

Dominika Crnjac Milić
Josip Juraj Strossmayer
University of Osijek
Faculty of Electrical Engineering,
Computer Science and Information
Technology Osijek
Kneza Trpimira 2b,
31000 Osijek, Croatia
dominika.crnjac@etfos.hr
Phone: +385912246080

Karolina Štefanac
Polytechnic of Požega
Vukovarska 17,
34000 Požega, Croatia
kstefanac@vup.hr
Phone: +38598711013

UDK: 336.71:004](497.5)
Review article

Received: July 11, 2017

Accepted for publishing: September 26, 2017

This work is licensed under a
Creative Commons Attribution-
NonCommercial-NoDerivatives 4.0
International License



Dario Kovačević
NTH Media d.o.o.
Ivana Gundulića 5,
31000 Osijek, Croatia
dario.kovacevic993@gmail.com
Phone: +385955439414

SYNERGY OF INFORMATION COMMUNICATION TECHNOLOGIES AND THE BANKING SYSTEM IN THE FUNCTIONING OF SUCCESSFUL BANKING OPERATIONS

ABSTRACT

Nowadays, modern banking cannot function without information and communications technology; hence banks heavily invest in the implementation of technology currently present on the market. Every aspect of the banking business includes information and communications technology, which points to the necessity of building an infrastructure for modern banking. Investing in development and implementation of new technologies simplifies everyday business activities and security, in addition to creating a competitive edge over rival businesses. It ensures fast and efficient customer service delivery by providing support to the distribution channels, as well as supporting bankers with making crucial decisions.

The aim of this paper is to analyse trends in the use of information and communications technologies in the banking system, using publicly available business data, documentation and online bank information, as well as previously published findings of other researchers. Using the example of one of the largest banks in the Republic of Croatia, the possibilities provided by information and communications technology in the banking business sector are illustrated. Additionally, better economic efficiency and effectiveness, as well as the means of contemporary bank functioning are presented. Special attention is devoted to the security of ICT systems used in Internet Banking and the protection of banking service users' data.

Keywords: Information and communications technology, banking system, banking business

1. Introduction

With the increasing development of information communication technology and the service segment of banking, banks have introduced new distribution channels in their banking systems, and today modern banking cannot be imagined any longer without an implemented ICT system. Using ICT technology enables faster and simpler transactions to be performed and more cost-effective and faster communication with banks at a more affordable fee for performing their services. "Home Banking" provides benefits, like avoiding queues at a bank by simply logging into an application on your account, which in fact represents the user's bank account via PC, tablet or smartphone. It enables everyday checking of account balances, an overview of operations (view and print traffic conditions, statements, payment orders, review of approved loans, cards and turnover per card account), payment (payment in national and international payment transactions, internal payments, etc.), time deposits (contracting domestic and foreign currency time deposits, and view of the archive of all time deposits), control of resources in the investment funds, trading in financial instruments on the stock exchange and others.

Human resources can be optimized using technology, but banks are very cautious because the quality relationship between a client's trust and the bank has to be maintained and it has to be continually developed for the purpose of retaining clients (Ibok, Ikoh, 2013: 181). Banks are increasingly aware that the "people to people" mode of business cannot be bypassed, and that an important link in this relationship is the banker. Using the latest technology, a bank can optimize costs, reducing the number of bank branch offices, since clients can be counselled in a remote way through video conferencing with a personal banker, but also, on the client's behalf, based on his instructions, the banker can remotely do all the work and transitions, once the client has given authentication and authorization via a card, password, cell phone or other authentication device. Part of the client's and personal-banker's communication has become virtual due to the information communication technologies, but in order to maintain the quality of banking sector performance, progressive removal of banking officers is considered as an ill suggestion.

Monitoring of business activities in the banking sector through ICT technology is important at all

times, in order to know the direction of the bank's business, and whether business plans are fulfilled as planned. Daily and segmented measurements of the effects are necessary for the continuous monitoring, in order to have an overview of the business plan implementation on the market; therefore, it is necessary to automatize monitoring that allows the authorities to be alerted if something goes wrong. One more segment in which ICT technology is essentially used and its application is becoming increasingly important, is the control of the service quality (Kunac, 2012: 69). Online monitoring in bank branch offices controls the waiting of an individual customer and the occurrence of work breaks, enabling timely intervention and results in improved business. It also collects data about the transactions the client has performed and gives directions how to organize the work in each branch bank office. Such implemented systems allow banks to become familiar with the clients' structure, their needs and to get adjusted to their needs; sometimes give a correction in real-time work. The use of information and communication technology in the bank office is important, but also in the work of companies in another sector, as it enables the optimization and improvement of operations through easier control and increases the efficiency of the steps taken in business processes. It is of great importance to convert all business documents from paper format to electronic format to enable archiving, stacking in databases and later searching if necessary. Also, e-form documentation is easier to monitor. Particular attention should be given to the continuous and comprehensive reporting of employees responsible for particular segments of business, for example by email, internal web or via web portal. The aim of this paper was to analyse the use of information communication technology in banking, such as: Information System, Automated Teller Machine (ATM), Electronic Banking, Internet Banking, and Mobile Banking (m-banking). Some services, production technologies and their implementation at work are presented in the example of Privredna Banka Zagreb, the leading bank on the Croatian market, and one of the first banks that introduced the Internet into their business. Apart from examining the benefit of information technology in today's banking business, the architecture of information systems and its functioning have been explored, using examples of the application of information technologies in everyday operation of banking systems, and describing their advantages and disad-

vantages. Knowing the risk of ICT use in all forms of business, including banking, a part of this paper discusses the protection measures against possible user data attacks. Also, it has been pointed out how important the continuous monitoring of the security of Internet Banking is and the paper presents the application of various security mechanisms for data protection.

2. Research methodology

The research for this paper started with a comprehensive interdisciplinary research study and its final result was written by a computer science undergraduate student and defended at the Josip Juraj Strossmayer University of Osijek, Faculty of Electrical Engineering, Computer Science and Information Technology Osijek.

The paper was titled "Application of Information Technology in Banking"¹ and its goal was to give an overlook of IT past and present, but also to suggest future projection of ICT implementation in banking systems.

The research presented in this paper was mainly based on secondary sources of information and col-

lected data. The significance of information technology communications which support the banking system has been described using publicly available business information, documentation and available Internet information about banks, as well as previously found experiences of other researchers. The benefits of ICT in the banking sector have been demonstrated in this example and the trends of using advanced technologies in the modern bank have been shown. Part of the paper research was focused on the security of the ICT systems used and the protection of client data. Methods of analysis, synthesis, induction, deduction, comparison, and other scientific methods were used in this research.

3. Development of the application of information technology in banking in the Republic of Croatia and the world

The idea of Internet Banking was developed in the 1980s, including the development of the World Wide Web parallel Internet Banking. Programmers working on database development had come up with the idea to offer online banking transactions. The following table shows several significant years that marked the development of Internet Banking.

Table 1 Significant years in the development of Internet Banking

| YEAR | CHARACTERISTICS OF INTERNET BANKING |
|------|---|
| 1983 | Nottingham Building Society (NBS) – The first Internet Banking service in the UK |
| 1994 | Stanton Federal Credit Union – The first Internet Banking in the USA |
| 1995 | Security First Network Bank (Pineville, USA) – The first Internet-only bank |
| 2007 | Apple – The first smartphone iPhone that introduced Internet Banking |

Source: Created by authors

As can be seen in Table 1, in year 2007, by launching the first smartphone iPhone, Apple made a turning point - Internet Banking became more mobile and the waiting time was shorter, reducing the crowds in bank branches. From the 1990s to the present time, there has been an increase in the fast development of the technology required for Internet Banking and the increasing number of users who understand the benefits of this type of banking. According to the data of the Online Banking Report, in April 1996 there were a million users of Internet Banking in the United States. In 1997 there were already 4.2 million Internet Banking users. Research shows that in

2001, 19 million US households used some form of Internet Banking².

The influence of modern technologies on the development of Internet Banking in Panian's book (Panian, 2013: 173) is analysed through several phases: initiation, interactivity, personalization, virtualization and mobility. The phase of virtualization occurred in the 21st century when there was a strong expansion of mobile and mobile technologies and devices. Due to the globalization, clients have become more mobile at work, and in private life, putting pressure on the banks and other financial

services to offer time-saving mobile services and to enable the globalization of their business.

With the development of the Internet and Internet technologies, banks in the Republic of Croatia also began to implement the Internet in their business, but at the beginning its role was considerably smaller than it is today. At the beginning, banks used the Internet as a marketing medium for advertising and bidding. Internet Banking in the Republic of Croatia, as we know it today, formed gradually and with several years of lagging behind the United States and Europe. Varaždin Bank can be considered as the “architect” of Internet Banking in the Republic of Croatia, since it introduced the option to inspect the account balance in 1997. It was a very simple option, helping users of this bank to access their accounts from their computer without going to a branch office and losing time waiting in queues. Two years later, Medimurska Bank decided

to introduce the same option. The first pioneers in “modern Internet Banking” were a few banks, while today’s leaders in the banking world were slower in introducing these changes. Thus, Raiffeisen Bank and Privredna Banka Zagreb introduced Internet Banking in 2000 and Hypo Alpe Adria Bank in 2001.

The reason why Croatia lagged behind the United States and Europe for a few years was the lack of legal regulations in the country and a low percentage of Internet users. The Law on Payment Transactions in the Country enabled the rapid development of Internet Banking. Following the adoption of the Law on Payment Transactions, Internet use increased and banks used these circumstances to attract users to Internet Banking. Table 2 shows the number of Internet users today in the Republic of Croatia according to the latest available data from the Croatian National Bank, dated 20 Feb 2017 (Table 2).

Table 2 The number of users by payment instrument – year 2016

| | As at 31 January | | As at 30 June | | As at 31 December | |
|---------------------|---------------------|-------------------------|---------------------|-------------------------|---------------------|-------------------------|
| | Transaction account | Another payment account | Transaction account | Another payment account | Transaction account | Another payment account |
| CONSUMER | | | | | | |
| Internet | 1,235,222 | 20,484 | 1,254,164 | 21,072 | 1,277,133 | 21,327 |
| Telebanking | | | | | | |
| Mobile phone | 655,550 | 9,566 | 736,363 | 11,030 | 821,114 | 12,547 |
| E-bill | 33,673 | 964 | 26,207 | | 42,822 | 1,165 |
| Standing order | 1,083,301 | 1,029 | 1,099,647 | 1,001 | 1,133,644 | 941 |
| Direct debit | 1,084,559 | 635 | 1,068,462 | 571 | 1,075,055 | 523 |
| Other | 83,190 | | 80,710 | | 78,264 | |
| NON-CONSUMER | | | | | | |
| Internet | 308,750 | 316 | 315,797 | 341 | 252,736 | 365 |
| Telebanking | 5,983 | | 5,793 | | 2,594 | |
| Mobile phone | 59,056 | 11 | 66,466 | 24 | 41,458 | 36 |
| E-bill | 112 | | 108 | | 69 | |
| Standing order | 28,421 | | 30,183 | | 11,428 | |
| Direct debit | 1,531 | | 1,502 | | 1,562 | |
| Other | 26,977 | 47 | 26,469 | 41 | 2,012 | 45 |

Source: Created by the authors on the basis of the source “Number of users by payment instrument for 2016, the Croatian National Bank”¹⁸

4. Advantages and disadvantages of using Internet Banking

As a global computer network, the Internet makes it easy for its users to do a lot of business. The specific characteristics of Internet Banking, which are primarily reflected in time and money savings, as well as speed and effectiveness and a significant channel of distribution, have been recognized by the banks as well. The advantages and disadvantages of using Internet Banking can be viewed from the standpoint of the bank and from the client’s point of view as the main stakeholders of the business.

In his paper, Rončević (2006: 765) points out the following advantages of Internet Banking from

the bank’s standpoint: improved market reputation, reduced transaction costs, faster and better responses to changes in the environment, greater market penetration, and the use of the Internet to advertise and sell new financial products. Using the service of Internet Banking, banks have been able to manage customer relations better, since they offer a wide range of services available 24 hours a day. The services offered are standardized, enabling banks to create services at a lower cost. However, standardized services can be seen as an advantage, but also as a disadvantage for banks because they have no personal contact and might find it difficult to respond to the wishes and needs of more demanding clients. Talking about the disadvantage, it can be

said that the transaction may cause a mistake in the software, and thus the loss of data on the executed transaction. The bank may not provide a 100% guarantee for the security of Internet banking services. One of the biggest obstacles to wider application of

Internet Banking is low IT knowledge (Milanović, Čibarić, 2015: 70).

Table 3 shows the percentage of individuals using the Internet for Internet Banking of individuals aged 16 to 74 in 2011 and 2016 in European countries.

Table 3 Individuals using the Internet for Internet Banking

| COUNTRY | % 2011 | % 2016 | COUNTRY | % 2011 | % 2016 |
|-------------------|-----------|-----------|----------------|--------|--------|
| EU (28 countries) | 36 | 49 | | | |
| Belgium | 54 | 64 | Lithuania | 40 | 54 |
| Bulgaria | 3 | 4 | Luxembourg | 59 | 71 |
| Czech Republic | 30 | 51 | Hungary | 21 | 35 |
| Denmark | 75 | 88 | Malta | 42 | 46 |
| Germany | 45 | 53 | Netherlands | 79 | 85 |
| Estonia | 68 | 79 | Austria | 44 | 53 |
| Ireland | 33 | 52 | Poland | 27 | 39 |
| Greece | 9 | 19 | Portugal | 22 | 29 |
| Spain | 27 | 43 | Romania | 4 | 5 |
| France | 51 | 59 | Slovenia | 31 | 35 |
| Croatia | 20 | 38 | Slovakia | 34 | 45 |
| Italy | 20 | 29 | Finland | 79 | 86 |
| Cyprus | 20 | 28 | Sweden | 78 | 83 |
| Latvia | 53 | 62 | United Kingdom | – | 64 |

Source: Created by authors on the basis of source "Individuals using the Internet for Internet banking in 2011 and 2016 in European countries"⁴

Table 3 shows an increase of 13% in the total number of users of Internet Banking at the EU level in 2016 compared to 2011. A significant number of Internet Banking users were recorded in Denmark, Finland and the Netherlands. In these countries, Internet Banking was used by 85% to 88% of citizens in 2016.

In the European Union, in 2016, the smallest share of Internet Banking users was recorded in Bulgaria, Romania and Greece. The number of Internet Banking users in these countries ranged from 4% to 19%.

In accordance with this criterion, the Republic of Croatia is below the EU average. In 2011, Internet Banking in the Republic of Croatia was used by 20% of citizens, and five years later, in 2016, 38% of Croatian citizens used the services of Internet Banking.

Forrester Research estimates that in 2013, there were 51 million mobile banking users in Europe, or 42 million that used m-banking services via a mobile phone and 19 million through tablets. They also predicted that these numbers would grow in 2018 up to a total of 214 million, of which 99 million refer to mobile phone access and 115 with tablets (Ružić et al., 2014: 220).

Comparing Internet Banking to traditional banking, it can be seen that Internet Banking offers the following advantages to customers (Vidović, 2015: 18):

- Unlimited time and space;
- Increased customer satisfaction due to time savings and transaction speeds;
- Cost reduction for the citizens because they use minimum bank fees using Internet Banking;

- Controlled access to information;
- The client has continuous access to information;
- Lower bank fees than in traditional banking;
- Complete financial control;
- Working with Multiple Owners (Companies) Computers;
- Access to services by using tokens, mToken.

Looking at the above, it is evident that the benefits of Internet Banking are numerous, and that its popularity and global representation will promote it even more. However, it should be stressed that the main disadvantage of using Internet Banking from the client's point of view is the lack of security while performing transactions. Clients are extremely sensitive when it comes to their money and are not ready to risk having their data stolen or misused. Therefore, banks today invest significant amounts of money, time and human resources in order to raise and maintain information security.

5. Functionality and technological background of ICT application in the banking system

In a modern bank, ICT technology now covers every part of the business with clients of banking services, but also supports the banker's decisions in his work.

Services that users of banking services use in this way, can be roughly divided into basic services (per-

forming financial transactions, transferring money to other banks' accounts, exchanging currencies, reviewing bank account balances, using currency exchange rates and currency calculators, paying bills, depositing funds, etc.) and additional services (email notification, SMS support, alarms and reminders on actions such as bill payment and over-run of account minus allowed, purchase of shares in investment funds, purchase of shares etc.). Information technology used in banks includes information systems of bank generally, e-banking, Automated Teller Machine (ATMs), Internet Banking and mobile banking (m-banking).

5.1 Information systems (IS)

The term information system (IS) describes the comprehensiveness of infrastructure, organization, people and procedures for collecting, processing, generating, storing, transferring, displaying, information distribution and how available they are.

Since the use of information technology in all aspects of the banking business has created great dependence on information technology, it is of great importance how to manage the information system as an integral part of bank management as a whole. According to the decision on appropriate management of the information system (Croatian National Bank, 2010), the components of the bank's information system are presented in Table 4.

Table 4 The components of the bank's information system

| Software components | Hardware components | Information assets |
|------------------------------|--|--------------------------------------|
| Application Software | Computers and computer equipment | Data in databases |
| System Software | Communication equipment | Data files |
| Databases | Media for data storage | Program code |
| Software development tools | Other technical equipment that supports work of the Information System | System and application documentation |
| Utilities and other software | | |

Source: Created by authors on the basis of source "Decision on Appropriate Management of the Information System" (NN, 37/2010)⁵

5.1.1 Architecture of the Information System software

Architecture of the Information System software is comprised of three main parts, and it has the so-called "Three-layer architecture":

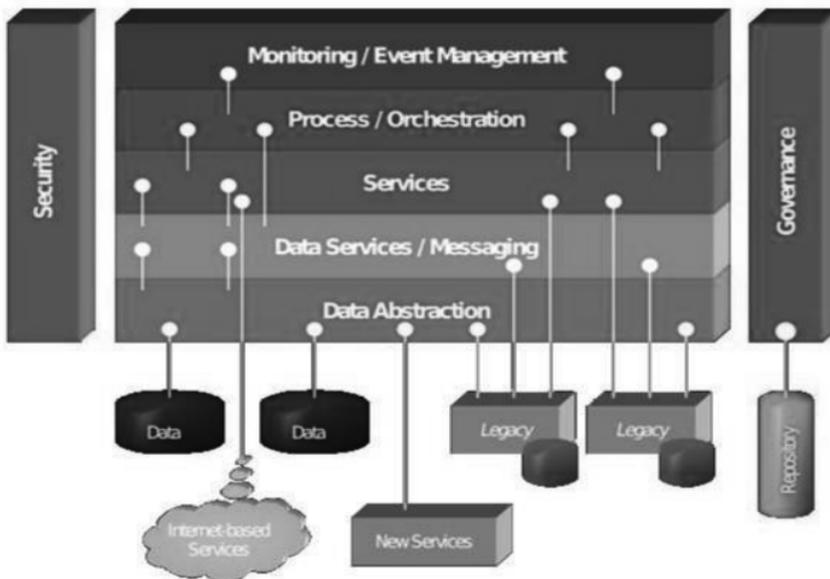
1. The User Interface (Front-End) is the part that customers see and use when authenticating and using the services the bank offers to them in this way. Nowadays, special attention is paid to attractive visual appearance when the interface is created and

some guidelines are followed to customize applications for all age groups of users in order to make them easier to use, enabling good user navigation through applications, as well as referring users to the use of security protocols for data protection. Service providers try to provide clients with constant information about changes in their account balances and preferred transactions via mobile applications. The user interface is most often programmed using mobile web technology and operating systems (IOS) by Android, Windows, etc. The technologies which are used in creating user systems are most commonly HTML, CSS, XHTML, JavaScript and PHP.

2. The Central part of the system (Middleware) contains programs that act as a mediator between multiple applications, between applications and databases, or between several databases. The applications interact with each other through a messaging system (messaging - GET and PUT) that serves to load data that the user enters to transfer between applications. Technology that has proven to be effective in connecting large and independent parts of an application to establish efficient system functionality is the Service Oriented Architecture (SOA). This technology has proven to be effective in connecting front-end and back-end systems. It can be used for

interactive applications on the Internet, but also for interactions from one workstation to another (using the PPP protocol and the EDI (Electronic Data Interchange) network). It consists of software services that are independent of each other and sometimes they run on different platforms (most commonly are .NET or Java). Program services can manage memory, create links between programs components, and create data mapping (organizing data so that applications can be processed). SOA can be used on different platforms: Windows, Linux / Unix and other operating systems⁶. The Internet Banking application is like a black box, helping the user only to see the data he or she enters and the end result of the query. Communication between front-end and back-end systems is an asynchronous type, meaning they do not have to work at the same time (e.g. if the front-end connection does not work, the back-end continues to work, and vice versa). The back-end looks at the front end as a series of services with a high granularity, enabling integration of different applications through SOA protocols. Two parts of the back-end system provide the message flow in the system (Back-end connector and Back-end handler of messages in the message queue). The SOA model is shown in Figure 1.

Figure 1 The SOA model and its components

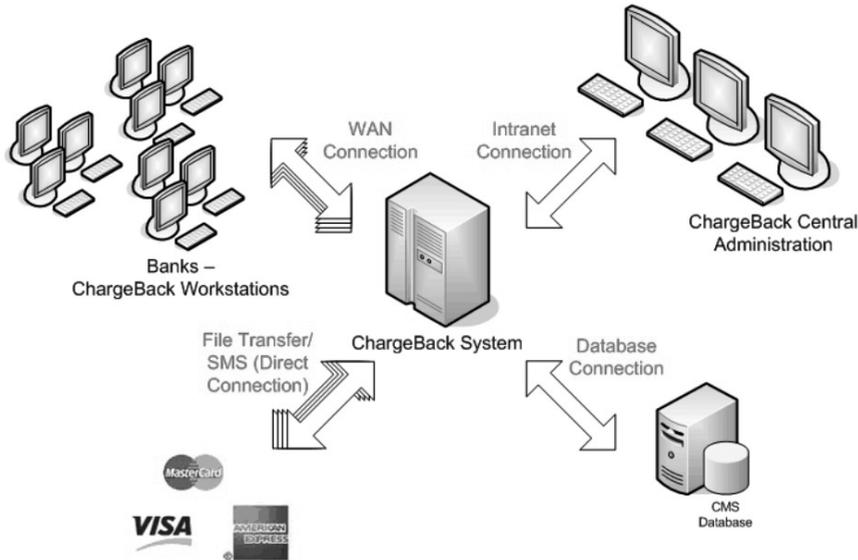


Source: David S. Linthicum, "Leveraging EA Concepts to Make Your SOA a Guaranteed Success"

3. The back-end system (where centralized data processing is done) collects transactions in various forms and then the requirements are translated into the form the machine understands and executes. This part requires great computing power, addition-

al security measures, and advanced programming techniques. The core of the back-end system creates a database. Centralized data processing in the background of the system (Back-end system) is shown in the Figure 2.

Figure 2 Back-end system - credit card payment module



Source: Al-Khatib (2012: 16)

Important elements of Internet Banking that enable its functions are SSL (Secure Socket Layer), Firewall, Application Server, LAN (Local Area Network), and Middleware. Where the SSL (Secure Socket Layer) is a standard security technology for establishing encrypted connections between a server and a client, usually a web server and an Internet site. It represents a security protocol that defines the connection encryption variables and data that are transmitted over that link. Firewall is a network security system that prevents unauthorized access to or from unauthorized private networks and may be implemented by hardware, software, or a combination of both. A Web server is a program that uses HTTP (Hypertext Transfer Protocol) to distribute information which creates users' web sites in response to their requests that are transmitted by the HTTP client from the client computer. An application server is a server type designed to support a web server when it handles dynamic content. An application server is listening to the web server

work and automatically intercepts all user requirements for dynamic content. The Web server still sends static web pages and graphics files, and can also create dynamic content with the application server by mixing data with templates, it can run applications, or access databases.

LAN (Local Area Network) is a computer network within a certain area, like business premises. It consists of interconnected computers, databases, and other devices. Middleware is a software layer that connects two different separate applications. For example, there are a number of layers linking the database system to a web server. It allows users to search database data using forms displayed on the Internet browser and enables the web server to restore the dynamic page based on user requests.

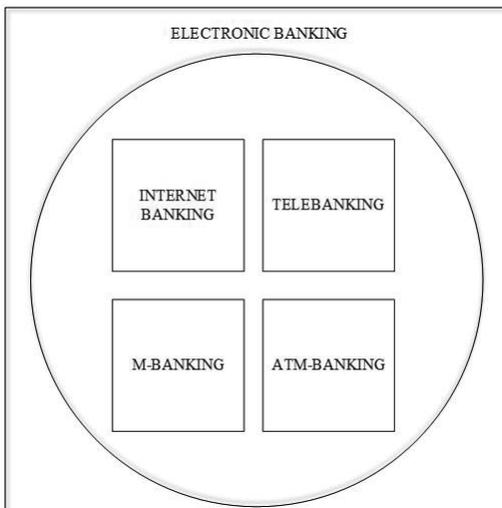
5.2 Electronic banking

Electronic banking (e-banking) is the most widely used form of access to bank accounts and making

transactions using information technology that does not necessarily use Internet access. E-banking is the automatic delivery of new and traditional banking products and services directly to the customers via electronic interactive communication channels (FFIEC, 2003)⁸.

E-banking encompasses Internet Banking, telecommunications, m-banking, and banking through ATMs (Automated Teller Machine). Clients can access e-banking services via an electronic device, such as a Personal Computer, ATMs, or a smartphone.

Figure 3 The scope of electronic banking



Source: Created by authors

5.2.1 Use of the Automated Teller Machine

The Automated Teller Machine as an electronic telecommunications device enables the customers of a bank to perform financial transactions (from or on current or giro accounts), like cash withdrawal, payments to accounts or to check the account balance. If the currency withdrawn from the ATM is different from that in which the bank account is denominated, the money will be converted at an official exchange rate. All of that optimizes human resources. Using ATMs saves time of clients, reduces the crowds and costs of banks. It allows the banks longer working hours because ATMs can be used 24 hours a day. Within each ATM there is a computer system (in most cases a PC) whose basic function is to connect the ATM network with the bank and enables access to the information of the

account for the requested client. The operating systems used for computer work at the ATM, can be Windows, Unix (Linux) or others. The ATM's components are the processor (computer) - the "brain" of the ATM controlling the user interface and the transaction devices, card reader (magnetic and / or chip) - which contains all customer information and serves to identify the client, keyboard, function keys - which are located on the left and right side of the screen and serve to select the offered options on the screen itself, printer - which can print a certificate of a completed or failed transaction, print the account status, cabinets (lower and upper) - which incorporate machine parts and mechanisms for processing the required authorized access, and various sensors and indicators.

Since the protection of the users' data and the bank while using the ATM is of foremost importance, it is very important that the data is protected and that no one else has the opportunity to reach the data in any way. The cash inside the ATM is protected with a dual level of ATM security, such as:

1. Securing User Data through a card reader, equipped with a high-level security crypto processor in order to provide information that the user enters (e.g. a PIN number), while protecting the transfer of messages from the ATM to the financial institution via network (Message Authentication Code (MAC) or Partial MAC). The user is protected if the card reader keeps the card too long in the ATM without any activity or if the wrong pin is repeated consecutively.
2. Physical security of money is guaranteed by using a safe deposit box inside the ATM's cabinet which consists of multiple cassettes with bills which are secured with the containers with colour or smoke in order to disable the bills use if someone attempts to access the safe deposit box violently⁹.

Although the ATM is a significant distribution channel and with the help of ICT technology it can support various functions, the banks are cautious about the number of implemented functions, because the focus of the ATM remains the basic cash payment function, with its primary goal to reduce waiting in rows. However, if there were other functions incorporated (like paying bills) into ATM system, we could have crowds waiting again.

5.2.2 Internet Banking (IB)

Internet Banking is a banking service that allows users access to their account and performs financial affairs from anywhere where the clients have access to a computer, but also from any other device which is connected to the Internet. IB is performed with a browser which can access a secure web point of the bank, so that clients can access their account using the security data they have received from the bank. Internet Banking enables the user to inspect the account balance, transfer money between accounts, and execute the deposit on account, buy foreign currency and other activities. The conditions required for the functioning of Internet Banking can be divided into bank prerequisites and prerequisites for clients (Trenkić et al., 2015: 72).

The prerequisites for the bank are: the existence of an Internet connection, server computers and web server programs, the existence of appropriate software web applications (user interface), adhering to the appropriate security protocols and certificates, and the legal regulations on e-documents and e-signatures. Prerequisites for the clients are: a signed contract with the bank with an agreed monthly fee for using Internet Banking. Then the user gets his or her user number and PIN number (or the device that generates the PIN number for security reasons), thus enabling the client to use Internet Banking and the Bank.

Our example of Internet Banking is "Privredna Banka Zagreb". Its IB is intended for all its clients who are the owners or assignees of a current account in kuna, a current account in a foreign currency, a giro account in kuna, a giro account in a foreign currency or a transaction account of craftsmen. The user is given access to bank accounts 24 hours a day for account traffic, payment of financial obligations, transferring funds from one account to another, the possibility of issuing orders in the announcement, review of all executed orders, contracting insurance policies, payment of loan instalments, and etc. In order to use IB services, it is necessary to sign the Agreement on Use, to take the authorization device, to provide minimum technical conditions (including Internet access)¹⁰.

Furthermore, it is necessary to log into the system with the username and PIN number that the user receives from the bank when he or she has signed the contract. Except the login via the mToken application, it is also possible to log in using the card

reader. The card reader is an identifier, the size of a human hand, consisting of a small screen and a keyboard with the function keys. It reads the chip on the user's card. When the card is inserted into the reader, the reader recognizes the chip and asks the user to enter their pin on the screen, and generates and prints a user's one-time password on the Internet Banking Web site after the pin entry. When the registration is completed, the main menu appears showing the users' data like name and family name, Barometer Innovations, currency list, active accounts and menus with available functionality.

Under the "Accounts" option, the user has access to all his or her open accounts in that bank, the type of account the user deals with and information about the amount available on each account if there are more. The next option is payment and a currency exchange in which a user can perform all payment transactions. For instance, the user creates a payment order by filling out the required fields in the order and pays bills by simply clicking the mouse. The "Exchange" option offers the user the option of buying and selling the currency without going to the exchange office. Under the card menu, the user has detailed insight into his or her credit cards and can make a payment for the selected card. The user is given an insight into the state of the savings, deposit or investment already made on his or her saving and investment card or the option to open new savings or to change the terms of deposit. In the "Credits" menu, the user can view details concerning transactions, annuity, outstanding debt and total borrowing as well as quick loans if the user has them. It is also possible to review the details of the loans, even those already repaid, and make the payment of funds and the premature final repayment of short-term and long-term loans if the beneficiary has them. Under the insurance option, the user is able to arrange supplemental health insurance, full health insurance, property insurance, and compulsory motor insurance. Upon completing all desired transactions, the user must log out of the Internet Banking application by selecting the logout icon.

5.2.3 Mobile banking

The service offered on mobile devices (smartphone or tablet), provides fast and easy access to information about the services and products the customer has in the bank, with the possibility to execute financial transactions. The services are intended for all bank customers who are the owners or assignees

of a current or giro account, and they can be used via software installed on the mobile device. Within the program support, a token is used to identify the user and authorize the default orders. Usually, applications that use their client interface appearance and client authorization mode are tailored to the dimensions and technology platform offered by the classic, contemporary smart phone. This means that the information, the menus and everything else that the independent banking service consists of, will be on the screen in the most concise form possible, but also that the authorization will be simpler than on the Internet, since the cell phone and the SIM card that is in it - with its unique calling number - is in some way already identified with the owner. If a user wishes to access his or her account via mobile banking, the smartphone must be connected to a particular type of Internet, most often it is wireless (WiFi) or mobile (3G, 4G).

We use the mPBZ as an example and it is a service offered by Privredna Banka Zagreb. Prerequisites for using mPBZ services are: a mobile phone that supports Java2 Mobile Edition (J2ME) versions of MIDP 2.0 and CLDC 1.1, enough memory to store mobile software support (about 300 kB of free storage space for all files that come with the application and its installation on the device, and this includes all the files that are created when programming such applications and when executing them on the device itself) and the user-enabled GPRS Internet access from the mobile device.

When the mPBZ application is started, an identification screen appears on the mobile device display that prompts the users to enter the token PIN, so that the users can access the application itself and their account. Once when the identification is over, which is much simpler than Internet Banking, the user enters the main menu, which consists of several options like entry into accounts, payments, mPBZ investor, savings, cards, loans and adoptions, GSM bills, mutual funds, exchange offices, etc¹¹. If the account option is selected, a new screen with a list of all open accounts in the bank appears on the screen. In continuation, for example, under the payment option, we can enter into the part of the account intended for fast and easy payment. By selecting 2D bar code scanning, the smartphone uses a built-in camera that scans a 2D bar code from the account and creates a filled-in payment order on the screen and the user needs only to confirm the payment order by re-enrolling his or her token PIN.

The user has the ability to fill in an order form by selecting a new order option, where an empty order form will be created and which the user fills in, also authentication will be needed by entering the token PIN before the completion. Java Platform, Micro Edition (JME or J2ME) is a platform that provides a flexible environment for applications on mobile and other devices. The Mobile Information Device Profile (MIDP) enables writing of applications and services for network-connection mobile devices and in combination with the CLDC (Connected Limited Device Configuration) makes the Java Mobile Device Environment and enables the launch of Java-oriented applications. The CLDC defines a basic set of interfaces for the application cell phones programming and in combination with the MIDP, provides a strong Java application development platform that will run on devices with limited-memory, processor, and graphics capabilities. The General Packet Radio Services (GPRS) is an older standard of wireless communications available to the second and the third-generation mobile devices that use the GSM (Global System for Mobile Communications). Communication (network) is achieved by merging the packet, which makes it possible to use the network more efficiently because the resources are only occupied when they are really needed. Because of its quality, speed and reliability, it has enabled the development of user-friendly applications of diverse content. SMS (Short Message Service) Banking is another type of mobile banking that allows clients to make limited numbers of services via a mobile phone using the SMS messaging system. SMS is a system for short messaging (up to 160 characters) via mobile and fixed phones by using standard telephone protocols (GSM). SMS banking uses PUSH and PULL messages. PUSH messages are information that the bank sends to the client without the client sending the query like: mobile marketing, bank news, or a one-time password used as a protection against fraud, whereby the user will be given a new one-time passphrase every time he or she accesses SMS banking. The PULL messages are the ones that the client sends to a bank using a mobile device asking for information or doing transactions (e.g. wanting to see his or her account balance, exchange rate, etc.).

5.2.4 Telephone banking

Telephone or tele-banking is a financial institution service, enabling clients to perform financial trans-

actions via a fixed telephone without the need to visit a bank or ATM. If it is necessary to contact a bank clerk by phone, the user can do so during the official working hours of bank, which can be longer than the regular business hours that banks offer to their clients.

The benefit of this service from the client's point of view is that it can reduce costs and save time, since the client does not have to come to the office to perform the transaction, but the disadvantage is the limited time in which the client can use this type of banking, since banks do not work 24 hours a day and they have restrictions for disabling access to all accounts via telecommunications. The procedure for the implementation of telephone banking is as follows:

1. The client should be registered for this service by the bank, obtain the authorization password (the password for telecoms is generally different from that for Internet Banking) and the customer number.
2. The bank has to be able to locate client phone numbers.
3. To access tele-banking, the client needs to call the special telephone number of the bank, which is provided by the bank for that purpose and it is accessible via phone.
4. By using the username and password, the client can access his or her account (current, credit, savings, credit card etc.). Some banks also have additional authorization steps (e.g. using numeric and voice passwords, or answering a number of security questions set by a bank official, etc.).¹²

6. The Security of Internet Banking

The security and protection of Internet Banking is a problem that needs to be seriously taken care of, because it is most important for the user that his or her money in the bank is safe. Today, security concerns are far more than buying a safe to save money. By developing e-banking, security has become more a software problem (Al-Khatib, 2012: 15).

When it comes to Internet Banking and business over the Internet, there are risks and some security breaches might occur. Internet banking is mostly conducted through the Internet. The Internet is a public medium, with open communication

and there are no formal control mechanisms. The risks of using Internet Banking are usually related to fraud attempts by third parties or various errors while processing information. The level of security while performing transactions through Internet Banking affects the Internet Banking system that the bank uses.

In Internet Banking, banks use various algorithms for secure data flow across the Internet. Banks operating in the Republic of Croatia use the SSL algorithm (Secure Socket Layer).

Network hardware and software equipment are two main areas used to protect bank data. Attacks on the bank's communications network are most common in the form of hacker attacks and theft of data in their network transmission, and strong encryption systems are being used as pre-emptive measures for those data transmitted over the network. While attacks on the hardware and software of banks are mainly aimed at disabling their functionality (so called Denial of Service – DoS attacks), there are attempts of intruder logging in order to perform an illegal transaction or to set up a virus to collapse the system. Preventive measures for these types of attacks are firewalls at points where the bank equipment connects to the network.

The risks of security breach are great, but the banks invest a lot of resources into different types of protection to reduce these risks as much as possible. There is a need to create a security management strategy, a document in which the bank elaborates in detail the procedures for safeguarding security. The goal of this strategy is to provide unmatched and safe operations for all parts of the business.

In order to develop such a strategy, it is necessary to look at details, such as to plan security systems for each part of the business, since all parts of the business are important and it is necessary to constantly invest in new security systems, which include not only financial investments in the technical part of the system, but also professional training of the staff responsible for system maintenance.

Some of the ways that business security could be jeopardized are thefts of digital content or software hardware, intense attacks on vulnerable areas (server crashes with irrelevant requests that cause system crashes), launch of viruses or malicious programs that attack software or hardware, and unauthorized access (Hiding IP addresses, punctuation of passwords).

Some of the more important mechanisms and protection techniques that prevent such and similar attempts to attack the system are: identification, authentication and authorization. The identification is a procedure by which a user is required to enter a name, surname, identification number or username obtained from a bank, authentication - an identification procedure that proves whether a person trying to enter a site is actually that person. It represents the most common way (something that only the user knows (password, PIN etc.); or has (smart card, TAN table, stick etc.) or something that the user is (biometrics - fingerprint, eye cornea, manuscripts, etc.) and authorization - a procedure to check if a person who is presented to the system, has the authority to access the system itself (checking and matching with pre-stored data within the system).

Authentication and identification can be done in two ways. The first is applying physical measures, meaning that only the user owns some object, most often it is an identification card, a smart card, a token device, and the other is a password-related logic that only the user knows.

The second mechanism concerns the protection of secrecy when transmitting data to computer networks for which encryption methods (cryptography and cryptanalysis) are used. Cryptography causes the original message to be incomprehensible to persons who are not communication participants, and then cryptanalysis is used to reverse the procedure, so that the recipient of the message with the help of the secret key (encrypted message) finds its contents, that is, the original message.

The virus protection often includes the protection measures against viruses, such as preventive measures, and measures for damage already incurred. For preventive protection measures, the user is encouraged to avoid using suspicious programs, to open messages of unknown origin, to regularly back up his or her files and programs, and to use antivirus programs to detect viruses. If the users are already trying to do so, they should try to save data and business programs using antivirus cleaning and to eradicate infected files and their contents. The most used antivirus programs that can perform the above tasks are: AVG, McAfee Antivirus, Eset NOD32, Bit Defender, F-prot, and House Call. If virus infection occurs, there is the possibility of uncontrolled sending of spam messages, a large number of messages are sent to a large number of

users in a very brief period of time. The user is not even aware of the operations that happen because the virus keeps sending spam messages. To prevent sending spam messages, users should use anti-spam programs such as Add Aware, StopZilla, Panda Titanium Antivirus + Antispam, etc.

6.1 *The Security of Internet Banking in the Republic of Croatia*

Data published by Eurostat in 2015 indicate a very high level of security problems in using the Internet in the Republic of Croatia. At EU level in 2015, 25 percent of the Internet users experienced certain security issues (viruses, personal data misuse, financial losses, or inability to block inappropriate online content).

Countries with the highest incidence of security problems are: Croatia (41 percent), Hungary (39 percent), Portugal (36 percent), Malta (34 percent), France (33 percent). The least problems are incurred by the Czechs (10 percent), the Dutch (11 percent), the Slovaks (13 percent) and the Irish (14 percent).

On the other hand, Croatian citizens are not among the first when it comes to avoiding certain Internet services for security reasons. Internet Banking services are mostly avoided by the Germans (27 percent), the Portuguese (26 percent) and Italians (24 percent), and only six percent of the Croats use this service for security reasons¹³.

Despite all protective measures, however, there are security breaches, so we have newer examples, such as the hacking of the bank pages of the Karlovac bank or the Samberg bank in 2012. In mid-2014, the Croatian National Bank warned citizens about attacks by hackers who had stolen large amounts of money from the bank funds and the accounts of citizens and business entities.

The most common forms of fraud that may be encountered in our area are the use of malicious programs (viruses, Trojans and the like) that are sent to users' email addresses. The content of these emails refers mostly to links that redirect users to the fraudulent Web site of their banks and seek authorizations from users on pages that look like authentic source pages. Counterfeiters are able to make identical pages because pages are written with HTML (descriptive language for website creation) and its code is available to everyone. The main goal of the fraud is to use the information that the users have

unconsciously forwarded to the misappropriation of the cash funds of the user. Such methods are specifically targeted at business users who use the Internet most to authorize card transactions or some other methods mentioned in this paper. Users are continuously informed that if they notice any irregularities they must immediately notify their banks because a timely reaction can significantly reduce the damage or completely prevent it.

7. Conclusion

The development of information and telecommunication technologies directly affects the development of society and globalization, and has a major impact on the advancement of Internet Banking in a relatively short period of time. Since the emergence of information technology in banking, banking has made a major step forward in its business, not only in service but also in the overall system of a modern bank. This paper emphasizes the importance of synergy between information communication technologies and the banking system. The advantages and disadvantages of using information communication technologies in the daily work of banks are analysed, such as optimizing customer time (avoiding long queues in bank branches and providing access to user accounts at all locations where there is Internet access), as well as optimizing the number of employees in the banking sector with sustained quality of services provided. The method of using information communication technologies related to infrastructure, devices (hardware parts) and software components (software components) is presented.

The functionality and the production of some of the technologies used are described, as well as the description of the information system and its main

components. Components are displayed using physical devices such as ATMs, card readers, and application apps, including mobile apps and web pages that provide users with quick and easy access to their customer data and bank accounts. Special attention was paid to the security of using technology and Internet Banking. The protection of data and users is very important in modern banking. The banks are also developing new types of customer protection, the best examples of this is the replacement of magnetic strips on chip shortcuts that are very difficult to scan. The access to data over the Internet is carried out through secure channels (SSH tunnelling), introducing multiple single passwords that are generated at the user's request, etc.

The application of technology in banking nowadays penetrates almost all aspects of business, and it is certain that in the coming years there will be tremendously rapid progress. In this respect, the intensification of the importance and use of new technological achievements and informatics is expected to increase, while the role of Internet Banking will be even greater and the global representation broader. Given the continued growth of the number of Internet Banking users, it is to be expected that in the future, IB will become a serious rival to traditional banking. Modernization can be expected in the mode and technology in which banking services, payments and interaction between the client and the bank will be performed, as well as in guaranteeing greater security of new distribution channel services. Furthermore, scientific research is important and can comprise several aspects. Along with the performance of the services themselves, attention needs to be paid to the mechanisms and technology that will be used in the future to implement security and data protection and to maintain trust between banks and banking users.

REFERENCES

1. Al-Khatib, A. L. (2012), "E-Banking: Survey", *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. 2, No. 10, pp. 12-19.
2. Ibok, N., Ikoh, I. M. (2013.), "Determinants of Customers Satisfaction with Internet Banking Services", *British Journal of Arts and Social Sciences*, Vol. 14, No. 2, pp. 178-186.
3. Kunac, J. (2012), "Bankarsko komuniciranje s javnostima", *Media, Culture and Public Relations*, Vol. 3, No. 1, pp. 68-77.
4. Milanović Glavan, Lj., Čibarić, A. (2015), "Analiza korištenja Internet bankarstva među studentskom populacijom u Republici Hrvatskoj", *Collected papers of Šibenik College*, No. 3/4, pp. 69-79.
5. Panian, Ž. (2013). *Elektroničko poslovanje druge generacije*. Zagreb: University of Zagreb, Faculty of Economics and Business.
6. Panian, Ž. (2013). *Informatizacija poslovanja*. Zagreb: University of Zagreb, Faculty of Economics and Business.
7. Rončević, A. (2006), "Nove usluge bankarskog sektora: Razvitak samoposlužnog bankarstva u Republici Hrvatskoj", *Ekonomski pregled*, Vol. 57, No. 11, pp. 753-777.
8. Ružić, D., Biloš, A., Turkalj, D. (2014), *E-marketing, 3rd modified and extended edition*. Osijek: Josip Juraj Strossmayer University of Osijek, Faculty of Economics in Osijek.
9. Trenkić, B., Simović, A., Staletić, N. (2015). *E-bankarstvo*. Belgrade: VISER.
10. Vidović, M. (2015). *Internet banking*. Graduate thesis. Split: University of Split, Faculty of Economics in Split.

(ENDNOTES)

- 1 Nacionalni repozitorij završnih i diplomskih radova ZIR, available at: <https://zir.nsk.hr/islandora/object/etfos%3A1164> (Accessed on: May 17, 2017)
- 2 Online Banking Report, available at: <http://www.onlinebankingreport.com> (Accessed on: May 17, 2017)
- 3 Number of users by payment instrument for 2016, Croatian National Bank, available at: <http://www.hnb.hr/analize-i-publikacije> (Accessed on: May 17, 2017)
- 4 Individuals using the Internet for Internet banking in 2011 and 2016 in European countries, available at: <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tinoo09g&plugin=1> (Accessed on: April 15, 2017)
- 5 Decision on appropriate management of the information systems, available at: <http://old.hnb.hr/propisi/odluke-nadzor-kontrola/odluke-zoki-ozujak-2010/h-odluka-primjereno-upravljanje-info-sustavom.pdf> (Accessed on: April 20, 2017)
- 6 Service Oriented Architecture, available at: <http://banksoft.eu/bankarstvo-rjesenja#internet-bankarstvo> (Accessed on: April 11, 2017)
- 7 David S. Linthicum, Leveraging EA Concepts to Make Your SOA a Guaranteed Success, available at: http://semanticcommunity.info/@api/deki/files/7623/=EAo7_Keynote_Linthicum.pdf (Accessed on: April 21, 2017)
- 8 Federal Financial Institutions Examination Council, available at: <http://www.isaca.org/Groups/Professional-English/it-audit-tools-and-techniques/Pages/Overview.aspx> (Accessed on: April 26, 2017)
- 9 Functionality of PBZ ATMs, available at: https://www.pbz.hr/bankomati#.VBJH-fl_uwk (Accessed on: April 28, 2017)
- 10 Internet banking, PBZ365@net, available at: https://net.pbz.hr/doc/PBZ365@NET_Uputa_za_koristenje_hr.pdf (Accessed on: April 23, 2017)
- 11 Mobile banking, available at: <http://with.pbz.hr/products/mpbz/> (Accessed on: May 02, 2017)
- 12 Telephone banking-Terms and conditions, available at: <http://www.nationwide.co.uk/support/ways-to-bank/telephone-banking/terms-and-conditions#tab:TermsandampConditions> (Accessed on: May 10, 2017)
- 13 Security problems in using the Internet, available at: <http://net.hr/tehnoklik/vijesti-tehnoklik/eurostat-objavio-korisnici-interneta-u-hrvatskoj-imaju-najvise-sigurnosnih-problema-u-eu/> (Accessed on: May 10, 2017)

Dominika Crnjac Milić

Dario Kovačević

Karolina Štefanac

SINERGIJA INFORMACIJSKO-KOMUNIKACIJSKIH TEHNOLOGIJA I BANKARSKOGA SUSTAVA U FUNKCIJI USPJEŠNOGA BANKARSKOGA POSLOVANJA

SAŽETAK

Suvremeno bankarsko poslovanje danas je nezamislivo bez informacijsko-komunikacijske tehnologije i iz toga razloga banke čine velika ulaganja u implementaciju tehnologije prisutne na tržištu. Informacijsko-komunikacijska tehnologija danas pokriva svaki dio poslovanja banaka i nužna je infrastruktura suvremenoga bankarskoga poslovanja kod kojega se sve više uviđa da je ulaganje u razvoj i implementaciju novih tehnologija, ne samo ulog u pojednostavljenje svakodnevnih poslovnih operacija i sigurnost poslovanja, nego i stvaranje strateške prednosti pred konkurencijom. Osim osiguranja brzih i učinkovitih pružanja usluga klijentima dajući potporu distribucijskim kanalima, daje potporu bankarima pri odlučivanju, ali i podržava ostale funkcije poslovanja bankarskoga sustava.

Cilj je ovoga rada napraviti analizu trendova u korištenju informacijsko-komunikacijskih tehnologija u bankarskome sustavu koristeći javno objavljene poslovne podatke, dokumentaciju i dostupne internetske informacije banaka, ali i prethodno utvrđene spoznaje drugih istraživača. Na primjeru jedne od najvećih banaka u Republici Hrvatskoj pokazane su mogućnosti koje je informacijsko-komunikacijska tehnologija donijela u sektoru bankarskoga poslovanja te je ukazano na prednosti i nedostatke njezinoga korištenja, ali i načine funkcioniranja suvremene banke. Posebna pozornost pri istraživanju za ovaj rad usmjerena je na sigurnost informacijsko-komunikacijskih sustava koji se koriste prilikom internetskoga bankarstva i na zaštitu podataka korisnika bankarskih usluga.

Ključne riječi: informacijsko-komunikacijska tehnologija, bankarski sustav, bankarsko poslovanje