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Intelligent information systems of the banking sector: General characteristics and information environment

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Abstract. Due to the rapid development of digitalization and information technology, the study of intelligent information systems (IIS) in the banking sector is becoming an urgent task. Intelligent information systems are able to optimize banking processes, increase security, improve the quality of customer service, mitigate risks, and optimize internal processes of financial stability management. The purpose of this study is to reveal the potential and impact of IIS on banking management processes; to study their capabilities. To achieve this goal, this study used an analytical approach, in particular, methods of information and morphological data analysis, as well as the method of generalization, which allowed the identification of key aspects, features, and properties of intelligent information systems of the banking sector, and to provide a generalized structure of their functioning by the relevant processes. This article generalizes a group of intelligent information systems of the banking sector (IISBS), their general features and properties, proposes an innovative architecture of financial management support, and identifies their advantages in comparison with existing intelligent systems. The study proves that intelligent information systems of the banking sector are endowed with hybrid data analytics provided by deep learning methods using self-learning algorithms; are able to assess possible risks and plan strategies for their resolution; recognize unauthorized entries and suspicious transactions; thanks to virtual assistants, are suitable for robotizing management processes; and visually present the results of analysing large amounts of data in real time. The research conducted in this paper shows that the introduction of intelligent information systems in the banking

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sector is of high practical value, as it provides interactivity and personalization for customers, online interaction, and support in solving problems through various communication channels

Keywords: artificial intelligence; predictive analytics; machine learning; dashboard; chatbot; intellectual analysis; financial stability

Introduction

The introduction of digital technologies is an integral part of the digitalization of the banking sector. Digital technologies and innovations are effectively used by almost all banks in international countries. The development of digital technologies in banking institutions opens up a wide range of opportunities to improve the efficiency of banking activities, enhance the quality of service and provide innovative financial services. Digitalization of the banking sector is the process of introducing technologies and digital innovations in banking activities to improve customer experience, optimize processes and develop innovative business models. The key aspects of the use of digital technologies in banks are:

- mobile applications and online banking – customers are provided with convenient applications and online platforms for use, on the basis of which banking operations are carried out, and access to financial information is provided in real time);
- artificial intelligence (AI) and machine learning (ML) – banking institutions use AI and ML to process and analyse large amounts of data, identify patterns, forecast trends, credit scoring, and manage risks, which significantly speeds up automation and decision-making processes, increases the accuracy of data processing and the efficiency of banking operations.

It is with the introduction of digital technologies that intelligent systems (IS), which are a categorical component of information systems, are developing. The development of intelligent systems is studied in the work of Ukrainian scientist V.M. Kotsovsky (2019), which reveals the basic concepts of intelligent systems, provides the conceptual component of an intelligent information system (IIS) as a type of IS, presents the general processes of their functioning in various architectures, and suggests general approaches to knowledge representation.

In the monograph by O.G. Avrunin *et al.* (2022), Ukrainian scientists summarize the theoretical and practical aspects of the use of intelligent information systems in various fields of activity, investigate the general stages of theoretical developments and practical applications of artificial intelligence in the field of expert, problem-oriented intelligent systems, and propose modern tools for intelligent information management of economic databases. The work of the Ukrainian scientist L.D. Yaroshchuk (2019) reveals the main provisions for modelling intelligent control systems based on the classical structure of expert systems and based on existing knowledge models. In this paper, the author proposes a methodology for creating expert systems, formulates recommendations for choosing mechanisms for logical data retrieval and building a knowledge base for solving problems in various subject areas of industry. American

scientists C. Pimenta & A. Seco (2021) studied information systems in financial management using artificial intelligence, machine learning, and data analysis and proposed a subgroup of intelligent systems called financial management information systems (FMIS). The authors focused on the processes of data visualization (dashboards) used in innovative robotic platforms. It is known that the use of virtual agents (chatbots, voice bots) in FMIS systems is promising, and the authors paid considerable attention to this.

The work of the Chinese scientist M. Lai (2022) proposes a model of an intelligent financial management system (IDSS) with an innovative architecture based on data mining technology. IDSS systems use intelligent financial forecasting of management decisions based on data analysis, with a basic financial management structure and a decision support system. Currently, the Ukrainian banking sector does not fully use intelligent systems, but only introduces elements and/or tools of artificial intelligence in some of them. The work of the scientist V.P. Kravchenko (2023) analyses the current state of application of artificial intelligence tools in the banking sector and provides examples of their implementation in existing information systems.

A review of the literature of domestic and foreign scholars suggests that as of 2023, there is no single methodology for designing intelligent systems in the banking sector, so there is a problem in determining the general methodology for designing intelligent information systems and their implementation in banking institutions of Ukraine. The purpose of this study is to summarize the common features, properties, and processes of functioning of intelligent information systems, design their architecture according to a modernized structure, which will further ensure their implementation in national and/or foreign banking institutions.

Materials and Methods

The theoretical basis for this study is the work of Ukrainian scholars A.S. Dovbysh (2009), V.L. Pleskach & T.G. Zatonatska (2011), M.P. Voinarenko *et al.* (2015) and O.V. Nesterenko *et al.* (2017), which established the general concepts, development, and classification of intelligent systems, their advantages, and application in comparison with existing information systems.

Since intelligent systems cover such areas of IT technologies as artificial intelligence, machine learning, neural networks, and data mining, the methodology presented in the works of American researchers J. McCarthy (John McCarthy's Home Page..., 2023), A. Seco & A. Muñoz (2019), C. Pimenta & A. Seco (2021), Chinese researcher M. Lai (2022), as well as Ukrainian scientists M.P. Voinarenko *et al.* (2015),

A.O. Zamula (2014), V.M. Kotsovsky (2019), L.D. Yaroshchuk (2019), T. Kysil (2020) allowed systematizing general approaches to the introduction and use of modern technologies, as well as to assess their effectiveness in the management of banking institutions.

The use of the method of regulatory and index evaluation in intelligent information systems proposed by domestic scientists L. Prymostka & L. Lysenok (2008), I. Dominoва (2020) and its adapted model allowed determining the effectiveness or degree of achievement of certain regulatory or index indicators, which is used to determine the processes of financial activity. In the context of financial management, the method of regulatory and index assessment included an assessment of the bank's financial stability, where regulatory indicators such as liquidity, capitalization, profitability, and others had to meet the requirements of regulators or banking sector standards.

The visualization of data analysis methods proposed by domestic scientists O. Lezhnina *et al.* (2022), O. Zinchenko *et al.* (2022) was promising for presenting complex concepts, architecture of intelligent systems, data, and analytics results in a convenient and understandable form for employees, managers, and clients of banking institutions. In addition to predictive methods, this study used the information method and the method of morphological analysis. The method of morphological analysis was used to consider intelligent systems in terms of their structure, functions, characteristics, and basic properties. The information approach ensured an effective search for information from scientific sources on the essence and categorical differences of models of intelligent information systems, including manuals, monographs and scientific articles published in international scientific and metric databases.

This study uses the basic approaches to cognition of the banking sector's features based on the general scientific methods of induction and deduction. The method of induction made it possible to identify general trends in the formation of intelligent systems and to formulate a hypothesis about the concept of "intelligent information system of the banking sector". The method of deduction was used to formulate the general principle of functioning of intelligent systems based on innovative IT technologies, to obtain a comparative analysis of existing intelligent systems and to propose a categorical group of them in banking activities.

Using the method of generalization, the study identifies common features and properties of intelligent information systems in the banking sector, substantiates their general structure of functioning, and formulates a concept that should be followed when designing and implementing digitalization in banking institutions.

Results and Discussion

Intelligent information systems: signs and properties

Intelligent systems are widely used in various industries, including the banking sector. This is due to the increasing amount of data generated and stored by banks, as well as the need to analyse this data quickly and efficiently to make

informed decisions and improve the quality of customer service. In the banking system, IIS can be used to optimize management processes, increase efficiency, and improve the quality of customer service. An important factor in the application of IIS in the banking sector is the processing and analysis of a large amount of financial data. Banks collect a large amount of information about their customers, their transactions, credit history, etc. The IIS can automatically analyse this data, identify dependencies and trends, make forecasts, and provide effective management recommendations to bank specialists.

Since existing information systems have limitations in processing/analysing large amounts of data, do not guarantee reliability, efficiency, and do not ensure confidentiality and protection of personal information of customers, intelligent systems are a powerful tool that significantly enhances the process of optimizing and analysing large amounts of financial data, making informed decisions with high quality management performance. The issue of developing intelligent systems is a complex and multifaceted task, and it has been studied by many scientists and researchers in the field of artificial intelligence, information technology and other relevant areas. However, it is difficult to point to a specific scholar who has exclusively studied the concepts of intelligent systems' development, as it has been the subject of research by many researchers for decades. Among the scientists who have worked on the classification of intelligent systems and other aspects of artificial intelligence is J. McCarthy (John McCarthy's Home Page..., 2023), who defined the term "artificial intelligence" and classified them according to various aspects depending on their purpose, functionality and main characteristics.

As it is known, intelligent systems can be classified according to their application in various industries, and currently, scientists have identified a categorical group of financial intelligent systems that have corresponding special needs for financial activities. According to the authors, it will be important to allocate a categorical group of intelligent systems for banking management processes. Such systems should combine information technologies, methods of data analysis and artificial intelligence to ensure effective management of banking processes, risk management and informed decision-making to ensure financial stability in the face of economic changes and adverse factors.

It is intelligent information systems (IIS) that enable the search, analysis, processing, and interpretation of relevant information. Such systems recognize and process large amounts of data, providing users with "smart" recommendations, analyse structured/unstructured data, text documents, images, video and/or audio content, etc. in real time with detailed justification of the results obtained. The term "intelligent information systems" was proposed by domestic scientists O.V. Nesterenko *et al.* (2017). In their work, they summarize the concept of existing systems in various areas of their use, which significantly expands the range of their use in business, management, and administration.

The intelligent information systems of the banking sector (IISBS) should combine not only information technology, but also data mining to ensure high efficiency and effectiveness of banking operations. The IISBS should be capable of collecting, storing, processing, and analysing large amounts of data from open sources, including internal and external sources of banking institutions. These systems should use a variety of IT technologies, such as artificial intelligence, machine learning, data analytics, forecasting and image recognition, visualization, etc., which are effective tools for identifying and analysing relevant patterns, trends, and other information resources.

The fundamental contribution to the design of intelligent systems is the study of a domestic scientist (Dovbysh, 2009), which reveals the essence, properties, types of IIS, the main stages of their design and operation. The author highlights the general provisions of intelligent systems and presents methods for optimizing training parameters within the framework of information-extreme technology for analysis and synthesis of intelligent systems, which allows using training samples as decisive rules under conditions of a priori uncertainty. The researcher has identified the properties of the IIS, such as stability, controllability/self-controllability, verifiability, accuracy, reliability, and stability, which should be considered as general in the design process (Fig. 1). V.M. Kotsovsky (2019) highlights the property of the learning/self-learning process, during which the system acquires knowledge, identifies patterns, creates forecasts, makes decisions based on the information provided, based on machine learning methods using models and data analysis algorithms to gain new knowledge.

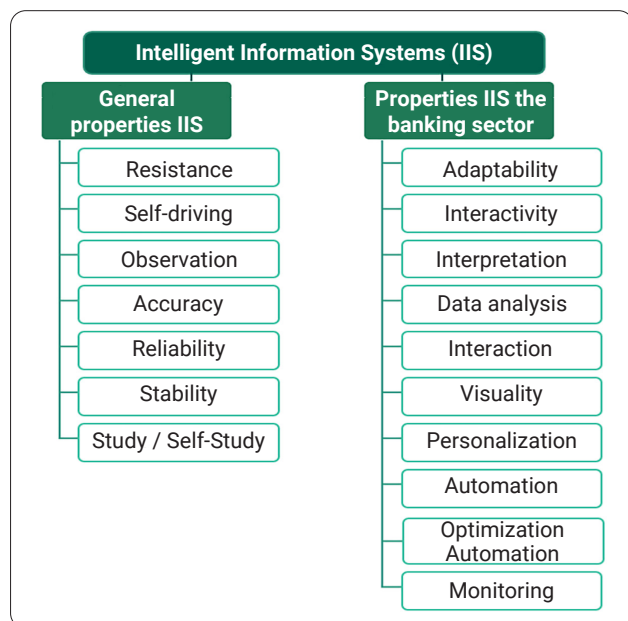


Figure 1. Properties of intelligent information systems of the banking sector

Source: summarized and supplemented by the authors based on the research of A.S. Dovbysh (2009), V.M. Kotsovsky (2019), M. Milojević & S. Redzepagic (2021)

For the banking sector, intelligent information systems, in addition to the group of general properties of IIS, should also have such properties as (Fig. 1) adaptability, which will ensure their learning in new operating conditions and gaining knowledge based on data from experience. Since, in the process of functioning, IIS can change their models, rules, strategies in accordance with changes in the environment, obtaining additional input data enables timely response to changes in difficult conditions. It is important to note such a feature as interactivity, which will provide the system with interaction with users and customers of banking institutions in order to provide information, resolve personalized issues, perform relevant functions and operations in real time through the use of virtual assistants (voice assistants, chatbots), which will significantly increase communication with customers. Quick access to information and services guarantees a personalized and convenient result of using IIS. It is worth giving the system an interpretation property that will allow detecting and recognizing data in the IIS, including text, images, video, and audio information. It is this property that will determine the optimal information for analysis, distinguishing its content by appropriate classifiers.

The main feature of any intelligent system should be data analysis. It is this ability, such as making appropriate decisions on a set of big data, that will be able to make an assessment based on well-known scientific methods (static, dynamic, Big Data) and implement appropriate decisions based on specified criteria or rules, considering many dependent/independent factors. Having analysed the experience of existing systems, it is possible to assure that no system can cooperate without interaction. With the help of various interfaces (multimedia, virtual, intelligent) that have the ability to fully engage in dialogue, recognize speech, identify emotions, ensure the execution of commands/operations at the request of customers/staff, provide information/recommendations in real time.

One of the disadvantages of intelligent information systems is the difficulty in obtaining analytical/prognostic results that significantly affect management decision-making. Therefore, it would be appropriate to present data and analysis results in systems in the form of graphs, charts, images, and other visual tools, which will make it easier for users/staff to perceive and understand information. It was the scientists C. Pimenta & A. Seco (2021) who studied this process, which is now known as visualization. Data personalization can also be identified in systems, which will ensure the process of setting up an IIS for the unique needs and requirements of a particular user when providing individual recommendations, solutions, and services, taking into account personal characteristics, preferences, context, and other relevant parameters. An important aspect of intelligent systems is optimization, which enables automation of repetitive or complex processes, detects anomalies in them, improves productivity, and ensures high efficiency, thereby eliminating human error.

Modern systems cannot function properly without timely, real-time data monitoring. It is monitoring that allows ensuring the effective operation of IIS, identifying

possible problems and responding to them in a timely manner, and includes checking the system's performance, availability, and speed; detecting intrusions and/or fraudulent activities that may require an immediate response; providing ongoing support, search and updating of IIS. As a result, it is possible to state that the proposed properties of PIS for the banking sector will make them more flexible, suitable for self-learning and adaptation, and provide effective analysis in processing large amounts of data with high-quality management decision-making.

Intelligent information systems: information environment

It is worth mentioning the work of domestic scientists V.L. Pleskach & T.G. Zatonatska (2011), which describes the information environment of intelligent systems, consisting of a fact base and a knowledge base. The authors define the concept of "intelligent automated information system" (IAIS), provide a general structure of the organization's management process by its main characteristics. It is in the work of these authors that the main components of the IAIS are presented, namely, the solver (machine output), the information environment and the intelligent interface. In the researchers' work, the information environment consists of a fact base and a knowledge base, and the intelligent interface provides a machine-human dialogue in the system, while demonstrating its learning and performance. It should be noted that such systems do not have a process of visualizing the results, which greatly complicates the interpretation of the analysis and management decision-making. Data analysis in such systems is provided by weak artificial intelligence, as it is limited in the choice of machine learning algorithms.

The process of functioning of intelligent systems is shown in more detail in the work of M.P. Voinarenko *et al.* (2015) and its main components, such as the user interface, knowledge base, interpreter and system creation module, are presented. The structure of the systems presented by the authors is mostly used by expert decision-making systems (EDMS), so the user interface is proposed to be used for entering information and commands containing parameters aimed at the process of knowledge processing and obtaining output results from the knowledge base (KB). The structure of the IIS proposed by scientists is more generally aimed at the intelligence of the use of information systems, but is limited to machine learning methods.

The information processes of an intelligent information system have been studied by domestic scientists O.V. Nesterenko *et al.* (2017), whose functioning is shown in Figure 2. As can be seen from the diagram, the user interface component is divided into input and output data. The user of the system receives the result based on the relevant data/queries. This system has the following components: data management, data processing, and machine learning. Based on the above structure, it is to be concluded that these systems have a significant drawback: they are capable of solving problems using weak artificial intelligence algorithms.

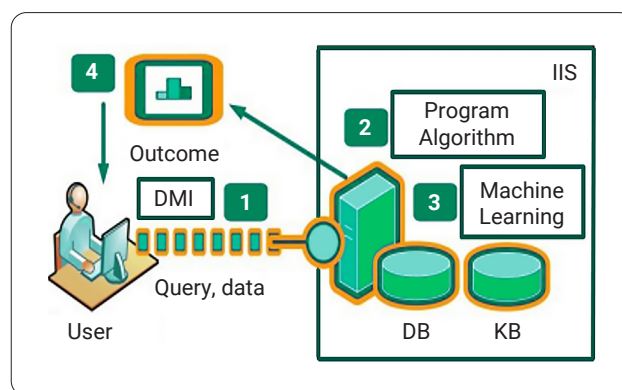


Figure 2. Functioning of information processes in intelligent information systems

Source: suggested by authors O.V. Nesterenko *et al.* (2017)

The study by the national author A.O. Zamula (2014) is aimed at improving the efficiency of management of financial and qualitative indicators of banking activities, in which methods and models of intelligent management are proposed. This paper describes the basic principles and methods of using artificial intelligence, machine learning, and data analysis to predict financial risks under the improved structure of management decision-making in banking. The structure of the hybrid intelligent system for the banking sector proposed in this paper, in addition to the user interface, contains three main modules, namely

- data management, which includes external and internal sources of information stored in the database;
- knowledge management, which contains a knowledge base relying upon the sources of conceptual description of banks and created product rules;
- model management, which has three main components: a dynamic model of the banking system, a dynamic model of the bank, and a fuzzy model of bank management.

As can be seen from the above structure (Fig. 3), hybrid systems, in comparison with the previous systems, have the advantage of forming a database of models used in data analysis, but are limited in algorithms and methods of training/self-learning. In his work, the researcher focused on fuzzy logic models, which are subject to subjectivity and complexity of interpretation, limited in solving personalized tasks, slow in the learning process, and have insufficient adaptability and accuracy of analysis.

Data mining is an important component of any intelligent system. In the work of scientists O.G. Avrunin *et al.* (2022), intelligent analysis is implemented as an extension of relational databases that combine a large amount of data with the ability to analyse, interpret and make decisions. This is the highest level of the database, which includes intelligent analysis and understanding of data to identify complex relationships and make informed decisions. Based on the results of the research, the scientists proposed the methodology of intelligent databases (IDB), which is appropriate to use in the structure of the banking sector's IIS.

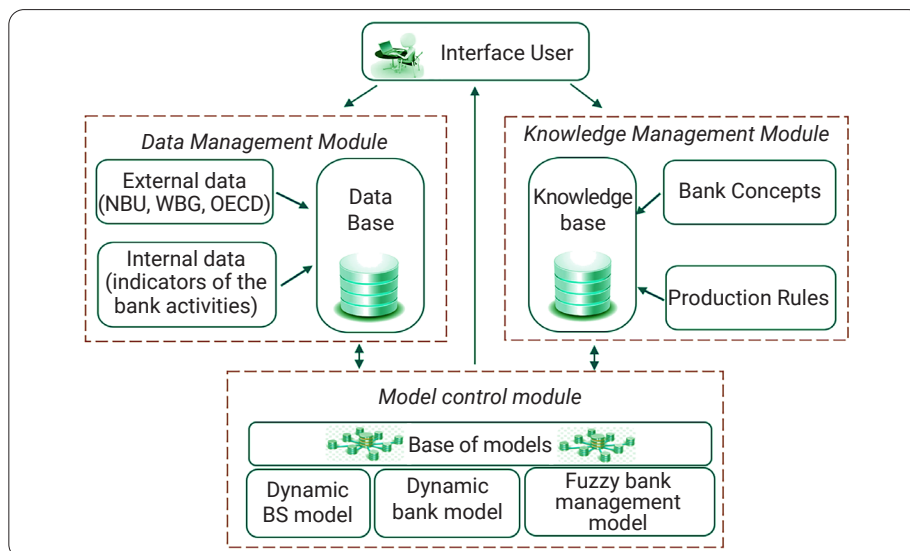


Figure 3. Information processes of intelligent information systems

Source: suggested by author A.O. Zamula (2014)

With the development of e-banking, intelligent information systems are not practical for the mass consumer in the financial sector. E-banking (internet banking) involves the use of electronic devices on the Internet to conduct financial transactions and access banking services (Domino-va, 2020). As e-banking provides opportunities for online transactions, analytics, and personalization, it encourages banks to innovate and improve customer service processes. It is for the convenience, speed, and accessibility of banking services for customers that IIS should introduce visualization of results and data analysis, as well as informative panels (dashboards). The general structure of dashboards can be interactive depending on the purpose and personalized data of the target audience. However, the main components of dashboards can be identified: controlled panels and/or filters, graphs and/or charts, tables and/or numerical data (indicators), geographic visualization (maps, markers, geo-location data), additional components (advanced analytical reports, etc.). It is important to note that dashboards can display results tailored to a specific situation or the needs of a particular user (Basyuk & Vasylyuk, 2010). A significant advantage of using dashboards is their real-time use.

According to such principles, dashboards and IIS can be implemented according to the methodology proposed by O. Lezhnina *et al.* (2022). The use of the Flask (Python) server together with ORKG library queries and the use of Pygal library visual components allows users to receive the results of the analysed information in mobile banking applications. The visualization of the obtained data is dynamic, and when the filtered results are sent to ORKG, the content of the dashboard is automatically updated. It can be noted that mobile banking has the advantage of providing users with access to banking services, checking account balances, transferring funds, paying bills, and receiving notifications of completed transactions from mobile devices online 24/7 (Zinchenko *et al.*, 2022). American scientists have focused

on data visualization processes (dashboards) used in innovative robotic platforms (Pimenta & Seco, 2021).

The use of virtual agents (chatbots, voice bots) in FMIS systems is promising, and it would be appropriate to introduce them in the banking sector's intelligent systems (Pimenta & Seco, 2021). Virtual assistants (chatbots) will provide convenient and efficient communication with the bank, improve customer experience, and provide access to financial services in real time. According to the study, virtual assistants (VAs) use semantic and deep learning based on artificial intelligence methods using neural networks and their variants, which provides natural language processing, forecasting, and personalized recommendations. In the case of FMIS, the best VA will be the main component of the customer support service in an intelligent information system. The functional diagram of such a chatbot is presented in the work of A. Seco & A. Muñoz (2019), in which the helpdesk provides simultaneous support through several channels of the user's choice.

With the development of digital artificial intelligence technologies, an important component of the IIS is the data processing module, using Data mining methods to identify useful information, patterns, templates, and trends in large data sets. This area combines methods and techniques from the fields of statistics, machine learning, artificial intelligence, databases, and data visualization. The main goal of Data Mining is to find hidden information that can be useful for decision-making, forecasting future trends, identifying associations and patterns between data. To achieve this goal, various algorithms and methods are used, such as classification, clustering, associative rules, regression analysis, outlier (anomaly) detection, forecasting, and others. Data Mining is used as a tool that allows extracting valuable information from large amounts of data to support and/or make decisions and understand and/or analyse business processes.

In the architecture of an intelligent financial management system, processes are formed by integrating a decision-making support system (DMSS) and an expert system (ES). The decision support system consists of a model base and human-computer interaction, while the expert system consists of machine analysis, a dynamic database and a knowledge base. The basis of the modernized IDSS architecture is the database, which includes a knowledge base and a model base, allowing to obtain auxiliary information about decisions by combining qualitative analysis (knowledge substantiation) and quantitative analysis (evaluation and analytics). Another component is a data warehouse and a data mining approach is proposed, in which the personalized information found reflects an inherent law in the processing of large amounts of data (Lai, 2022).

It is in the processing of Big Data that analysis from different sources of information in different formats is used. Big Data analytics allows identifying complex dependencies, trends, and patterns in data, making predictions, discovering associations and hidden knowledge. The authors

C. Pimenta & A. Seco (2021) propose a method of predictive analytics, which is a form of advanced analytics that determines the forecast using methods such as regression analysis, multivariate statistics, modelling, and forecasting. This approach to data analysis provides timely forecasting trends in economic activity in the short term (nowcasting). An important component of the intelligent system is the analytics and forecasting module, which uses artificial intelligence (AI) methods (Ghandour, 2021) to identify financial trends and predict risks, as well as assess the bank's financial performance. It is AI algorithms that enable effective management in banking institutions, which will help in making informed decisions on asset allocation, risky transactions, and financial management strategies.

Intelligent information systems: general structure

Having studied the processes of functioning of modern IIS, it is possible to present a modernized structure of the banking sector's IIS, which includes six component modules (Fig. 4)

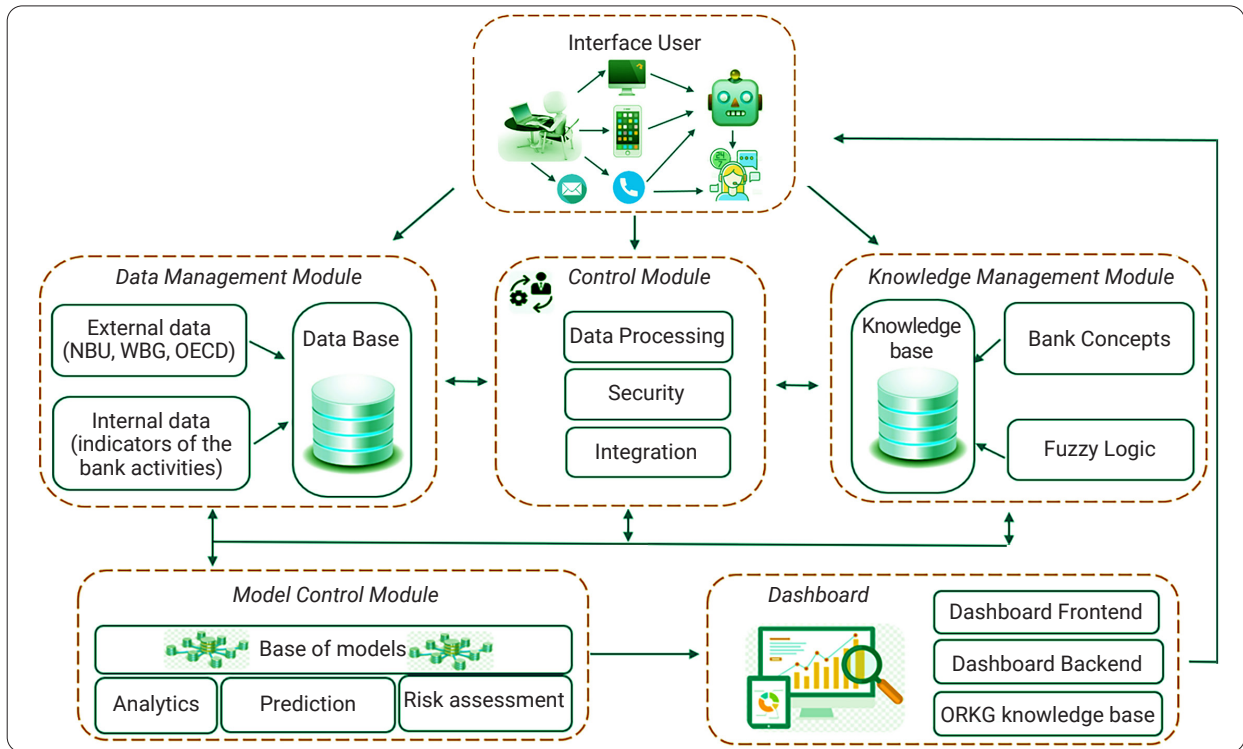


Figure 4. A modernized structural diagram of the functioning of intelligent information systems within the banking institution

Source: summarized and supplemented by the authors based on the research of A.O. Zamula (2014), C. Pimenta & A. Seco (2021), O. Lezhnina *et al.* (2022)

As it can be seen from the diagram, the user interface is responsible for collecting input information to the II system. The introduction of chatbots (voice bots) in the system will help customers perform financial transactions (money transfers, payments, checking account balances, loan applications, blocking cards, etc.), which will ensure speed and convenience for customers, online without visiting the

bank or calling the contact centre. Virtual assistants can be useful for attracting new customers by providing information about banking services, account opening procedures, credit terms and other financial opportunities. Virtual assistants can analyse customer data, transaction history, financial status, expenses, and other parameters to provide personalized advice and recommendations.

The core of the data management module is an intelligent database that stores data on customers, their financial transactions, services, and products. The database can be distributed according to the needs of the banking institution, allowing data to be stored on servers/clouds and providing access to various nodes of the II system. In the system, the management module is responsible for managing the IIS, including controlling access to the system, setting parameters, monitoring, and allocating resources among various components. This module includes the following components: data processing, which is responsible for processing and analysing data by selecting information from the database and processing it using various artificial intelligence algorithms; security, which is responsible for authentication and authorization of users, data encryption, detection, and elimination of security threats, activity monitoring, etc., integration, which is responsible for interacting and exchanging data with other systems, such as customer relationship management (CRM), payment processing systems, reporting systems, etc. (Abdalla *et al.*, 2020).

A component of an II system such as a knowledge management module will ensure the management and distribution of knowledge for banking institutions of different groups and activities. The rules developed using fuzzy logic methods contribute to the efficient processing and use of knowledge to support business processes, decision-making, and the development of banking institutions. The main functions of the knowledge management module include: knowledge storage, which provides mechanisms for preserving and integrating knowledge, ensuring its security and confidentiality by controlling access and access rights; search and selection of knowledge, which provides fast and efficient search for knowledge in the system by keywords by similarity, performs filtering, and provides personalized recommendations; analysis and updating of knowledge, which provides tools for identifying new dependencies and relationships, detecting anomalies or irrelevant knowledge,

and helps customers identify specific knowledge fragments (comments, feedback, reviews, etc.).

The model management module modified in the system will allow effectively managing the life cycle of models used for analysis, forecasting, optimization, and decision-making. This module provides centralized storage, version control, access, and management of models in an intelligent system and contains the following components: analytics, which provides the process of identifying, interpreting and communicating useful information from data and includes the use of statistical methods, mathematical models, machine learning and other techniques to identify dependencies, trends, and patterns in information for the purpose of understanding, forecasting and decision-making; forecasting, in which, based on data analysis, forecasts of future events and trends can be made, and models can be used to optimize business processes and make further decisions; risk assessment, which is responsible for the process of identifying, analysing and assessing threatening events or situations that may adversely affect the goals, projects, or activities of banking institutions, and, if identified, allows for informed decisions and measures to be taken for their effective management (Arjun *et al.*, 2021).

The dashboards added to II systems generate output information for analytical reports and graphs that provide clear and comprehensive information about the bank's financial stability. This helps both users and bank management to visually receive information to simplify decision-making and relevant financial management strategies. The functioning of the proposed IIS framework in the banking sector will help banking institutions to increase the return on equity, improve customer service more efficiently and effectively with high real-time accuracy, predict financial stability, and ensure financial stability. As a result, let us compare the key aspects of intelligent information systems in the banking sector with the existing intelligent systems (Table 1), which were considered in this study, with the proposed AI system of the banking sector.

Table 1. Main features of intelligent information systems

Main features of IIS	A type of intelligent information systems					
	IIS	IAIS	IDSSBM	FMIS	IDSS	IISBS
Data analytics	big data	big data	fuzzy logic	predictive	data mining	hybrid
Methods of artificial intelligence	Machine learning	Neural networks	Expert systems	Deep learning	Deep learning	Deep learning
Prediction	supervised learning	supervised learning	supervised learning	unsupervised learning	unsupervised learning	reinforcement learning
Robotization of processes	absent	absent	absent	chatbots	absent	chatbots, voice bots
Risk assessment	absent	absent	absent	present	absent	present
Planning	absent	absent	absent	absent	absent	present
Cybersecurity	absent	absent	absent	present	absent	present
Visualization of processes	absent	absent	absent	present	absent	present

Source: developed by the authors based on the research of scientists O.V. Nesterenko *et al.* (2017), V.L. Pleskach & T.G. Zatonatska (2011), A.O. Zamula (2014)

Judging by the results obtained, it can be concluded that the proposed model of the banking sector's IIS is powerful and efficient, providing accurate data analysis, clear decision-making, and personalized services. Intelligent information systems in banks have a high potential for use in banking, which will significantly increase the efficiency, accuracy, and quality of financial transactions and the banking system as a whole. II systems are becoming an important tool for decision-making support, customer interaction, and risk management. However, it is worth noting that research and development is ongoing to expand the functionality of II systems and improve them for widespread implementation in banking institutions of various groups and activities. It is possible to assume that intelligent information systems will modernize the information systems of electronic banking and mobile banking, which were studied by O. Moroz (2019) and will increase their efficiency in functioning. In addition, it will be appropriate to adapt intelligent information systems on crowdfunding and crowdsourcing platforms, which will lead to significant benefits for all participants in the financing process (Leonov *et al.*, 2019; Tanklevska *et al.*, 2023).

Summarizing the results of the study, it can be said that these intelligent information systems are able to show high potential in risk management, optimize management processes and plan strategic decisions to increase the level of financial sustainability and stability.

Conclusions

The research conducted in this paper shows that intelligent information systems are a powerful tool in banking. Based on the results of the analysis, the paper substantiates the properties of II systems that should be observed when designing them. Conclusions are drawn: Firstly, the proposed intelligent systems use analytical methods, algorithms for automatic analysis and interpretation of large amounts of data, which greatly contributes to understanding trends, customer demand, considering all possible risks. Secondly, intelligent information systems should use artificial intelligence and machine learning to automate decision-making processes, which will help with the analysis of customer data, previous transactions, and other behavioural factors. This is what provides personalized recommendations and offers to customers in optimizing credit risks, and will help improve customer service processes. Thirdly, intelligent information systems in banks can detect and prevent fraud and cyberattacks, and should use anomaly detection algorithms, network analysis, and

machine learning to identify suspicious activity, which will significantly protect the system from unauthorized access to banking information. In addition, intelligent information systems in banks should provide interactivity and personalization for customers, provide online interaction opportunities, and provide support in solving problems through various communication channels.

The article confirms the hypothesis that the proposed model of IIS in the banking sector is capable of analysing large amounts of data using algorithms and machine learning methods, allows creating forecasts of possible risks, visually providing customers with personalized information, and recognizing unauthorized logins and suspicious transactions. The development of intelligent information systems is relatively rapid, and in the future, they will be supplemented by financial analytics methods and models, which will allow for a clearer assessment of external factors affecting the financial stability of banking institutions. This approach allows for a full analysis of the current economic situation and monetary and banking statistics: SWOT analysis, analysis of the banking services market, the market share held by the bank, its position among competing banks; analysis of assets, liabilities, liquidity, profitability; structural analysis of assets and liabilities; financial risk analysis. Financial sustainability in intelligent information systems is enhanced by the ability of IIS to analyse and forecast, respond quickly to changes, automate processes, and improve risk management, and help ensure the stability and reliability of the banking sector.

Hence, it is to be concluded that intelligent information systems are designed to optimize the banking sector's performance, help banks analyse and understand large amounts of financial data, make informed decisions, and improve the quality of customer service. IIS are becoming an integral part of the modern banking sector and continue to develop, providing innovative digitalization opportunities. In the future, promising areas in this context will include research aimed at developing AI models that help banks identify and assess risks associated with lending, investments, and financial transactions, as well as research related to the development of methods for detecting and responding to cyber threats.

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Conflict of Interest

None.

References

- [1] Abdalla, A., *et al.* (2020). *Cybersecurity and information technologies*. Kharkiv: DISA PLUS.
- [2] Arjun, R., Abhisek, K., & Suprabha, K. (2021). Developing banking intelligence in emerging markets: Systematic review and agenda. *International Journal of Information Management Data Insights*, 1(2), article number 1000126. doi: 10.1016/j.ijime.2021.100026.
- [3] Avrunin, O.G., Vladov, S.I., & Petchenko M.V. (2022). *Intelligent automation systems*. Kremenchuk: "NOVABUK". doi 10.30837/978-617-639-347-4.
- [4] Basyuk, T.M., & Vasylyuk, A.S. (2010). *Data visualization methods in distributed systems*. *Bulletin of the National University of Lviv Polytechnic*, 673(1), 24-31.

- [5] Dominova, I. (2020). Evaluation of the effectiveness of risk management of electronic banking based on the regulatory index model. *Accounting & Finance*, 1(87), 91-99. doi: [10.33146/2307-9878-2020-1\(87\)-91-99](https://doi.org/10.33146/2307-9878-2020-1(87)-91-99).
- [6] Dovbysh, A.S. (2009). *Basics of designing intelligent systems: A study guide*. Sumy: Sumy State University.
- [7] Ghandour, A. (2021). Opportunities and challenges of artificial intelligence in banking: Systematic literature review. *TEM Journal*, 10(4), 1581-1587. doi: [10.18421/TEM104-12](https://doi.org/10.18421/TEM104-12).
- [8] John McCarthy's Home Page. (2023). Retrieved from <http://www-formal.stanford.edu/jmc/>.
- [9] Kotsovsky, V.M. (2019). *Intelligent information systems lecture notes*. Uzhgorod: UNU.
- [10] Kravchenko, V.P. (2023). Modern practice of application of artificial intelligence in the banking field. *Modern Engineering and Innovative Technologies*, 25(4), 62-67. doi: [10.30890/2567-5273.2023-25-04-066](https://doi.org/10.30890/2567-5273.2023-25-04-066).
- [11] Kysil, T. (2020). Operation algorithm of intellectual bank system. *Modeling and Information System in Economics*, 100, 93-103. doi: [10.33111/mise.100.7](https://doi.org/10.33111/mise.100.7).
- [12] Lai, M. (2022). Smart financial management system based on data mining and man-machine management. *Wireless Communications and Mobile Computing*, 2022, article number 2717982. doi: [10.1155/2022/2717982](https://doi.org/10.1155/2022/2717982).
- [13] Leonov, S., Yarovenko, Y., Boiko, A., & Dotsenko, T. (2019). Prototyping of information system for monitoring banking transactions related to money laundering. *SHS Web of Conferences*, 65(1), article number 04013. doi: [10.1051/shsconf/20196504013_M3E2_2019](https://doi.org/10.1051/shsconf/20196504013_M3E2_2019).
- [14] Lezhnina, O., Kismihók, G., Prinz, M., Stocker, M., & Auer, S. (2022). A scholarly knowledge graph-powered dashboard: Implementation and user evaluation. *Frontiers in Research Metrics and Analytics*, 7. doi: [10.3389/frma.2022.934930](https://doi.org/10.3389/frma.2022.934930).
- [15] Milojević, M., & Redzepagic, S. (2021). Prospects of artificial intelligence and machine learning application in banking risk management. *Journal of Central Banking Theory and Practice*, 10(3), 41-57. doi: [10.2478/jcbtp-2021-0023](https://doi.org/10.2478/jcbtp-2021-0023).
- [16] Moroz, O. (2019). Benefits of using hybrid mobile apps and progressive web apps in business. *Herald of Agrarian Science of the Black Sea Region*, 1, 96-102. doi: [10.31521/2313-092X/2019-1\(101\)-14](https://doi.org/10.31521/2313-092X/2019-1(101)-14).
- [17] Nesterenko, O.V., Kovtunets, O.V., & Falovskyi, O.O. (2017). *Intelligent information systems and technologies. Introductory course: Textbook*. Kyiv: National Academy of Management.
- [18] Pimenta, C., & Seco, A., (2021). *Financial management information systems (fmis) – project guide: Strategic, functional, technological, and governance issues in the design and implementation of new platforms for public financial management systems*. Washington: Inter-American Development Bank. doi: [10.18235/0003342](https://doi.org/10.18235/0003342).
- [19] Pleskach, V.L., & Zatonatska, T.G. (2011). *Information systems and technologies at enterprises: Textbook*. Kyiv: Knowledge.
- [20] Prymostka, L., & Lysenok, L., (2008). [Cumulative risk of the bank: Evaluation method based on regulatory index model](https://doi.org/10.33146/2307-9878-2008-1(147)-34-38). *Visnyk of the National Bank of Ukraine*, 5(147), 34-38.
- [21] Seco, A., & Muñoz, A. (2019). *Asistentes conversacionales virtuales en las administraciones tributarias*. Washington: Inter-American Development Bank. doi: [10.18235/0001901](https://doi.org/10.18235/0001901).
- [22] Tanklevska, N., Cherniavska, T., Skrypnyk, S., Boiko, V., & Karnaushenko, A. (2023). Financing of Ukrainian agricultural enterprises: Correlation-regression analysis. *Scientific Horizons*, 26(8), 127-139. doi: [10.48077/scihor8.2023.127](https://doi.org/10.48077/scihor8.2023.127).
- [23] Voinarenko, M.P., Kuzmina, O.M., & Yanchuk, T.V. (2015). *Information systems and technologies in organization management: Training manual for students*. Vinnytsia: Edelweiss & K.
- [24] Yaroshchuk, L.D. (2019). *Intelligent control systems: Expert systems – fundamentals of design and application in automation systems*. Kyiv: KPU named after Igor Sikorsky/
- [25] Zamula, A.O. (2014). *Methods and models of intelligent management of banking activity*. (Doctoral dissertation, Donetsk National Technical University, Donetsk, Ukraine).
- [26] Zinchenko, O., Kysil, T., & Moskalenko, N. (2022). Development of interactive Dashboards for Data Science models. In *The IV International scientific and practical conference. Mathematics. Information Technology. Education* (pp. 80-81). Lutsk: Lesya Ukrainka Volyn National University.

Інтелектуальні інформаційні системи банківського сектору: загальна характеристика та інформаційне середовище

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Анотація. У зв'язку з стрімким розвитком цифровізації та інформаційних технологій, актуальним завданням постає дослідження інтелектуальних інформаційних систем (ІІС) в банківському секторі. Саме інтелектуальні інформаційні системи здатні забезпечити оптимізацію банківських процесів, підвищити рівень безпеки, а також покращити якість обслуговування клієнтів, зменшити ризики та оптимізувати внутрішні процеси управління фінансовою стійкістю. Метою поточного дослідження є розкриття потенціалу та впливу ІІС на процеси управління банківської діяльності; вивчення їх можливостей. Для досягнення поставленої мети в даному дослідженні було використано аналітичний підхід, зокрема, методи інформаційного та морфологічного аналізу даних, а також метод узагальнення, що дозволило виділити ключові аспекти, ознаки та властивості інтелектуальних інформаційних систем банківського сектору, привести узагальнену їх структуру за відповідними процесами функціонування. У даній статті проведено узагальнення групи інтелектуальних інформаційних систем банківського сектору (ІІСБС), їх загальні ознаки та властивості, запропоновано інноваційну архітектуру підтримки фінансового управління, визначено їх переваги в порівнянні з існуючими інтелектуальними системами. У результаті дослідження доведено, що інтелектуальні інформаційні системи банківського сектору наділені гібридною аналітикою даних, що забезпечується методами глибокого навчання з використанням алгоритмів самонавчання; здатні оцінити можливі ризики та запланувати стратегії їх вирішення; розпізнають несанкціоновані входи та підозрілі транзакції; завдяки віртуальним асистентам, придатні роботизувати процеси управління; візуально надавати результати аналізу великих обсягів даних в режимі реального часу. Проведені в праці дослідження свідчать, що запровадження інтелектуальних інформаційних систем в банківському секторі мають високу практичну цінність, так як забезпечують інтерактивність та персоналізацію для клієнтів, можливості онлайн-взаємодії, надають підтримку у вирішенні проблем через різні канали комунікації

Ключові слова: штучний інтелект; прогностична аналітика; машинне навчання; дашборд; чат-бот; інтелектуальний аналіз; фінансова стійкість
