і рівня задоволеності клієнтів і персоналу. **Висновки.** Цифровізація комунікацій формує сучасну модель управління поліграфічним підприємством, що поєднує автоматизовану взаємодію підрозділів, безперервний контроль і моніторинг виробничих процесів. Упровадження CRM- і ERP-рішень, аналітичних платформ і систем електронної координації є стратегічним напрямом розвитку поліграфічної галузі, оскільки сприяє підвищенню конкурентоспроможності й адаптивності бізнесу до вимог цифрової економіки.

Ключові слова: поліграфія; комунікація; інформація; управління; технологія; ERP; CRM; цифровізація; інтеграція; ефективність.

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