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THE STUDY OF OPTIMAL CONTROL PROBLEMS IN THE DISTRIBUTED COMPUTING ENVIRONMENT

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Abstract: *One of the most effective methods for solving optimal control problems with mixed constraints is a continuation method for optimal trajectories. This method, unlike the direct methods, allows you to track the qualitative features of the behavior of optimal trajectories, which is especially important when solving applied tasks.*
KEYWORDS*: OPTIMAL CONTROL, DISTRIBUTED COMPUTING.*

1. Introduction

One of the most effective methods for solving optimal control problems with control-state constraints is a continuation method for optimal trajectories [1], [2]. This method, unlike the direct methods, allows you to track the qualitative features of the behavior of optimal trajectories, which is especially important when solving applied tasks. As a result of application of the method of continuation of optimal trajectories there is a sequence of modes. Each mode is defined by solving the special problems of mathematical programming. And the mode is the Cauchy problem for systems of ordinary differential equations. A significant feature of the proposed approach is the need to control the dependence of solutions from initial conditions. Therefore, it is advantageous to apply the methods of solving Cauchy problems for systems of ordinary differential equations based on an approximate analytic form of the solutions [3].

The proposed approach allows a natural decomposition of the optimal control problem and bring the solution to the model subproblems: the solution of finite-dimensional mathematical programming problems to systems for determining shift points; computing mode as a result of solving problems of mathematical programming. It is therefore advisable to carry out the numerical solution of this problem in a distributed computing environment. Typical subtasks are placed in the nodes of the computer network and issued in the form of web services. Management scenarios in a distributed environment MathCloud [4], [5], [6] is proposed for the implementation of the algorithm.

The optimal control problems with control-state constraints

2.

The optimal control problems with control-state constraints can be written in the form,

$$J[u] = \int_0^T F_0(x(t), u(t))\, d\,t \to \min,$$

$$\dot{x}(t) = u(t), \;\; x(0) = x_0$$

$$G(x(t), u(t)) \le 0,$$

$$F(x(t), u(t)) = 0,$$

where $x(\cdot) : [0,T] \to R^n$, $F(\cdot) : R^n \times R^n \to R$, $F(\cdot) : R^n \times R^n \to R^m$, $m < n$, $G(\cdot) : R^n \times R^n \to R^k$.

In this paper we will study the optimal control problems with control-state constraints
and linear controls. The problem (Problem A) can be written in the form

$$\int_0^T \langle g(x(t)), u(t) \rangle dt \to \min$$

$$\dot{x}(t) = u(t), \;\; x(t_0) = x_0,$$

$$K(x(t)) \cdot u(t) = L(x(t)),$$

$$M(x(t)) \cdot u(t) \ge N(x(t)),$$

$$x(t) = (x_1(t),...,x_n(t)),\; u = (u_1(t),...,u_n(t))$$

$$K(x(t)) \;-\; k \times n \;\; matrix,\; M(x(t)) \;-\; m \times n \;\; matrix$$

$$L(x(t)) \;-\; matrix\; k \times 1,\; N(x(t)) \;-\; matrix\; m \times 1$$

3. Local optimal control problem with linear controls

Let us connect the linear programming problem (Problem B)

$$\langle g(x_0), u \rangle \to \min$$

$$K(x_0) \cdot u = L(x_0),$$

$$M(x_0) \cdot u \ge N(x_0), u = (u_1,...,u_n),\; x_0 = (x_{01},...,x_{0n})$$

$$K(x_0) \;-\; k \times n \;\; matrix,\; M(x_0) \;-\; m \times n \;\; matrix$$

$$L(x_0) \;-\; matrix\; k \times 1,\; N(x_0) \;-\; matrix\; m \times 1$$

with Problem A. And let the Problem B has got a regular solution. This means

$$\langle g(x_0), u^* \rangle = \min, \qquad \int_0^T \langle g(x(t)), u(t) \rangle dt = \min,$$

$$K(x_0) \cdot u^* = L(x_0), \qquad \dot{x}(t) = u(t), \;\; x(t_0) = x_0,$$

$$M_A(x_0) \cdot u^* = N_A(x_0), \qquad K(x(t)) \cdot u(t) = L(x(t)),$$

$$M_P(x_0) \cdot u^* > N_P(x_0), \qquad M_A(x(t)) \cdot u(t) = N_A(x(t)),$$

$$M_P(x(t)) \cdot u(t) > N_P(x(t)),$$

where A – indexes of active constrains and P - indexes of passive constrains.

Theorem There exist $[0,T]$, that if $t \in [0,T]$, and then

$$u(t) = \dot{x}(t) = \begin{pmatrix} K(x(t)) \\ M_A(x(t)) \end{pmatrix}^{-1} \begin{pmatrix} L(x(t)) \\ N_A x(t)) \end{pmatrix}, \;\; x(0) = x_0, \;\; Caucshy \;\; problem.$$

4. *Continuation of the optimal trajectories in the optimal control problems with control-state constraintand linear controls*

Local optimal control problems give us an ability to restore the optimal trajectory for Problem A.

Let $x^*(t)$ - is the optimal trajectory of the Problem A.

Then continuation of the optimal trajectory to $[0, T+\Delta]$ is defined by the problem

$$\int_t^{t+\Delta} \langle g(x(\tau)) + \mu(\tau), u(\tau) \rangle d\tau \to \min, \quad t \in [0, T],$$

$$\dot{x}(\tau) = u(\tau), \quad x(t) = x^*(t),$$

$$K(x(\tau)) \cdot u(\tau) = L(x(\tau)),$$

$$M(x(\tau)) \cdot u(\tau) \geq N(x(\tau)).$$

5. *Computing of the optimal trajectories in the optimal control problems with control-state constraints and linear controls in distributed environment*

Required resources to solve the optimal control problems with mixed constraints and linear controls in distributed environment

- Finding roots of algebraic equations
  - Solution of problems of mathematical programming (LP, EP, BP)
  - Finding the dependence of the solution of the ODE system from the initial conditions, which allows several ways of distributed solutions, for example, the principles represent a solution in the form of formal "character" series
  - Resources that produce symbolic computation Calculating the values of polynomials in many variables (generalized Horner scheme).

The flowchart of the algorithm is shown below.

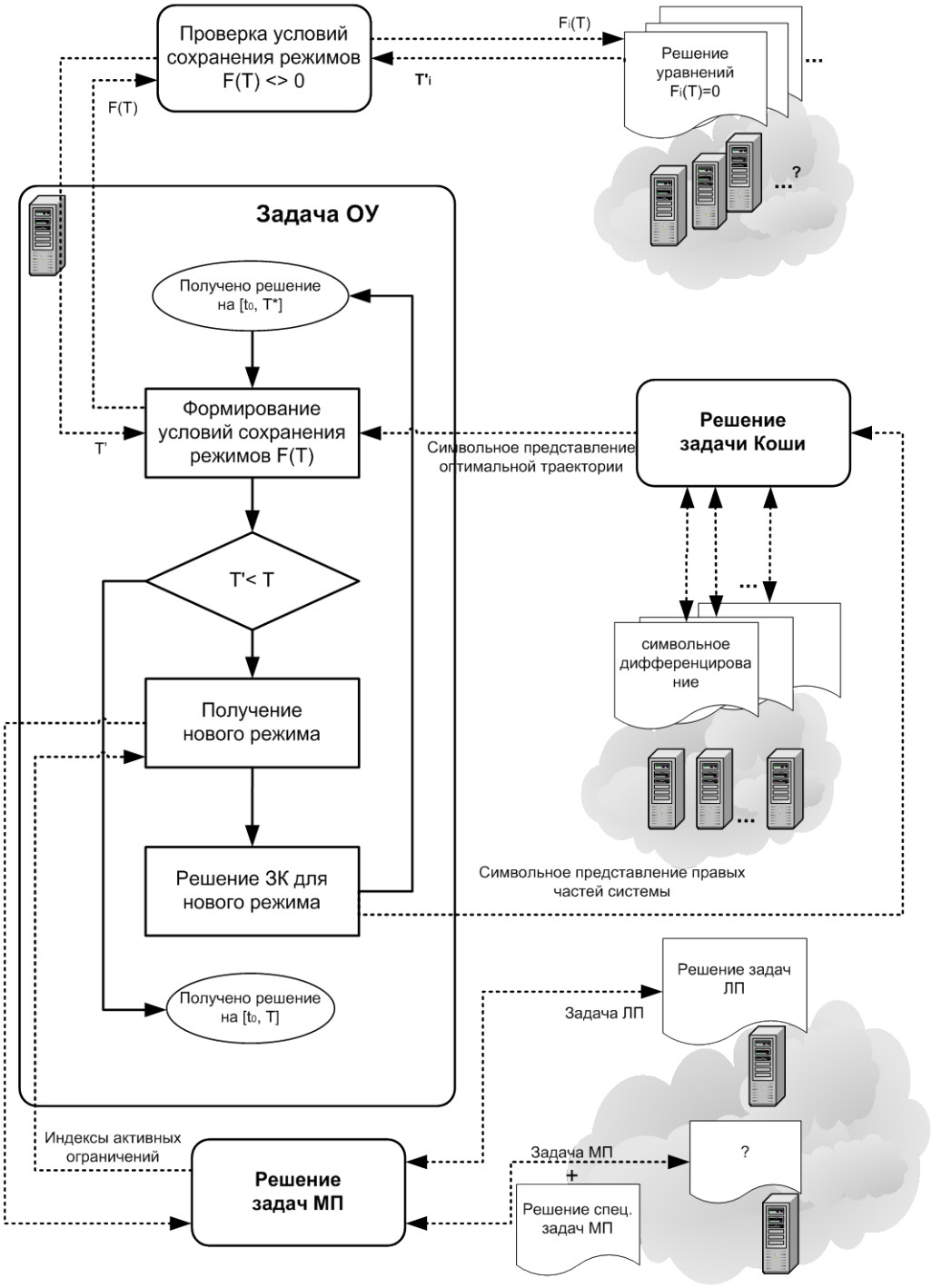


Figure 1. Flowchart of the algorithm.

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MODEL FOR A SMART AND SAFE CITY

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Abstract: *The idea of smart cities is timely considering that urbanisation is inevitable. While smart city as a concept has gained popularity over the past few years, there is vagueness in the definition, as multiple aspects including governance, public transport and traffic, waste management, entertainment and safety among others, need to be considered.*

Europe is among the most urbanised regions on the globe. It is estimated that by 2020 around 80% of Europeans will be living in urban areas, in several countries the proportion will be 90% or more. As we continue to magnetise towards urban hubs we need smart cities – places where networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of inhabitants, businesses and the environment. The EU is trying to ensure that smart solutions for cities can be explored, implemented and replicated.

The present paper defines some of the aspects of the smart city as safety as well as specific models of smart and safe city will be discussed.

KEYWORDS: SMART CITY, INTERNET OF THINGS, CLOUD COMPUTING, CLOUD SERVICES, BIG DATA, MOBILE APPLICATIONS, URBANISATION

1. Introduction

Cities nowadays face complex challenges to meet objectives regarding socio-economic development and quality of life. Cities, not countries, will drive wealth creation in the future. According to Frost and Sullivan report, 60% of the world's population is expected to live in urban environments by 2025. As well, it is expected that around 26 global cities and a hundred sustainable cities will develop extensively, which leads to the vast consumption of the world's resources and the necessity of their smart utility.

The concept of smart cities is a response to these challenges. This paper explores smart cities as environments of open and user-driven innovation for experimenting and validating Future Internet-enabled services. Based on an analysis of the current landscape of smart city pilot programs, Future Internet experimentally-driven research and projects in the domain of Living Labs, common resources regarding research and innovation can be identified that can be shared in open innovation environments. Effectively sharing these common resources for the purpose of establishing urban and regional innovation ecosystems requires sustainable partnerships and cooperation strategies among the main stakeholders.

The increased growth of smart cities will drive the need to innovate and provide solutions to foster convergence within the city. The smart city market is growing, especially with the rapid rate of urbanization taking place, with the market expected to be a $1.5 trillion by 2020.The significant growth presents certain challenges for organisations and city authorities.

Given the urbanization trend the cities have to cope with the pressing challenges and continue to prosper. Indeed, civic leaders and policy makers must start to consider cities as complex ecosystems and adjust strategy, governance and operations accordingly. New solutions and insights are required to be able to manage these scarce resources efficiently and to be able to manage urbanization process for the benefit of all. The significant growth presents certain challenges for organisations and city authorities.

Rapid urbanization plays an integral role in economic and societal progress. However, it also strains a city's infrastructure. Key challenges, such as traffic congestion, energy usage, public safety and the building of sustainable communities are top of mind. Such challenges need to be addressed through the development and implementation of intelligent solutions. [1]

Smart city solution providers face the challenge yet a great opportunity of integrating key initiatives within a city's existing framework. Smart cities are measured by the integration of their infrastructure and the intelligent ways by which they tackle challenges. A smart city puts emphasis on creating a system of networks to allow for a systematic flow of information and effective management of resources. Enabling integration and convergence with organisations and local authorities to provide solutions for the development of a smart city is crucial.

The need to improve our understanding of cities however, is pressed not only by the social relevance of urban environments, but also by the availability of new strategies for city-scale interventions that are enabled by emerging technologies. Leveraging advances in data analysis, sensor technologies and urban experiments, we will provide new insights into creating a data-driven approach to urban design and planning.

Our future cities will desperately need such understanding. Cities evolutions is already happening. This evolution will provide cities with excellent ways to improve its living standards and economies. As a result, people would have access to comfortable, clean, engaged, healthy and safe lifestyle. Cities in turn would access further economic development with the foundations of prosperity – the fundamental infrastructure services that let compete in the world economy.

2. Smart City Models

In this section we will first make an overview of smart cities and the role of "safe" in smart cities (see Fig.1).

The idea of smart cities is timely considering that urbanisation is inevitable. Europe is among the most urbanised regions on the globe. It is estimated that by 2020, around 80% of Europeans will be living in urban areas, in several countries the proportion will be 90% or more. As we continue to magnetise towards urban hubs, we need 'smart cities' – places where networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of inhabitants, businesses and the

environment. The EU is trying to ensure that smart solutions for cities can be explored, implemented and replicated.

Smart means intelligence. Intelligence on the other hand is the key factor to keep a city safe. With the evolution of communication technology, the dissemination of information has become an extremely common task. When substantial investments are made in human and social capital, technology (communication infrastructure), and so on, that fuel sustainable economic development and increased quality of life, along with active participatory governance, the city can be defined as 'smart'. [2]

The below mentioned technologies and processes in Fig.1 are expected to be the core engine of a safer city in the future. Projects currently underway, are already implementing some of these technologies with the main goal of achieving greater integration in the near future. The emergence of smart technology from many devices, buildings, and critical infrastructure means that more information is widely available to gather and interpret. This analysis provides intelligence on how to act to critical situations. This is critical in making a city safe.



***Fig. 1** How smart drives safe – intelligence playing a major role in safer cities [2]*

The concept of 'smart' is expected to drive the further evolution of connectivity and communication to enhance safety. When mentioning smart technologies, we talk about smart buildings, smart transport, smart energy, smart grid, smart cars and smart devices. These new state-of-the-art technologies are the main drivers for city connectivity. The information flow from smart buildings will provide an overview of the status of current utility usage and any variation in the flow of information can trigger an alarm for first responders. Smart transport delivers information from the field and will inform traffic officials that an issue occurred; this may trigger an immediate
surveillance response and possible unit deployment.
Smart energy and smart grids are a crucial element in the surveillance of critical infrastructure and may reduce the risk of power failures. Smart cars give perfect information feed for graphical information systems (GIS) which could be used for the identification of potentially hazardous (traffic jams, accidents, etc.) areas in the city. Smart devices (Smart Phones, Tablets, etc.) allow the mapping of people through GPS and Wi-Fi internet. This also is a crucial aspect to having graphical information about the movement of people.

One common discussion on the market for safer city technology is how it relates to the creation of smart cities. A simple way of correlating these two concepts is by understanding their ultimate goals.

Smart city initiatives aim to deploy technology solutions across different infrastructures in a city with very specific goals. For example, smart transportation solutions are deployed to optimise traffic flow, increase transport connectivity, reduce time spent on mobility, etc. Smart energy technologies are used to increase efficiency, reduce pollution across urban areas, make use of renewable sources, amongst others. In essence, the "smart" concept is using cutting-edge technologies and solutions to make a city a better place to live. "Safe" is the enabler to "smart," simply because it must be present across all different factors—transportation, energy, etc. In other words, safer cites do not compete with smart cities.

Security and safety threat will be a factor influencing the implementation of safer city projects in the coming years. A part of the security factor is the internal/external terrorism threat a city faces.

The higher the internal/external threat of terrorist attacks the more probability there is of a city implementing a safer city project. Other elements that are included in the security and safety threat factor are natural disasters, crime, and so on. The element that is the most important in this segment is crime. The main purpose of safer cities is to decrease the crime rate and increase the feeling of safety amongst the citizens.

Key Trends for safer cities are [2]:
Move towards wireless transmission
Growth of cloud computing, data mining and analytics
Integration of smart technology

Wireless transmission is already present and fairly saturated today through mobile phone, tablet PCs, two way radios etc. The trend for 2012 will allow for large amounts of data to be transmitted wirelessly and real time at greater speeds. This includes development in Long Term Evolution Solutions (LTE), City Clouds, Machine to Machine communication (M2M), internet protocol (IP) technology etc. The development of the above technologies will allow for government agencies and departments to share information with one another seamlessly, thereby reducing the processing time for any activity. In terms of law enforcement, we are already seeing law enforcement agencies in India, China and Singapore using hand held smart devices to retrieve information from numerous vast databases. Mobile devices would also allow law officials to view city footage of key areas in a city remotely without having to be at a stationary location. Remote viewing would allow individuals to attend to a situation before the situation becomes more intensified. IP technology in video surveillance has allowed for cameras to be installed at locations where previously, because of the lack of infrastructure, wiring was not available for the cameras. Today, through IP technology, cameras can be installed immediately and effectively while also providing footage to multiple users across numerous remote locations.

The growth of cloud computing will allow companies and government agencies to have their data stored in a virtual cloud thereby, allowing for access from numerous locations and more importantly, save on cost and space, which would otherwise be used by physical servers. The implementation of cloud technology will allow for faster data retrieval as well as an increase in the size of data that can be retrieved. Cloud computing also allows for data to be retrieved instantly across a large number of devices. Data mining and analytics will allow for government officials to have key data to help them to interpret situations that are taking place currently and accordingly allow them to take preventive steps.

Smart technology is already present through the aid of smart phones, contactless payments, near field communication (NFC), integration of smart cards with biometrics etc. The next stage for smart cities will involve the integration of smart technologies with video surveillance, biometrics, access cards etc. Through this integration, law enforcement agencies will be able to identify criminals/offenders in a city and accordingly take steps towards apprehension. We are already witnessing the benefits of smart technology in the form of smart national ID cards in countries such as Malaysia, Singapore, Indonesia etc wherein the users details are present on the card itself thereby proving to be a key identification card for the user.

The key part of safer cities is technology. With the safer city concept becoming more popular on a worldwide basis, there will be a higher demand for new security solutions. Convergence is happening across industries and markets at a great pace and the security sector is no different from other infrastructure related markets such as energy and transportation. Technologies such as video surveillance, biometrics, and so on, are gradually changing the way intelligence is being gathered and processed. Without being noticed, CCTVs on the streets increase public safety through better surveillance.

Safer city solutions incorporate a wide array of technology. Integration and interoperability of various technologies is fundamental in obtaining better intelligence from various sources.

From CCTVs to crisis management centres, technology will act as a key enabler for law enforcement, emergency services and local decision makers to optimise their response to the expected and unexpected. With older technology reaching maturity new security solutions are implemented to strengthen city safety.

A new set of tools and technologies now exist to help city governments manage public safety and city services, improve management of city resources towards security and safety, share information effectively, manage data deluge, improve decision making and collaboration, develop smart innovation, deliver safer and more secure communities.

Given the complexity of a smart city, it can be represented using various models and modeling techniques and formalisms. Each of these models will represent a particular view of a smart city. A comprehensive modeling of a smart city needs to include different views. [3]

In what follows we present four relevant models for smart cities.

• **Domain Knowledge Model**

As the emergence of the requirement of building smart cities across many countries, the Domain Knowledge Model of smart city becomes necessary for two reasons. First, the aggregation of multi-source and heterogeneous data and service needs a set of unified concepts and terminologies. Second, the development of applications needs the support of common knowledge of smart cities.

The Domain Knowledge Model of smart city has abundant contents and involves many domains and cities. In order to support cross-domain and cross-city interoperation of knowledge, we should concise the common concepts and their relationship from domains and cities and construct a core concept model. Furthermore, the domain knowledge in smart city is abundant and complex. No single individual or organization can build it comprehensively and thoroughly. The model should use swarm intelligence to build it and the participants should work collaboratively. To support better cooperation, we should construct a standard and core concept model that can specify terms from different stakeholders, support semantic understanding and give standard knowledge expression [3].

This model aims to:

a) Support interoperation of cross-domain knowledge model:

The model provides a sharing model of common knowledge in Smart City's domains and supports interoperation among cross-domain knowledge model.

b) Support extension and customization for specific domains and cities:

The model only defines the cross-domain and cross-city core concepts and their relationships. It supports extension and customization for specific domains and cities to reflect their differences.

This model will apply to following circumstances:

— Support cities to build their own smart city Knowledge Model which processes specific city features.

— Support smart city related domains to build their own smart city Knowledge Model which has specific domain characteristics.

- **Data and Services Model**

Using the OSI2 (Open Solver Interface 2) as a template, a data services model would reflect the data, communications, service and application layers that are used by citizens, businesses, and city authorities. Such a model would provide an adequate technical view of and for a more general smart city model.

Given the complexity of a smart city, it can be represented using various models and modeling techniques and formalisms. Each of these models will represent a particular view of a smart city. A comprehensive modeling of a smart city needs to include different views.

As a system of systems, a smart city can be modelled using formalism described in Joined JTC 1/SC7 standards such as ISO/IEC 42010 Software and Systems Engineering –Architecture description or ISO/IEC 19505 Information Technology – Object Management Group Unified Modeling Language (OMG UML). [3]

The view on Fig. 3 put the emphasis on the concepts that characterize the smart cities.

The physical city is collapsed in the bottom layer and three characteristics of a smart city are expanded: citizen centric, digital and openness & collaboration. This view is well tailored to explain the characteristics of a smart city to city administrators and governors.

Citizen-centric refers principally to the accessibility of pertinent services to citizens and business in the city. The digital city is essentially the IT enabled connectivity and integration of the different elements and services of the city. Finally, the openness & collaboration characteristic, also IT enabled, put an emphasis on the elements that drive innovation, and thus competitiveness and economic growth in a city.

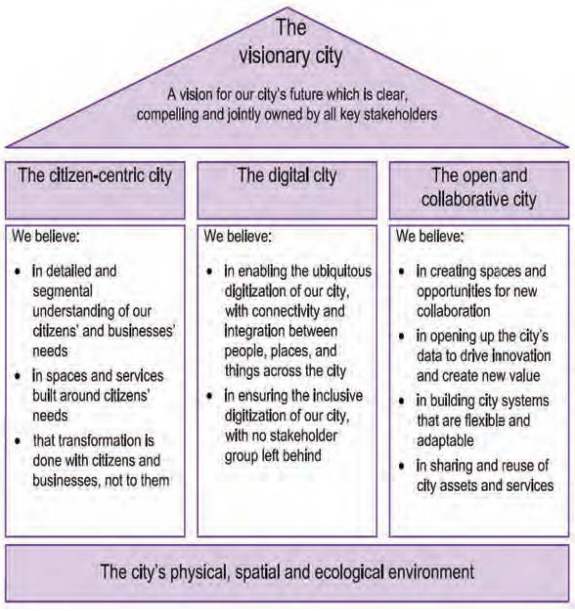


Fig. 3 *Smart city concepts and outcomes [3]*

We can also put the emphasis in a simple model on the system integration and synergistic characteristic of a smart city (see Fig. 4). Such a view not only illustrate succinctly the 'glue', or the system integration property that ICT provides in smart cities, but it also makes the contributions of JTC 1 very visible.

In this view, a smart city is presented as a combination of four Internets or networks: Internet of Data, Internet of Things, Internet of People and Internet of Services. [3]

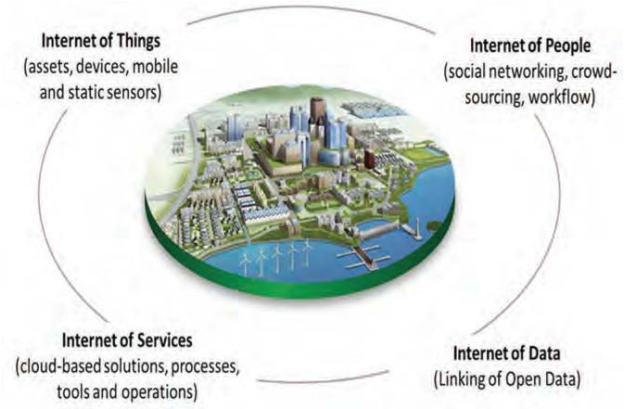


Fig. 4 *The smart city as a set of 'Internets' [3]*

- **Urban Information Model**

Could be viewed as a means to structure and classify the many different types of information contained or flowing in these networks. From an information technology point of view, it is helpful to think of the Urban Information Model as a very large number of layers representing a common two-dimensional space, the territory of the urban environment, whether that is a single city or a metropolis. Such a model is often instantiated in a Geographic Information System (GIS), however increasingly social networking tools are taking this model in new directions [4].

The groups of layers are:

1. The Natural Environment group including topography, flora and fauna, natural resources, geology, and so forth.

2. The Infrastructure group including the Built Environment (roads, bridges, tunnels, buildings, pipelines, electrical and communication lines, and so forth) as well as Things That Move (trains, boats, buses, and so forth) that is constructed on the Natural Environment.

3. The Resources group representing materials that originate in and eventually return to the Natural Environment after passing through various processes of refining and consumption in the Services group as well as capacities that are temporarily consumed.

4. The Services group representing many kinds of services, including transportation, energy, commerce, healthcare, and so forth. Many of these services consume or transform resources from the Resource group.

5. The Social Systems group, including the locations and Actions of people, such as commerce and culture, laws, regulations, governance, and so forth that exploit the Services and Resources from these respective groups. This group contains the topmost and most interesting layer in which we find the People Systems.

So the representation of an Urban Systems model takes place on these five groups of layers. The ordering of the layers is not important. The grouping of layers is also somewhat arbitrary, for example, some or all of the layers in the Resources group could well be included in the Natural Environment group.

Another basic concept is the Service. This is a very general concept and again may be simple or highly complex. Services are Things That People Interact With in the city, including other people or even oneself. Services often consume or transform Resources and always require some form of payment or exchange. The act of invoking a Service is called an Action, which is initiated by a person or another Service and is always either bi-lateral or multi-lateral.

In the topmost layer of the Urban Information Model are the People Systems. People Systems represent Processes For Things That People Do, whether in their work or in their private lives. A People System is a composition of Actions upon high-level Services to achieve some goal. [4]

- **Security- as- a-service and managed services**

Security-as-a-service (SaaS) is a fast emerging outsourcing model for security management and the technology is expected to play a significant role in the development of safer cities in the coming years. It may refer to security management provided in-house by an external organization.

Numerous security vendors are planning to leverage cloud based models to deliver security solutions. With growing interest from various security solutions providers, Frost & Sullivan expects this technology to fast catch up and witness significant growth in the coming years. [2]

Various types of SaaS are listed in Fig.5 below:



Fig. 5 *Safer cities market: security as a service [2]*

Following are some of the major drivers of the global SaaS market:

- Replacement of human resources
- Convergence of physical security
- Switch from CAPEX to OPEX
- Complexity reduction

Following are some of the major restraints of the SaaS market:

- Privacy and data concern
- Reduced control of security systems

3. Concluding discussion

Market value of smart city solutions is forecasted to reach $1.5 trillion by 2020. These tremendous figures create huge opportunities, both for smart city providers and local city authorities to deploy.

At a more general level, the growing effort to standardise concepts, such as smart cities, sustainable communities and eco-cities on the part of national agencies, professional bodies as well as voluntary organisations reconfirms the trend towards more ubiquitous approaches to urban design and planning. This is quite understandable, given both the challenges and opportunities of unprecedented urbanisation globally, and the related economic and technological potential. At the same time, one needs to be mindful of the limits of the technocratic language and use of standards, given the social, cultural and political plurality and diversity of cities and city life.

It is clear from the presented models that the 'smart' in the context of a smart city is ICT based and also that JTC 1 standards play a key role in the implementation of a smart city. It is also clear that building and operating a smart city is like building and operating an IT enabled organisation. As well, it is very visible that close cooperation with ISO TCs would be required given that the domain expertise lies there. Since it is difficult to communicate effectively without a common vocabulary, and even more difficult to develop IT system in such a situation, it is very apparent that a priority should be put on smart city vocabulary/ terminology and ontologies.

In a future research, to truly develop a market for the IT applications that will make a city 'smart', the ideal approach would be to develop a Reference Business Architecture.

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VELOCITY: A SYSTEM FOR A SMART BIKE MANAGEMENT

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Abstract: *The present paper presents the development of the VeloCity project which seeks to promote the cycling as a part of daily transport and recreation. One of the main objectives is integration of bicycle into urban multimodal mobility and urban planning and other relevant policy sectors where cycling plays an important role. For obtaining the goal a survey is conducted locally and via Internet and the results are analyzed; user requirements analysis is conducted through information resources study, and a number of user scenario are defined.*
Basic parameters of a smart bicycle are defined through summarizing the most interesting and useful user scenarios, applicable for more safety, flexible and comfortable cycling. The user scenarios are the base for hardware and software development for a smart bicycle, selection of proper technologies, building of a prototype and experimental platform for the smart system testing.

Keywords: VELO-CITY, INTERNET OF THINGS, SMART CITIES, SMART MOBILITY

1. Introduction

The aim of the present paper is to develop a model of a smart bike prototype and a system for smart bike management based on technologies of the Future Internet, in particular the Internet of Things (IoT). First, it has been built a prototype of the experimental platform for monitoring as well as a smart bike management.

Second, it has been built a prototype of a data analysis system, integrating the smart bike into a smart system for city transport management. The results from that activities are as follows:

- Analysis, design and development of a software and hardware;
- Prototypes of a web and mobile application

The specific goals of the present paper are:

a) to perform a basic analysis of the current situation in the field of smart bike systems in Bulgaria, EC and worldwide. Particular attention is paid to the analysis of the results of European research and innovation projects.

b) to analyze the users needs of smart bike systems, infrastructure and services (through surveys and based on information sources); system requirements definition for smart bikes; user scenarios definition and scenario selection which are meeting the actual situation in Bulgaria and the profile of the participating partners.

c) to organize an experimental pilot in a Living Lab of the system and to test and analysis of the prototype of a smart bike system with potential users participation, experimental results analysis and definition of ways for system improvement.

d) to analyse the results in Bulgaria, EC and worldwide so, to identify the issues related to integration of a Pan-European cyber-physical infrastructure and special services dedicated to smart mobility schemes that embed smart bikes.

During the development phase a research has been done on a dedicated Cloud platform based on open source components (Future of Internet enablers) giving possibility for analysis of open and big data. A prototype of a back office platform has been developed as well as a web application and a mobile application.

For the purposes of the experimental development, we make use of object-oriented approach for system modeling by using open source - Future of Internet (FIWARE enablers), for development of Cloud operating system, web and mobile applications, data bases, data analytics, development of a prototype of a device for data gathering and light signaling on the base of a hardware with open code – Arduino.

An agile approach (responsive design) for web application development has been applied, giving possibility for work with it on desktop, smartphone and tablets. A study of the concept is done, a reference architecture of IoT has been implemented and the advantages of the use of common reference model of IoT have been outlined. The research is based on open hardware as well as on the base of the Arduino platform for development of innovative agile solutions for smart bike. Components of the open hardware are Arduino plates, software, shields for communication, Ethernet with SD Shield, Wireless SD Shield, WiFi Shield, GSM/GPRS Shield, Shields and drivers for engine management. Special attention is given to the sensors for temperature measurement, humidity and pressure, sensors for orientation and acceleration, sensors for illumination measurement, colors and gestures recognition and noise measurement. A prototype has been built for data collection and light signaling on the base of Arduino.

2. Development methodology

The main purpose of the present research is to study the possibilities for development of hardware and software for a smart bike based on IoT and open source software and open hardware (Arduino). An approach of open innovation as well as methods and tools of living labs is applied. In particular, the experience of Virtech, living lab VirtSOI and of many others from the EU network ENoLL is taken into consideration (http://www.openlivinglabs.eu/).

The proposed system aims at designing and development of a prototype of light indicators and user interface of a software for monitoring and smart bike management.

The basic model of the smart sensor system includes a software and user electronics and aims at increasing the level of bike safety.

During the development of the present project a bike signaling system is built up. The team has built up a prototype on the base of a hardware with open source as well as a device for data gathering by intelligent sensors has been built.

The project team is focused on the application of modern and innovative approaches and solutions, as follows:

1. Application of the methodology of IoT.
2. Application of a hardware with open code – Arduino.

Nowadays the companies are facing the pressure for new technology implementation due to the massive penetration of information technologies in our day life. In the last years the mobile

devices, cloud computing and IoT are influencing the business processes through new business models, globalization and the ever increasing volume of processed information. Looking back at the evolution of the Internet we could see the great influence of connectivity over the society and organizations – from the email and web through the connected economy till entire e-business. This is followed by the real experience – social relationship in Facebook and LinkedIn. The next step is IoT where people, processes, data and devices are connected. Every building block in this structure has its added value – the right person or device has to receive the right information for a given process just in time. Data is transformed into a valuable information ready for analysis and decision making, and the devices are connected with each other through Internet for a better service sets.

The IoT builds out from today's internet by creating a pervasive and selforganising network of connected, identifiable and addressable physical objects enabling application development in and across key vertical sectors through the use of embedded chips, sensors, actuators and low-cost miniaturization.

IoT is the connection between autonomous computing devices through the existing Internet infrastructure. Communication between devices is done at a high level by means of a set of protocols, domains and applications. Thanks to that connectivity the automated processes are assured in almost all fields as well as smart applications are built up at a new level.

As identified by Atzori et al. [3], IoT can be realized in three paradigms—internet-oriented (middleware), things oriented (sensors) and semantic-oriented (knowledge). Although this type of delineation is required due to the interdisciplinary nature of the subject, the usefulness of IoT can be unleashed only in an application domain where the three paradigms intersect. IoT has been identified as one of the emerging technologies in IT.

The vision of IoT can be seen from two perspectives—'Internet' centric and 'Thing' centric. The Internet centric architecture will involve internet services being the main focus while data is contributed by the objects. In the object centric architecture, the smart objects take the center stage.

The devices can be with totally different application – devices for
heart rate monitoring, implemented in a pocket biochips, cars with sensors, etc. There are already smart thermostats and domestic devices with remote control. A study of Gartner reveals that till 2020 there will be 26 million connected devices. The integration of these devices with Internet is done through IPv6 protocol, due to the limited space of the IPv4 standard (up to 4.3 mil. IP addresses). The devices not only transmit data, but also can manage a particular activity (electrical bulbs, locks, etc.). Due to the character of these devices it is necessary to use platforms with lower energy consumption as the analysis of gathered data is done in dynamic computational data centers.

The proposed system VeloCity gives effective bike management through integrated multisensory software and hardware system for bike management and monitoring, user and traffic conditions. As well, it provides increased safety and enhanced communication with the other participants in the traffic through an effective light signalization.

Sofia is one of the cities which has a strategy and plan for bike transportation development. The present research is contributing to the project of bike transportation development on the territory of Sofia Municipality 2012-2017.
(http://www.sofiatraffic.bg/bg/cycling_not_working/340/plan-za-razvitie-na-velosipedniia).

Available on the market are protective helmets with smart signalization, smart lights for embedding the helmets, etc. Some other innovations do exist that have not yet been implemented in practice and need financing, for example: Helios Bars
(http://www.kickstarter.com/projects/kennygibbs/helios-bars-transform-any-bike-into-a-smart-bike), Velodroom's Smart Bicycle Light (http://www.kickstarter.com/projects/velodroom/velodrooms-smart-bicycle-light) or SMART - The world's first smart cycling helmet (http://www.indiegogo.com/projects/smart-the-world-s-first-smart-cycling-helmet). Although a significant research have been done so far in technology and in methods for similar systems for other transportation modalities, it does not yet exist an integral smart transport system for bike transportation in the world market. At a national and European level similar developments that have been implemented in practice are not yet available.

Existing alternatives on the market

So far there are several similar devices on the market like "LED Bike Turn Signal (in Amazon), "Bicycle Turn Signal Brake LED Light & Horn" (in SintekStore), Bike Light Kit (Global Murchants). [5]. What is clear is that after intelligent bracelets and smart watches it is time for the smart bikes.

Scientists from Massachusetts Institute of Technology have developed a particular system for smart bike (http://senseable.mit.edu/copenhagenwheel/), in which the bike wheel has a battery that saves the energy (produced by pedals) and can use it when one is cycling. This is a model of a hybrid bike for use in the city. Moreover, the bike is provided with a Bluetooth technology which allows the data exchange with smartphones and other mobile devices. By means of a special mobile application (iPhone) the bike could monitor the speed, direction, destination, road conditions, traffic, etc.

Another similar development is the social bike (SoBi Social Bicycle) of AT&T:
(http://www.att.com/att/InnovationStore/products/social-bicycles/#fbid=a5hRs1OKzMH). The social bike has to be available for everyone. It has an integral system for locking and GPS as well as mobile applications –bike booking (in a system for bike sharing), access to interactive maps, etc.
The project Instant Mobility (http://instant-mobility.org) demonstrates the need for city transport optimization through realization of multimodal transport scheme with IoT application and data in real time from the transport infrastructure, the public vehicles, citizens, open public data, etc. Bike are also an option, but real user scenarios and real experiments have not been done yet. The same holds true for the projects from the 7FP program: TEAM (http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=13355104) and WISETRIP (http://www.wisetrip-eu.org/).

The system VeloCity has several substantial advantages in particular, the utilization of IoT and infrastructure based on big and open data (big/ open data) in the transportation field. Besides, the system is based on innovative model for multifunctional (prefabricated) bike. The system is applicable also in the fast growing segment of electric and hybrid bikes: (http://www.treehugger.com/bikes/closer-look-smarts-award-winning-ebike.html).

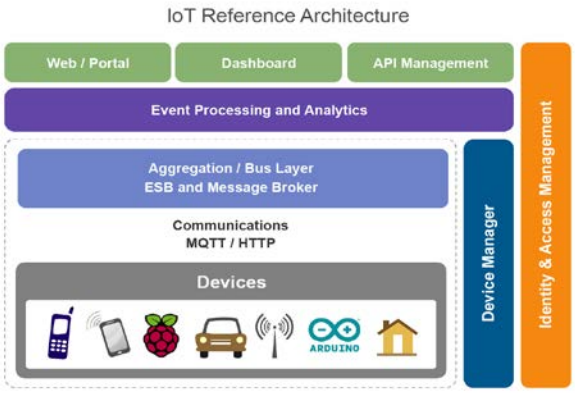
According to Pike research, the world market of e-bikes is increasing with a rate of 7.5% in the period 2012-2018, and will reach sales more than 47 million bikes per year 2018. In the present research the experience of Virtech LtD. in projects from FP7 ICT-2011.11.3 "Experiential Living Labs for the Internet Of Things" - ELLIOT is also taken into account. [6]

2.1 Reference Architecture of Internet of Things

The advantages of common reference model of IoT are as follows:

1. The architecture enables the discussion as it gives the participants a language to communicate that everyone could understand and that is interiorly connected with the architecture, systems, and the environment of IoT.
2. There is a view from a higher level so, it gives a broad view to the environment. This could help users who are new to this area to find their way and to understand the specific characteristics of IoT.

3. The reference architecture of IoT can help project managers in the field of IoT to plan activities. For instance, the groups of functions identified in the functional view of the reference architecture could be used as a base for team tasks definition.
4. The reference architecture of IoT makes possible the identification of structural components of IoT systems. This gives valuable information when we deal with system modularity, processors architectures, options of third party providers, reuse of already developed components, etc.



On Fig. 1 is shown a reference architecture of IoT.

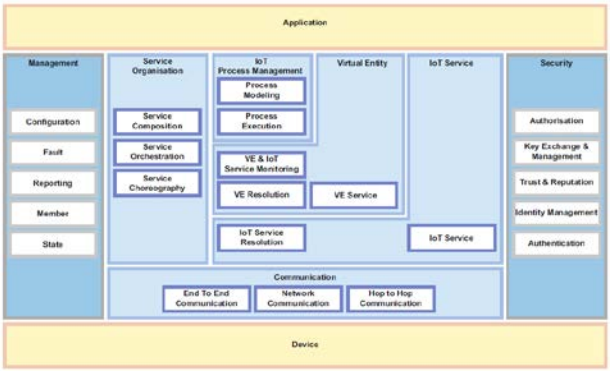


Fig.1 *Reference architecture of IoT*

Platform architecture

The architecture which enables data exchanged between user and the platform is connected through Internet and in particular by means of the architecture type client-server. There is one basic server with a data base and several other servers which makes use of one and the same data base. They give to the users content in the form of a web site in Internet. The users could communicate with the system (platform) by means of Internet browser and connection to Internet. The type of user devices (desktop, laptop, smartphone, tablet) has no particular importance (see Fig. 2).

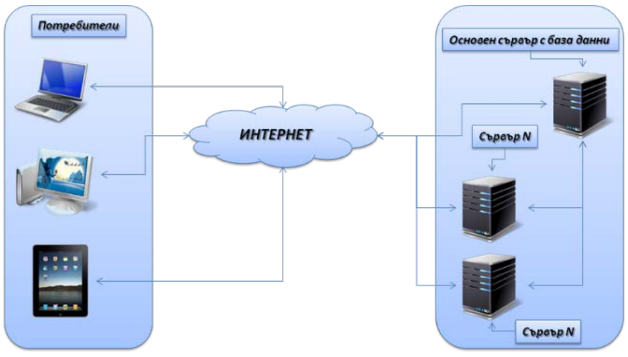


Fig. 2 *Arduino platform architecture*

Hardware with an open code. Arduino platform

Arduino (Fig. 2) is used in many education programs worldwide, in particular from designers and painters who would like to create prototypes, but they do not have to know more about the technical details beyond their developments. As this platform is dedicated to people who do not have any experience with programming and technical questions, the software includes variety of tools on the platform [1].

Arduino is an open code platform suitable for wide range of projects. The controller is able to extract data from different sensors, for instance for light, sound, temperature and finger print as well as to transform the enter data into input data, engine ignition, lights or to publish something in Internet, to send a message to a smartphone, many other examples do exist. Besides sensors and moving mechanisms (like electromotor, LEDs, piezo speakers, etc. [1], Arduino could communicate on both sides having software programs as Flash, Pure Data (PD), Processing, etc. Developed in a learning environment, the platform Arduino not only includes plate, but also includes a programming environment (IDE) easy for use and very suitable for ones who are new to the robotics and interactive projects. Although it is very easy for use, Arduino is very powerful platform with thousands of applications which makes it the most popular among “do-it-yourself’ enthusiastic in the world for the last years [4].

It is used for various projects as: controllers for computer games; robots, automation of buildings, monitoring and safety system, board computers. Arduino is different from the rest of the platforms on the market with the following:

- the platform is developed in a learning environment which makes it ideal for quick understanding by a beginner.
- it works under different operation systems– Windows, Mac and Linux.
- the programming environment is based on the Processing language, under the project Wiring.
- the programming is done not by serial port, but by means of USB cable. This is particularly useful, because most of the recent computers do not have serial port.
- the software and hardware are open code – one can download the scheme from the website of Arduino, buy the parts and assemble the plate by himself, without paying to the developers of Arduino.

The programs in Arduino are written in C and C++. The development environment Arduino has software library called „Wiring (See Fig. 3).

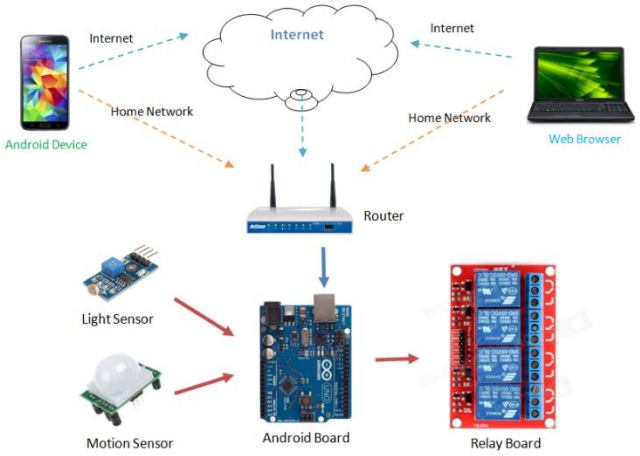


Fig. 3 *Configuration based on the Arduino platform*

3. Concluding discussion

Based on the present study some conclusions can be drawn, as follows:

1. The application of IoT as a most recent paradigm for collecting big data in real time is applicable in a system for smart bike.
2. The use of hardware with open code – Arduino - allows for quick prototyping of wide range hardware, realizing the paradigm of IoT.

The future research direction of the present study are:

1. Development of the platform on the base of IoT.
2. Development of a device for data gathering, which could communicate with a smartphone through Bluetooth protocol.
3. Further development of the light signalization and custom design of the plate for building up in a lighting body.

The web application VeloCity is used for giving geographic location and pulse of the user. The application could send in real time the location and pulse in the data base by means of Internet connection of the mobile device.

The present prototype is a system for data analysis and information necessary for the integration of the smart bike in a city transportation management system.

The performed study and analysis of the user experience and requirements are the base for building up the experimental environment and identifying indicators to be measured.

The platform performs the following analyses:

- Analysis of data relevant to the cyclist's behavior.
- Analysis of data relevant to the functional condition of the cyclists.
- Analysis of data relevant to the cyclists' environment.

Bike-sharing programs have expanded rapidly throughout Europe in recent years as cities search for ways to increase bike usage, meet increasing mobility demands and reduce adverse environmental impacts. The introduction of smart technology has resolved many of the vandalism and theft problems of earlier bike-sharing programs and has made bike sharing popular and trendy, especially among younger users. The bike sharing can be fully integrated with other transport modes by adopting a single smart card ticketing system for instance. A key ingredient for success in any city is the availability of an extensive and continuous bike lane/path or car free network. Equally important is the combination of a bike friendly topography and climate [7].

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Mechanisms for measuring output power and power spectral density of a transmitter in a WiMAX radio network

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Abstract: *The report examines current problem in wireless WiMAX networks, namely the possible ways and mechanisms to measure the output power and power spectral density of radio transmitter. The purpose of measurement is to determine the maximum output power of the transmitter is within the manufacturer's declared value with a certain tolerance set by EN / ETS and does not exceed the maximum limits. Also to measure or calculate the power spectral density of radiated power in the frequency channel with a specific width. The following parameters must be measured in full and coordinated load of the transmitter. These are the key parameters needed to research for the effective design of broadband WiMAX wireless data system.*

Keywords: WIMAX, MEASUREMENT, POWER, SPECTRAL DENSITY, RADIO TRANSMITTER.

Introduction

In a study of wireless networks for data broadcasting are considered and measure key parameters to evaluate the technical condition of the radio network.

Measurements of the parameters of transceiver equipment are divided into two types:

A) Measurements in the transmission part

- Transmitting power;
- Spectral mask of radiation;
- Signal level at any point of the coverage area;
- Side lobes in the transmitter;
- Instability of the frequency of the transmitter;
- Automatic power control of the transmitter;
- Remote control transmitter power;
- Automatic control of the frequency of the transmitter.

B) Measurements in the receiving section

- Receiver sensitivity;
- Resistance to interference in the same and adjacent channel;
- Side lobes in the receiver;
- Ratio of digital error (Bit Error Ratio, BER) as a function of the input signal.

To the listed parameters in the transmitting and receiving part can make the following clarifications:

The output power of the transmitter is measured as the transmitter is loaded with coherent load instead antenna system. Defines the minimum and maximum output power and the manufacturer of the equipment must be specifically asked the acceptable range of change of power.

Signal level at a point of the coverage area is measured to determine the power spectral density where it is needed. This measurement is required by the standards set in the license for "point-to-multipoint" wireless broadband data systems.

1. Parameters to measure

Manufacturer must declare the maximum rated output power for every base station. Have to be declared and the number of carrier frequencies N (respectively transceivers) to the base station, each of which can be modulated with the maximum speed of the digital stream at the same modulation scheme. The following parameters must be measured in full load of the transmitter. Each carrier, modulated with a specific modulation should broadcast signal power equal to 1 / N of the maximum rated power declared by the manufacturer. The transmission capacity of the base station should be divided equally between carriers.

1.1. Output power of the transmitter

Definition: The average power measured when the transmitter output is connected to the coherent absorbing load or antenna (with directional coupler - if you have access to output). The measurement is performed with a power meter or spectrum analyzer.

Objective measurement: To establish that the maximum output power of the transmitter is within the declared of the manufacturer value ± a certain tolerance (set by EN / ETS) and does not exceed the maximum limits set by EN / ETS.

Standard of the measurement: The measured maximum power at point must not exceed 35 dBm according to standards EN 301 021 and EN 301 080 of ETSI. The tolerance of this value for point-to-multipoint systems operating at frequencies below 11 GHz is ± 2 dB according to EN 302326-2.

Measuring staging:

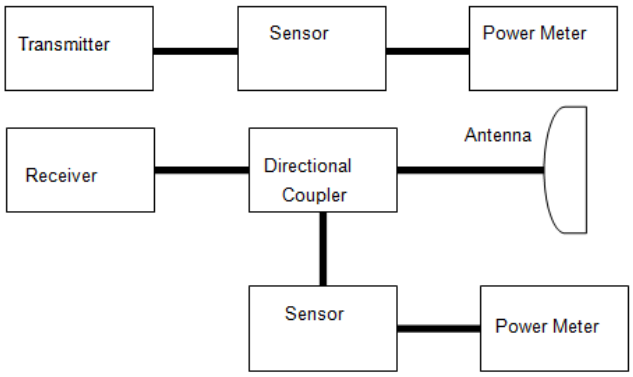


Fig. 1. *Measuring staging for determination of output power of the transmitter*

Measuring procedure:

a) FDD mode

1) The carrier frequency of the transmitter modulates with a signal representing normal traffic situation under conditions of traffic load and services.

2) The power level of the transmitter is set to the maximum possible value (with switched on Automatic Transmit Power Control - ATPC).

3) Measure the average value of the power

b) TDD mode

1) By attenuator the output power of the transmitter is fed to a diode detector (the measuring probe), which represents the measuring sensor head of the power meter.

2) The combination of detector measuring sensor and the power meter must be able to reproduce faithfully the duty cycle of the signal, which represents the period of time - Tx_{on}, in which the transmitter radiates to the overall period of time - $Tx_{on} / (Tx_{on}+Tx_{off})$, which includes the period when signal is not radiating. The observed segment of the operating cycle is marked by x, where $0 < x \leq 1$.

3) The maximum output power of the transmitter is defined using a broadband combined spectral analyzer with a coherent detector with thermocouple. The measured value is indicated by A.

4) The maximum Equivalent Isotropic Radiated Power (EIRP) is calculated by using x and A according to the formula:

$$EIRP\ [dBm] = A\ [dBm] + 10lg\ (1/x),$$

and when it is necessary to obtain EIRP after transmitting antenna with gain - G, is worked by the formula:

$$EIRP\ [dBm] = A\ [dBm] + G\ [dBi] + 10lg\ (1/x).$$

1.2. Power Spectral Density

Power spectral density (PSD) is a parameter that allows comparing power levels of the frequency transmit channel with different bandwidth.

Definition: The power level at a point, normalized to the channel with a single specific bandwidth. As the WiMAX "point-to-multipoint" systems the bandwidth of the transmit channels is measured in MHz, then the power spectral density is normalized to a bandwidth of 1 MHz.

Objective measurement: To measure and / or calculate the power spectral density of radiated power in the frequency channel with a specific bandwidth.

Standard of the measurement: For broadband "point to multipoint" systems in the 3.5 GHz, the standards for power spectral density are presented in Appendix 2 to the individual license of "point to multipoint" systems. For systems that use unlicensed frequency band 5.8 GHz, General License № 220 defines the following technical specifications as standards for EIRP and power spectral density:

Table 1. *Technical specifications for EIRP and power spectral density*

Channel bandwidth	Maximum average power at the antenna input, dBm	Maximum EIRP, dBm	Maximum average spectral density of EIRP, dBm/MHz
10 MHz	27	33	23
20 MHz	30	36	23

Measuring staging:

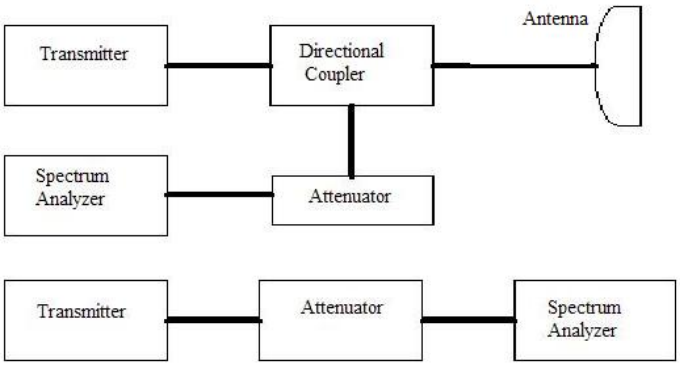


Fig. 2. *Measuring staging for determination of the spectral density of radiated power*

1) The transmitter is connected to the measuring equipment through an attenuator to the spectrum analyzer.

2) In the spectrum of the signal you need to find the frequency of the highest level. The settings of the spectrum analyzer must be as follows:

- *Resolution of 0.3 kHz*
- *Video bandwidth - 0.3 kHz*
- *Span - 1.5 times greater than the the width of the emitted spectrum range.*

3) Records found frequency with the highest level.

4) The center frequency of the spectrum analyzer is set to

the recorded frequency. The span is reduced to 1 MHz and then frequency with the highest level must be located.

5) If the frequency is different from that already written, it must save the new frequency.

6) The center frequency of the spectrum analyzer is set to the found frequency and switches to zero range of span i.e. signals are viewed in their original form. The power indicator of a spectrum analyzer displays the measured power density D.

7) For a TDD equipment an average spectral density PSD of EIRP is calculated from the measured density D and the observed duty cycle **x** on signal:

PSD [dBm/ MHz] = D [dBm/1 MHz] + 10lg (1/x).

When it is necessary to obtain the average spectral density of the EIRP of the output (aperture) of the transmitting antenna gain Gt, working according to the formula:

PSD [dBm/ MHz] = D [dBm/1 MHz] – L_a [dB] + G_t [dBi] + 10lg (1/x);

With L_a is indicated overall attenuation in attenuator, directional coupler and feeder. It is possible to measure the power spectral density to be done with a device that does not have the option of measuring this parameter - for example, with a simple power meter.

Then the value of the PSD is obtained from the measured power level to the following formula:

PSD [dBm/MHz] = P_r [dBm] – 10lg {BW [MHz]} – L_a [dB] + G_t [dBi],

where P_r is the indication of the unit, *BW* is frequency channel bandwidth and the passing of [dBW] to [dBm] and back, is used dependence:

P [dBW] = P [dBm] – 30.

Bandwidth of channel is default and can be one of the following:

- 1.75 MHz;
- 3.5 MHz;
- 7 MHz;
- 14 MHz

(it is selected when the operator planned the network depending on how many subscribers are serviced in that sector and available services).

2. Conclusion

WiMAX broadband data radio systems are an important part of mobile communications, contributing to the development of applications in the sector and increase the opportunities for end users. Gradual, new technologies and standards concerning to improve the quality of services, security and reliability of networks. The report presents an actual problem of possible approaches and mechanisms to measure the output power and power spectral density of radio transceiver of WiMAX broadband data radio network.

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APPLYING PRODUCTION RELATED KNOWLEDGE WHEN ANALYZING HEALTHCARE PROBLEMS USING SIMULATION APPROACHES

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Abstract: *The focus of this paper is the knowledge gained from the engineers when solving production related problems and how this can be utilized when solving issues in the healthcare. Based on this, a research has been made where engineers have conceptualized and developed a simulation model for one polyclinic using real data. The simulation model is a hybrid one using Discrete Event Simulation and Agent Based Modelling approaches. It is created applying the basic principles of the queuing theory that is unavoidable even in the simplest production systems. The model simulates the patient flow in the polyclinic. By using experiments and analysis, what is the ideal number of resources with whom the waiting time of the patient would be under a certain time limit is suggested. This research showed that the possibilities of the application of simulations in healthcare and the benefits of their use are endless.*

Keywords: simulation, model, healthcare, discrete event simulation, agent based modelling, hybrid model

1. Introduction

Interdisciplinarity is becoming a very usual thing these days. Already found solutions in one industry/field are being translated in completely different one – and this has proven to be working. In this way the already gained experience and knowledge is being further enriched and resources for new research are being reduced. The paper consists of overview of the healthcare industry, given through the eyes of the engineers, using their experience from the manufacturing industry.

Why the healthcare industry? The spending of one country for the healthcare has some really big numbers: OECD countries 8.9, USA 16,4%, Japan 10,2% etc. [OECD statistics 2013]. All have dramatically increased since 2000 by nearly 50% for each country, no exception. Meanwhile, the life expectancy for one population is not proportional with the expenditure in the health sector. Here, Switzerland, Spain and Japan top the list. Some call it "the largest industry in the world". These are one of the reasons why this industry has drawn a lot of attention, especially from experts outside of it.

Employment opportunities for Industrial Engineers in Healthcare are enormous. Healthcare is the largest and fastest-growing industry in the United States. According to the U.S. Department of Labor, wage and salary employment in the healthcare industry is projected to increase twice as fast as all industries combined through 2016. Hospitals, healthcare consulting companies, medical device manufacturers, and healthcare information technology firms, etc. are looking to Industrial Engineers to help them get their share of this growth in a cost-effective, well-coordinated, patient oriented, and profitable fashion, (n.a., 2012).

2. Industrial Engineers in Healthcare Management

In the recent decades, the healthcare management has been seen as a very interesting field for the industrial engineers (IE). The Institute of Industrial Engineers <www.iienet.org> have classified Healthcare Management with the same importance as Lean & Six Sigma, Supply Chain Management, Ergonomics, Quality systems etc. Some universities have a special IE curriculum for Healthcare management, e.g. TU Eindhoven <www.tue.nl>, School of Industrial Engineering at Perdue University <engineering.purdue.edu/IE>; at UW-Madison College of Engineering more than a half of the professors in the department Industrial and Systems Engineering conduct some kind of healthcare research <www.engr.wisc.edu/ie>.

The interest for this research sparked when a presentation was found titled "Operations Research in Health Care or Who Let the Engineer Into the Hospital?" by Michael W. Carter from Mechanical and Industrial Engineering, University of Toronto. IE helps integrate people, equipment, facilities, and other resources to improve work results. An IE uses skills learned in IE (Process Design, Flowcharting, Layout Optimization, Forecasting Methodologies, etc.) and performs cost-saving & quality improvement projects, (Salvendy, 2001). When talking about engineers in healthcare, there are plenty of areas to be included, but generally the term "optimisation" should be the umbrella above all. Optimising the cost per visit or on annual level; maximising the quality of life, service.

According to (Linenberger, 2015), facilities that have incorporated management engineering in their pre-design and design stages enjoy substantially lower operational costs across the board, particularly in personnel, equipment and supply utilization. Process engineering techniques are becoming increasingly popular in the conceptualization, pre-design and design of new hospitals across the USA. Some hospital facilities use multiple methods and employ management engineers on staff to support implementation, while others are using a hybrid approach. "Engineering methodologies… such as Lean and Six Sigma… have radically improved manufacturing in the last few decades; there is no comparison to what manufacturing was like before they were developed. As our economy spends more money on healthcare, both in absolute terms and relative terms, it is becoming extremely important to streamline our health systems and delivery utilizing these methods," - Hari Srihari, PhD., Chairman of Systems Science and Industrial Engineering, State University of New York at Binghamton.

Healthcare engineers are engaged in knowledge and hypothesis generation, predictive modelling, decision sciences, robust device design, and optimization – all of which should be very familiar to the Industrial Engineering. In addition, Healthcare engineers develop computational algorithms to implement the tools and calibrate them to healthcare data. This multidisciplinary field integrates knowledge from a variety of different areas, such as computer science, communication, public policy, management and all aspects of industrial engineering.

Apart from the positive sides of why an IE fellow should engage him/herself in healthcare management, there is also a study whit astonishing results, (Schuster, McGlynn, & Brook, 1998). The survey indicates that 30% from the patients with acute illness and 20% from the patients with chronic illness received contraindicated treatments. Inadequate levels of safety and inconsistent quality result from clinical uncertainty which in turn results from an increasingly complex healthcare environment, rapidly exploding medical knowledge, lack of valid clinical knowledge (poor evidence) or over reliance on subjective judgment.

Some of the projects that are stated and can be useful for the healthcare, but run by industrial engineers are Emergency Department Simulation, Patient Centered Care, Queueing model for CBS blood inventory, Clinical Managers workload measurement,

OR scheduling & peri-operative simulation, Fracture clinic scheduling, Diagnostic imaging scheduling, HIV/AIDS funding allocation in Africa, Bed allocation, Ambulance drop-off delays, Surgical equipment processing, etc.

Simulation modeling offers significant advantages in that making the model, and analyzing the problem with the aim of better understanding it, does not rely on the initial collection of data. As such, it offers considerable benefits for those involved in the decision-making process. Expert opinion is used to first establish the relationships which, in this study, concern the treatment and side effects and recurrences after treatment. Analysis can then be used to better understand what data does, in fact, need to be collected at a later stage. It also allows analysis and exploration of different decisions, and the impact of these decisions on future action. Simulation allows for discussions of 'better' solutions to the given probabilities, taking into account the previous history and or facts. It allows for identification of the key variables early in the process, and as such is a powerful tool to aid decision making. The wide range of durations of health states suggests that a discrete event simulation approach is an appropriate choice. Similarly, the fact that health state changes on the basis of patient history means that a modeling technique that can represent this is desirable. Again, discrete event simulation modeling appears to satisfy this requirement. Another factor in the choice of discrete event simulation modeling to support economic evaluation is the sophistication of software that exists to implement and experiment with such models.

Discrete event simulation is one of the most widely used operations research method in healthcare and its usage has increased over the years indicated by literature survey articles by Jun (1999), Gunal (2010) each citing more than 100 articles that use discrete event simulation modeling in healthcare. Roberts (2011) recognizes that in healthcare it is often difficult to define a single performance characteristic. Especially in healthcare further investigation is often needed to understand how a change in the process leads to downstream impact. Hence simulation is considered an ideal technique to be used. Literature also indicates that most researchers find value in using discrete event simulation to validate process improvement or re-engineering efforts as well as to provide support for operational decision making in relatively confined environments such as outpatient clinics, call centers, pharmacy, ICU, and Emergency Departments. Most simulation modeling literature describes the process of conducting extensive scenario analysis to find an optimal balance between staff, capital and facilities/equipment (Mustafee 2010, Caberara 2011). However, there are several potential disadvantages of resorting to iterative analysis that is required by simulation. Law and McComas (2000) pointed out that one of the problems with simulation is that historically it wasn't considered an optimization technique. The inability of simulation to provide a single optimal solution, unlike other analytical modeling approaches, is not always appealing to customers or decision makers. The trial and error method is time consuming and decision makers particularly in healthcare; do often not appreciate tedious iterative review of output data. (Lowery 1996). In addition, Wilson (1981), Lane (2003), Brailsford (2009) point out the conundrum of implementing the simulation results in practice and highlight that model turnaround time and accuracy play a significant role in gaining customer buy–in, which suffers in the iterative approach. In order to take advantage of the benefits of computer simulation modeling while trying to avoid some of the tedious nature of choosing the best solution or policy using a set of candidate parameter settings(inputs) we explore the nature of simulation based optimization in healthcare problems. Simulation based optimization is an emerging filed that integrates optimization into simulation analysis. Although this technique has been applied in other industries (Law 2000, Jung 2004, Schwartz 2006), simulation still not very popular in healthcare. Recent examples of application of this method in healthcare include study of Sundaramoorthi (2010), where this technique was used to plan nurse resource allocation to patients based on workload needs. Ahmed (2009) used simulation based optimization to design a decision support tool to determine the optimal number of doctors and other staff to maximize the number of patients seen. Most recently, Zhang (2012) applied this integrated approach to determine the staffing requirements of a long term care facility. With the continually increasing ability of computers to run complex simulations in a reasonable time and the rise in optimization algorithms, along with the fact that most discrete event simulation vendor packages are now offering this capability built into their simulation tools; the ability to perform simulation optimization is becoming a more a viable method of analysis.

Brailsford (2007) defines three main types of models in healthcare: human body modelling, operational models and strategic, system level models. The model presented in this study involves primarily operations modelling, but consists of strategic modelling as well.

3. Research Model

Due to the type of the polyclinic, and the analysis made, the simulation model consists of five different sections: general practice, dental medicine, radiology, gynecology and laboratory. These were found to be of most importance for the general management. The methodology from (Banks, 1998) was utilized in order to create the model.

Figure 1 presents the patient flow for the general practice treatment. It encompasses activities such as entering the polyclinic, waiting, administrative procedures, walking, treatment, finalizing the appointment, etc. Much of these activities are parallel to a production process where a part (material) has to be taken from a storage, identified through the information system, pass through several operations, waits for a machine to be idle, be entered in a finished parts storage and be identified there, etc. Sub-models for the other four treatments were developed as well and combined in a final model. This one was laid over the general map of the polyclinic and the flow of the patients was modeled.

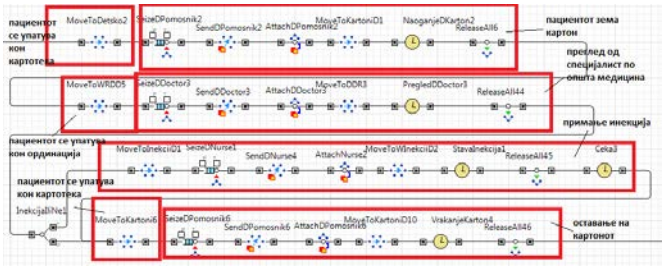


Fig. 1 *Model for the patients seeking general practice treatment*

The idea behind this model was to see the effectiveness of the polyclinic. What was measured? These three indicators where crucial for the outcome of the simulation project:

- Resources' utilization,
- The time the patient spends in the polyclinic and the
- Waiting time of the patient.

Through simulation modelling and experimentation, the goal was to develop different feasible scenarios, analyze them and choose the optimal set of parameters for the polyclinic. By parameters we mean number of doctors, number of assistants and number of offices.

It was decided that no patient should wait more than 3 minutes. In addition, for every treatment, a scenario of epidemics was modeled, increasing the patient number by 50%, thus giving the polyclinic a stress test. The later was modeled so that we can compare if the suggested parameters are suitable even in uncomfortable situations for the polyclinic. Figure 2 presents the result analysis for the general practice treatments. The upper part is

for the normal conditions and the lower part when there is an epidemics. In both cases, the waiting time is much lower than the goal (58 s and 68 s, compared to 180 s). Parallel to that, the utilization of the doctors is around 80%, and for the nurses that assist them is around 85%. The same kind of analysis is performed for very treatment, with every change of the parameters (Table 1).

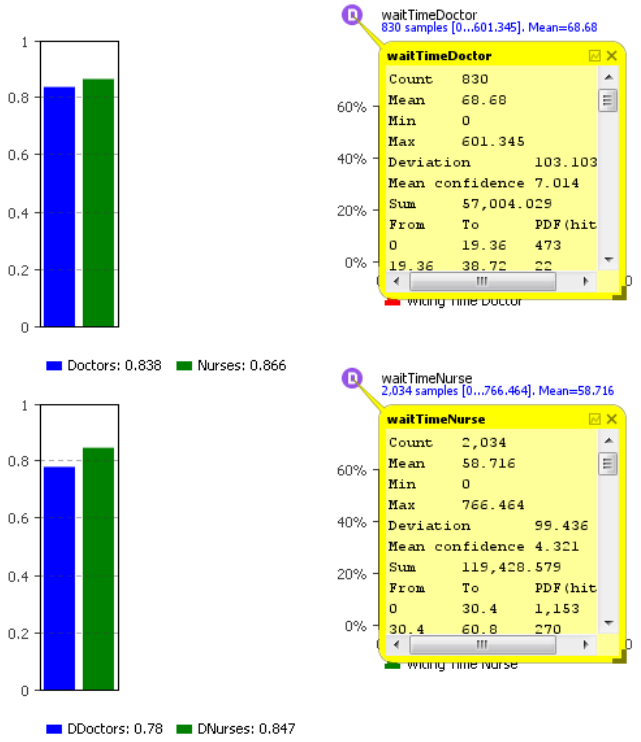


Fig. 2 *Output data from a single simulation run for the general practice (normal conditions and with epidemics)*

4. Results of discussion

Table 1 presents the results from the experiments and through it the discussion about the solution will be presented.

For the general practice treatments it was concluded that reducing the number of doctors from 13 to 12 will still leave the patients waiting under 3 minutes. Further reducing the number of doctors will generate results above the desired level. The patients going to the gynecologist will still have to wait longer because increasing the number of doctors and their assistants is not effective due to the fact that their current utilization percentage is only 33 %. That is why for these treatments it is suggested that there should be a scheduling mechanism implemented where each patients comes at a previously booked appointment. For the radiology department, it is suggested that the second assistant is not needed and even without him the defined goals will be met, without disturbing the utilization percentage too much. In the case of the laboratory and when there is epidemics, increasing the number of specialists will ensure stable work and waiting time for the patients that is still under the level of three minutes. For the patients asking for dental care treatment, who wait the most, adding another office with doctor and nurse does not solve the problem completely (460 s waiting time). In normal cases, another office should be added, but due to the limits in space in the polyclinic that is not possible and five is the maximum number of offices that can be allocated for the dental medicine. Here, like with the case of the gynecologists, scheduling the patients could solve the problem.

Table 1: *Detailed analysis of the performed experiments (the parameters of experimentation and the results).*

Experiment	Department	Epidemics	Number of			Utilization (%)		Mean waiting time for the patient [s]
			Spec.	Ass.	Office	Spec.	Ass.	
Normal conditions	GP (specialists)	no	13	13	13	54	/	22,5-
	GP (assistants)	no	13	13	13	/	58	14,3
	Dental medicine	no	4	4	4	69	69	814
	Radiology	no	1	2	1	39	6	36,8
	Gynecology	no	1	1	1	33	33	389,3
	Laboratory	no	2	4	1	66	42	35,2
GM with epidemics	GP (specialists)	yes	13	13	13	81	/	68,6
	GP (assistants)	yes	13	13	13	/	85	58,7
GP with 12 offices	GP (specialists)	yes	12	12	12	84	/	103
	GP (assistants)	yes	12	12	12	/	89	83,4
GP with 11 offices	GP (specialists)	yes	11	11	11	87	/	186,2
	GP (assistants)	yes	11	11	11	/	91	224,1
Radiology with 1 assistant	Radiology	yes	1	1	1	48	16	80,48
Laboratory with epidemics	Laboratory	yes	2	4	1	78	54	572
Laboratory with 3 spec.	Laboratory	yes	3	4	1	58	59	148,2
Dental medicine with 5 offices	Dental medicine	no	**5**	**5**	**5**	66	66	460

5. Conclusion

This paper gives an overview of how to deal with healthcare problems, from an Industrial Engineer perspective. The knowledge gained in solving production related problems, can be utilized when solving problems in this industry. Although many tools and approaches were mentioned, the authors focus on simulation and its application in the healthcare management. At the end, a brief overview has been given of the pilot research project of this kind.

With the simulation project, the work of the polyclinic was analyzed through the utilization of the staff, waiting time of the patients and the time the patients spend in the polyclinic. Using the results from the experiments, a set of different scenarios were developed by changing different parameters and an optimal number of offices, doctors and assistants were suggested.

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STUDY ON THE PROPERTIES OF DYED WITH REACTIVE DYES OFFSET PRINTING PAPER

ИЗСЛЕДВАНЕ НА СВОЙСТВАТА НА ОБАГРЕНА С РЕАКТИВНИ БАГРИЛА ОФСЕТОВА ХАРТИЯ ЗА ПЕЧАТ

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Abstract: *The amount of paper dyed is increasing each of the last few years, mainly because the increasing consumption of corrugated board papers. Paper is colored by dyes of different chemical nature – inorganic pigments; synthetic organic pigments; basic, acid, direct dyes and others. The reactive dyes are capable of forming covalent dye-polymers bonds, for instance, with the hydroxyl groups of cellulose. In this experiment are being used two laboratory synthesized reactive dyes, derivatives of chlorotriazine and one of them contains a stabilizer fragment. Dyes are used in the composition of offset printing paper with a fiber content of bleached softwood and hardwood pulp in a ratio of 1:1. The paper is sized with alkyl ketene dimer and as filler is used natural calcium carbonate. The strength and hydrophobic properties are being examined. The optical properties are also been examined before and after accelerated thermal ageing of the resulting paper samples and it is being found out that the examined dyes can be of an interest for an industrial production.*

Keywords: OFFSET PAPER, CHLOROTRIAZINE DYES, REACTIVE DYES, OPTICAL PROPERTIES, STRENGTH PROPERTIES, ACCELERATED THERMAL AGEING

1. Introduction

Dyes are widely used in many industries such as textile, paper, plastic, cosmetic and food manufacturing for coloring of their products. Economic and environmental aspects made the world`s paper production change to colored products manufactured from pulp with high content of recovered paper as well as mechanical pulp grades. The amount of paper dyed is increasing each of the last few years, mainly because the increasing consumption of corrugated board papers. According to Smithers Pira, the paper and board demand in the region of Central and East Europe, is expected to increase with about 2 million tons during 2014 to 2019 and not a small part of it is colored paper [1].

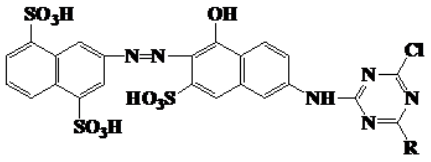
The paper manufacturing process is a complex technology considered of the following stages: preparation and refining of fiber semi-finished product, paper stock preparation, forming of a paper sheet material in the five main sections of the paper machine – head box, wire section, press section, drying section and the tambours with the produced paper. Paper is colored by dyes of different chemical nature – inorganic pigments; synthetic organic pigments; basic, acid, direct dyes and others [2,3]. The most commonly used method for dyeing of the paper is by adding the dye solution into the paper suspension before the paper web is formed. The advantage of this method is adsorption of dye molecules on the entire surface of cellulose fibers and the end result is entirely dyed paper.

The reactive dyes are widely used for dyeing of textile. By reactive dyes the following fibers can be dyed successfully: cotton, rayon, flax and other cellulosic fibers; polyamide and wool fibers; silk and acetate fibers but they have only limited use in paper. They have been tested in the late 1800s [4]. The first reactive dye is synthesized by IG Farben in 1932, but it first appeared commercially in 1956, after their invention in1954 by Rattee & Stepheness at the Imperial Chemical Industry (ICI), Dyestuffs Divion site in Bleckley, Manchetor, UK [5,6]. The reactive dyes are capable of forming covalent dye-polymers bonds, for instance, with the hydroxyl groups of cellulose [4]. In the last few years some experiments are carried out for dyeing of paper.

The purpose of the present study was to investigate the suitability of dyeing of offset printing paper with two laboratory synthesized reactive dyes and their effect over the main paper properties.

2. Materials and methods

The investigations are being carried out with laboratory obtained paper samples (70g/m^2) from bleached hardwood and softwood pulp in proportion 1:1, with beating degree 42°SR (Schopper Riegler). The paper samples are being sized with Alkyl Ketene Dimer (AKD) – 2% from o.d.f., filled with natural calcium carbonate ($CaCO_3$) – 20% from o.d.f. and as a retention additive (RA) is used modified poly acryl amide with cationic charge in consumption 0,05% from o.d.f. The two examined dyes are laboratory synthesized red reactive dyes, derivatives of chlorotriazine, one of which contains a stabilizer fragment (Fig.1):



R = - NH$_2$ - Reactive Dye 1

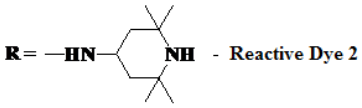


Fig.1 *Chemical characteristic of reactive dyes*

The consumption of Reactive Dye 1 (RD1) and Reactive Dye 2 (RD2) in the paper is 0,2%, 0,4%, 0,6% from o.d.f. For straightening out the interactions, the Dewatering time of paper furnishes were determined for 700ml, s. by Schopper Riegler method. The white waters are also being studied:

- Turbidity – NTU nephelometric acc. ISO 7020 (Turb 350 IR)
- Conductivity - µS acc. ISO 7888 (conductometer EC215)

The obtained paper samples are being examined for its strength properties - the Tensile Index (TI), Nm/g acc. ISO 1924-2:2008, hydrophobic properties – water absorptiveness $Cobb_{60}$, g/m^2 acc. ISO 535:2014 and optical properties – color coordinates L*, a* and b* before and after accelerated thermal ageing (105°C , 12h, 24h, 36h) by Frank – PTI spectrophotometer / D65_10.

3. *Experimental results and discussions*

- *Influence of the quantity and type of the reactive dyes, on the properties of the white waters*

The accelerated dewatering and increased retention as a result of flocculants effect usually means purer waters in paper mill as well. In the process of adding of the reactive dyes into the paper suspensions a covalent chemical bond - dyes-cellulose is obtaining. This is the reason of capturing part of the hydroxyl groups from the cellulose fibers, so they are not capable of forming bonds with the water. Therefore, the cellulose fibers are not so hydrated and it is easier for the water to pass through the formed cellulose web. Reactive dye 2 (RD 2) at 0,2% consumption gives best results for the dewatering ability (Fig.2). With increasing the dyes consumption the dewatering ability is decreasing, most probably because the saturation of the paper suspension with negative charge.

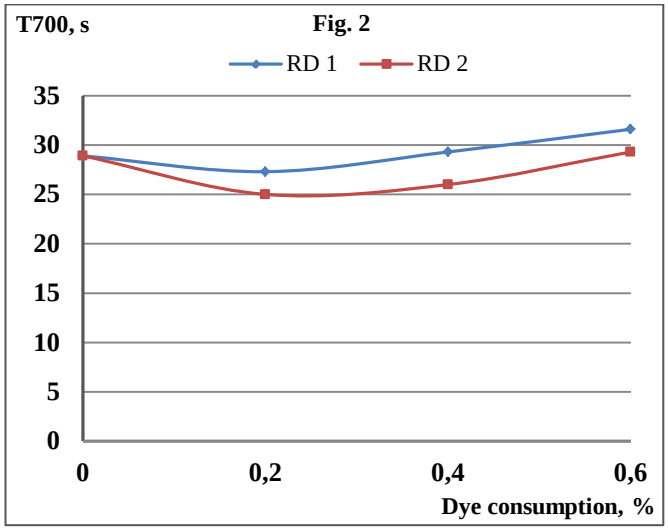


Fig.2 *Dewatering time (T_{700},s) of the paper suspensions at different Reactive Dyes (RD)consumption*

Regarding the turbidity of the white waters, the results are not so definitive, as well as it is for the dewatering ability and the conductivity. The both reactive dyes gives clarified white waters, but again best effect is seen in presence of RD 2 at 0,2% consumption (Fig.3). With increasing the dye quantity the turbidity is being aggravated and it is getting worse at RD 2 at 0,6% consumption, but still stays closely to the levels of the result for the paper without reactive dye. Probably with increasing the dye consumption the retention of the fines onto the fiber web is less, so that they occurs more in the white waters.

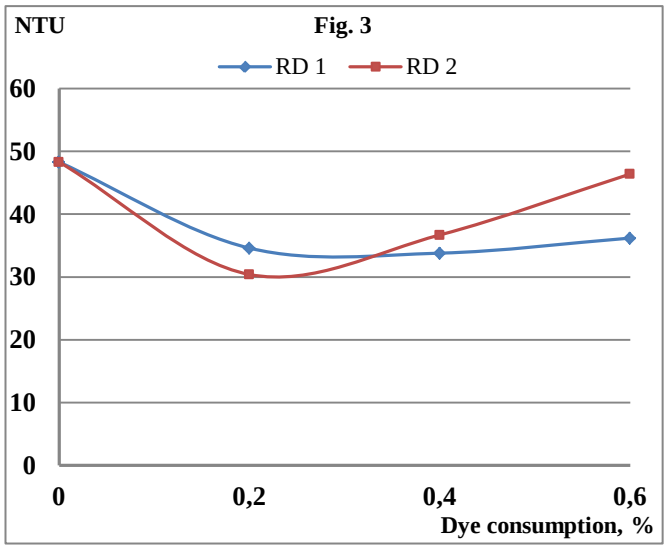


Fig.3 *Turbidity (NTU) of the paper suspensions at different Reactive Dyes (RD) consumption*

Measuring the electric conductivity gives an indication of the total concentration of electrolyte in the liquid phase. As it is shown on Fig.4, in the white waters from paper suspensions dyed with RD 2 there are more electrolytes and the conductivity is higher than that at RD 1. For this parameter the increasing of the dyes consumption do not gave effect over the conductivity. This effect probably is due to the bigger charge density of RD 2.

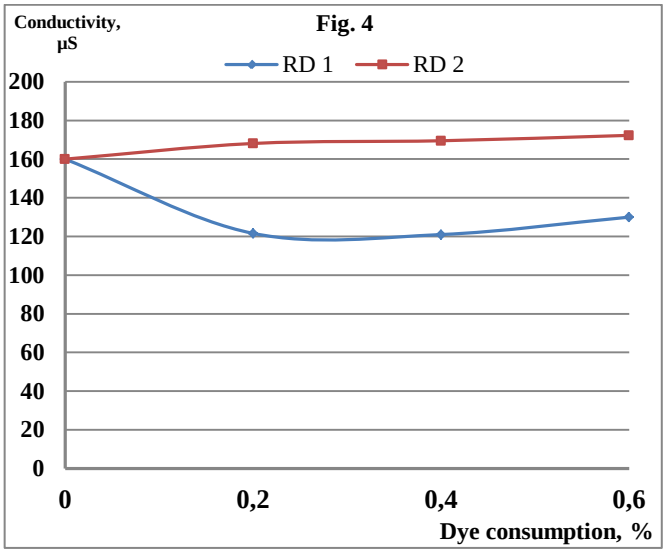


Fig.4 *Conductivity of the paper suspensions at different Reactive Dyes (RD) consumption*

- *Influence of the quantity and type of the reactive dyes, on the properties of the papers*

Tensile Index, N.m/g

This parameter depends primarily on the amount and strength of the bonding forces between the fibers in the finished paper sheet. As it is shown on Fig.5, with adding of reactive dyes, at consumption of 0,2% and 0,4%, the reactive dye causes a decrease for the tensile index of the paper samples. When adding 0,6% of RD the result is - increasing of the tensile index. Probably, with the small consumption of the reactive dyes the hydrogen bonds between the fibers are less, but after 0,5% dye, the bonding forces in the paper are also with the participation of the hydroxyl groups from the dye molecule.

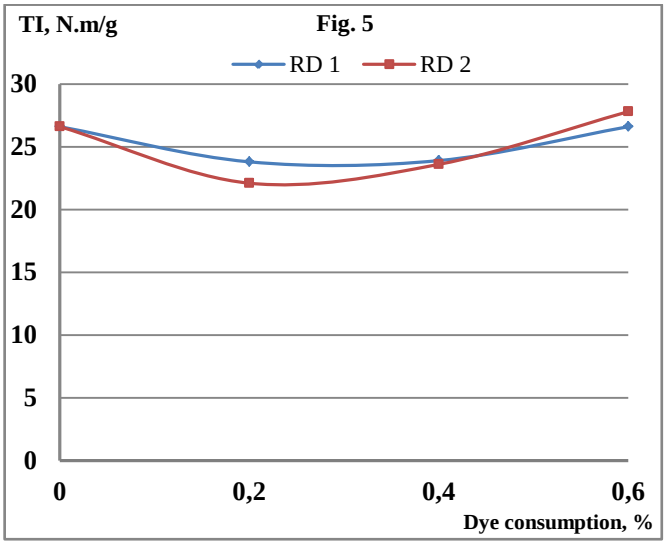


Fig. 5 *Tensile Index (TI) of the paper samples at different Reactive Dyes (RD) consumption*

Water absorptiveness Cobb$_{60}$, g/m^2

On Fig.6 are shown the water absorptiveness Cobb 60, g/m^2 of the obtained paper samples. With increasing the RD consumption, the water absorptiveness decreases, because of the presence of covalent bonds and the less free hydroxyl groups, which can react with the water.

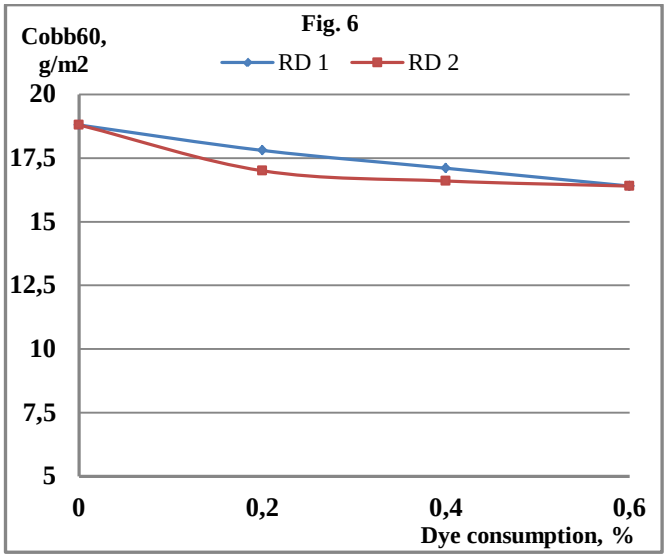


Fig. 6 *Water absorptiveness (Cobb$_{60}$) of the paper samples at different Reactive Dyes (RD) consumption*

Color coordinates L, a* and b* before and after accelerated thermal ageing*

The color coordinate - L*, which expresses the lightness, brightness and the brilliance of the paper, decreases with adding of both reactive dyes (Fig.7). The color parameters variation with time is comparatively low, being most sensitive during the first 24 hours. The differences between both dyes are small. At 0,2% consumption of the RD, the lightness of the paper samples is nearly the same and it stays stable after 36h accelerated thermal ageing. With increasing the dyes consumption and the duration of the thermal ageing, the color of the paper samples is slightly getting lighter.

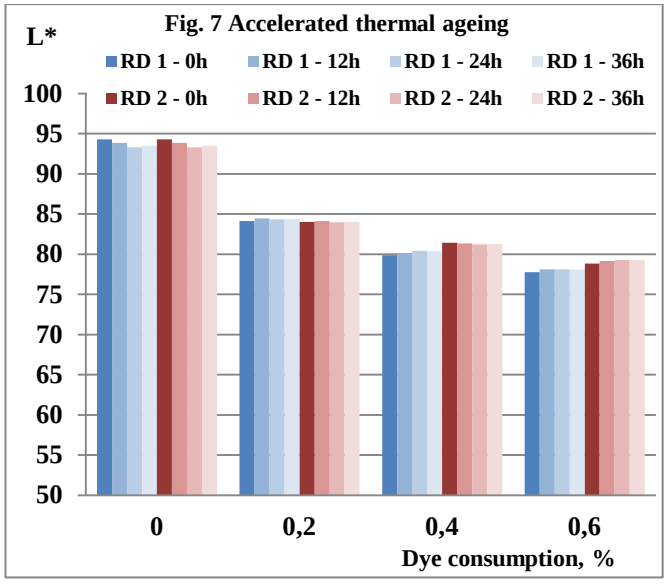
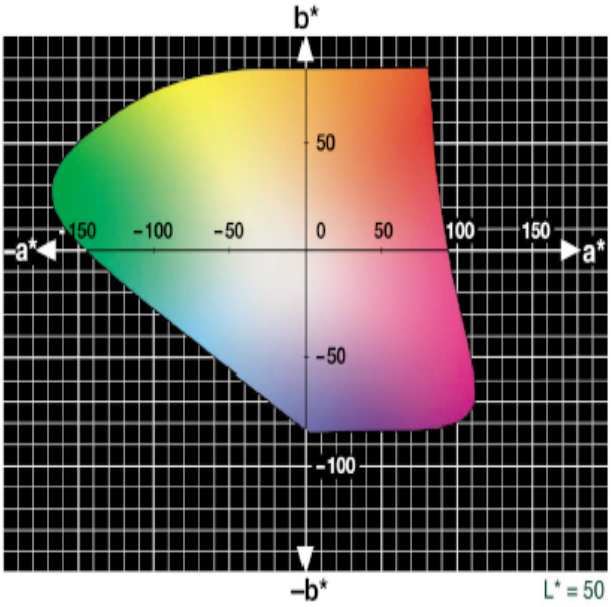


Fig. 7 *Color coordinate L* of the paper samples at different Reactive Dyes (RD) consumption, before and after accelerated thermal ageing*

With both reactive dyes are obtained paper samples with stable and uniform coloring. If the a* parameter, in the color system CIE L*a*b*, is positive the color is red and if the b* parameter is also positive the color is yellow (Pic.1) [7].



Pic.1 *CIE L*a*b* color space, at L*=50*

The color coordinates a* and b*, expressed as the stability of the color, for RD 1 are shown on Fig. 8, those for RD 2 are shown on Fig. 9.

The paper dyed with the Dye 1 is of lesser color stability and higher differences in color shade compared to the dye 2. Paper samples dyed with RD 2 have more saturated red color, barely perceptible to the human eye, but its color shade is more stable and the difference before and after the thermal aging of the paper is smallest at consumption of the dye at 0.6%. The process of ageing of both dyes alters the color of the resulting paper in a different way. The color of the paper with RD 1 is amended to a greater extent to the yellow hues, while those with RD 2 less. When the dyeing is obtained with RD 1, with the increasing of the quantity of the dye and the duration of the aging, paper is yellowing more compared to RD 2, by which the color remains more in the red shades.

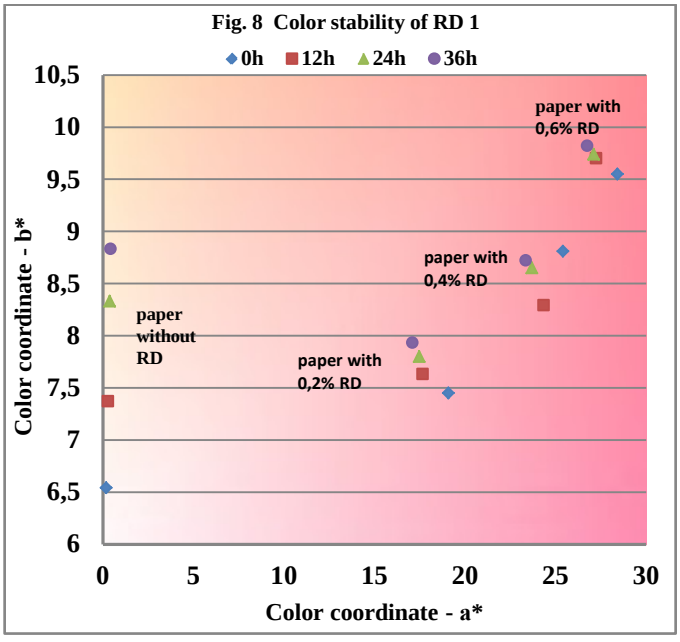


Fig. 8 *Color stability of RD 1 of the paper samples*

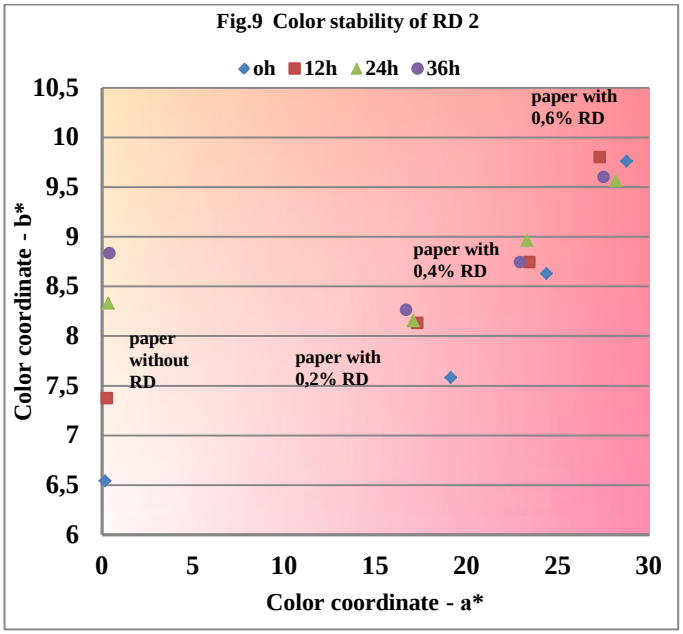


Fig. 9 *Color stability of RD 2 of the paper samples*

4. Conclusion

On the basis of the results of the studies carried out for dyeing wood free neutrally sized paper by two laboratory synthesized reactive dyes, using cationic polyacrylamide as retention additive and with a view of the complex influence on the processes and properties the following conclusions can be made:

- With both reactive dyes are obtained paper samples with stable and uniform coloring.
- Both reactive dyes, gave paper with close color shades, distinguished by stability under thermal aging.
- Most suitable in terms of dewatering ability and turbidity of the white waters, is reactive dye 2 at 0,2% consumption,
- Regarding all the properties of the obtained paper samples, best result are obtained with reactive dye 2 at consumption 0,4%.
- Both examined reactive dyes are suitable for dyeing of offset printing paper and may be of interest to industrial production.

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DEINKING OF WASTE OFFSET PRINTED PAPER BY THE USE OF ENZYMES

ОБЕЗМАСТИЛЯВАНЕ ЧРЕЗ ИЗПОЛЗВАНЕ ЕНЗИМИ НА ОТПАДЪЧНА ХАРТИЯ С ОФСЕТОВ ПЕЧАТ

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Abstract. *Recycled waste paper is a raw material for the paper industry. One of the most important processes in the recycling of waste paper, for the ability to print, is deinking. One perspective and ecological method for implementing that is the flotation process with enzymatic treatment. The aim of this study is to investigate the deinking of secondary fibrous material, obtained from waste paper, by flotation of offset printed paper by the use of different types of enzymes - lipase, cellulase, amylase, xylanase, on the process of deinking by flotation. In this research are being investigated various proportions of enzymes, and combinations thereof with surfactants. Their ability of deinking is calculated. As a result the treatment of the secondary fibers with the enzymes, improves the papermaking properties. The improved recovery papermaking properties of secondary fibers by the effect of enzymes, is able to increase the number of cycles of use of waste paper and to improve some parameters of the paper produced from secondary fiber. The optical properties of the obtained deinked fiber material are investigated and the possibilities for its usage in the composition of various types of paper and paperboard.*

Keywords: WASTE PAPER WITH OFFSET PRINTING, SECONDARY FIBROUS MATERIAL, ENZYMATIC DEINKING, FLOTATION

1.Introduction

The use of recycled fiber material for the production of paper and paperboard has a significant share of solving the problems of environmental protection and saving energy by reducing energy costs. The increased usage of waste paper is supported by the strengthened measures in environmental law in many countries, rising prices of energy, water and the territory for waste storage. The need for waste paper in the manufacturing process of various paper and paperboard types in the world will continue. Recycled waste paper is one of the most important raw materials for the paper industry. It represents about 50% of fibrous raw material used in the production of paper and paperboard. [1,2]

Traditionaly the deinking of waste paper, by alkaline chemicals and surfactants, leads to contamination of the waste water and high price for their treatment. One perspective method for the deinking of waste paper by flotation method is enzymatic treatment, leading to a modification of the cellulose fibers. The improved regeneration properties of the secondary fibers is capable of increasing the number of cycles of usage of waste paper and of improvement of some parameters of the paper produced from secondary fibers. Among the advantages of enzymatic deinking is the neutral pH of the suspensions, also less consumption of chemicals, reducing energy costs, improving recycling of the fibers. According to their specificity enzymes attack the surface of the fibers or the ink and the main mechanism is based on the weakening of the link fiber-ink removal of fiber. The positive effect of the enzyme can be explained by the destruction of the binders in the printing ink by hydrolysis and de-polymerization.[3-5]

The aim of this experiment was to study the de-inking of waste offset paper by flotation with the usage of different enzymes. The used waste paper is 70 g/m^2, with offset printing. The used enzymes are lipase, cellulase, amylase, xylanase and surfactants. The waste offset printed paper is subjected to a feathering flotation in the presence of enzymes. After the flotation a paper samples were obtained.[6]

2. Materials and methods

For straightening out the interactions the following materials and methods were used.[7]

- Waste Paper - 70 g/m^2, with offset printing.
- Reagents:
• Lipase - Lipase, Biovet Joint Stock Company
• Cellulase - Cellulase
• Amylase - BAN, Novo
• Xylanase - Xylanase, Biovet Joint Stock Company
• Surfactant - Tween 80, Sigma Aldrich

The waste paper with offset printing is subjected to a slushing in laboratory vertical pulper, then in a disintegrator at a concentration of 2%. The de-inking of the paper suspension is carried out by flotation with enzymes in the flotation cell. From the deinked fiber suspension paper samples are obtained in laboratory paper machine Rapid Köthen. The optical and physical-mechanical properties of paper samples are examined. The deinking ability is observed following the equation:

$$\text{Deinking ability} = \frac{B\ treated - B\ untreated}{B\ untreated} . 100$$

$B_{treated}$ - brightness of the treated sample, %

$B_{untreated}$ - brightness of the untreated sample, %

3. Experimental

The composition of the suspensions for the flotation and the obtained paper samples are shown in Table 1.

Table 1: *Composition of the samples*

Name of sample	Waste Paper, g	Surfactant %	Lipase %	Cellulase %	Amylase %	Xylanase %
Surf. 0,3	70	0,3	-	-	-	-
Surf + L 0,1	70	0,3	0,1	-	-	-
Surf.+ L. 0,3	70	0,3	0,3	-	-	-
Surf.+ Cell. 0,1	70	0,3	-	0,1	-	-
Surf.+ Cell. 0,3	70	0,3	-	0,3	-	-
Surf.+ A. 0,1	70	0,3	-	-	0,1	-
Surf.+ A 0,3	70	0,3	-	-	0,3	-
Surf + X 0,1	70	0,3	-	-	-	0,1
Surf + X.0,3	70	0,3	-	-	-	0,3
Surf.+L+Cell+ A+X ,[0,1]	70	0,3	0,1	0,1	0,1	0,1
Sample without Surf.	70	-	-	-	-	-

1. Microscopic analysis

The results from the microscopic analysis of the waste offset paper are shown on Fig.1 and Fig.2 It is well visible, that the composition of the paper is from 85-90% bleached hardwood pulp from beech and oak wood and 10-15% of bleached softwood pulp from pine and spruce wood.



Fig.1 *Microscopic picture of fiber from beech hardwood pulp*

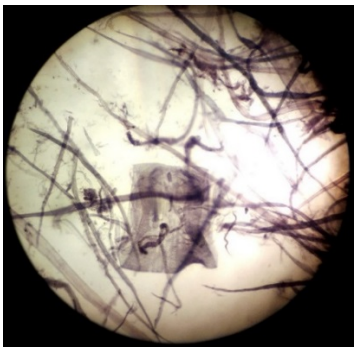


Fig.2 *Microscopic picture of fiber from oak hardwood pulp*

2. Study the degree of Brightness of the paper samples.

The degree of Brightness of the samples is presented on Fig. 3. From the figure it can be concluded that the brightness is increased in all the samples after the process of flotation. For all the examined samples with different consumption of the enzymes, the brightness increases with the increasing of the concentration of the enzymes in the suspension. The lowest results of improving the brightness of the samples are obtained during the flotation of the suspension with the enzyme amylase. The best results for the brightness of the samples are achieved in the sample flotated with the combination of four enzymes, due to the synergistic effect of the enzymes.

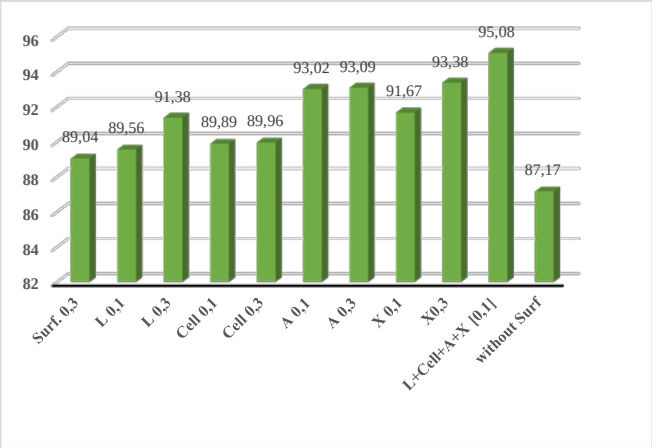


Fig. 3 *Degree of brightness in ISO Brightness of the samples [%]*

3. Study the degree of opacity of the paper samples.

On Fig.4 is shown the second examined optical property of the paper samples. It is visible that there is no significant change for this parameter. Better results are obtained when flotation is carried out with enzymes lipase, cellulase and xylanase with consumption of 0.1%. The lowest values are obtained with the 0.3% xylanase.

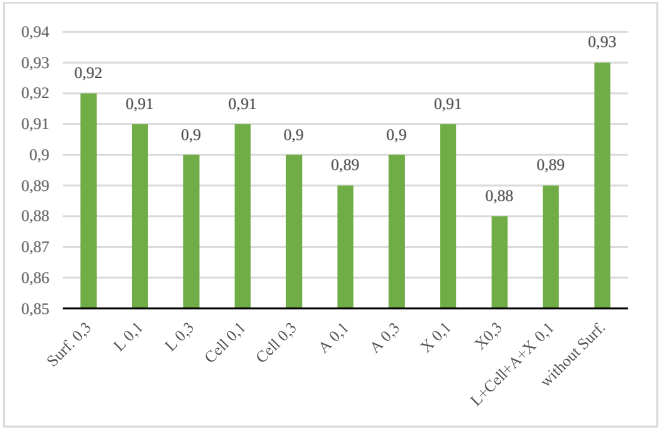


Fig. 4. *Opacity ISO 2471:2000 [%]*

4. Physical-mechanical properties of paper samples

4.1 Tensile strength

This parameter depends primarily on the amount and strength of the bonding forces between the fibers in the finished paper sheet and according to the results, shown on Fig.5, the enzyme cellulose with consumption of 0,3 % gave the highest increase of this parameter according to the paper samples without enzyme.

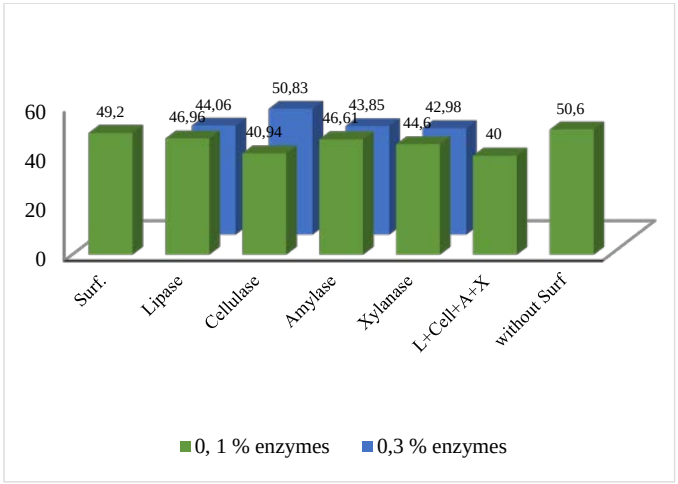


Fig. 5. *Tensile strength of the paper samples [Nm/ g]*

4.2 Burst resistance

The burst resistances of the paper samples are shown on Fig.6. This parameter depends primarily on the structure of the obtained paper samples, there for practically the consumption and the type of the enzyme for the flotation of the suspensions does not change the burst resistance of the paper.

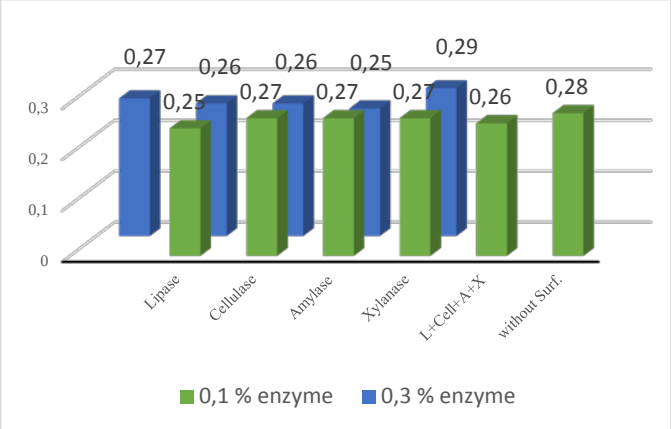


***Fig. 6**. Burst resistance of the paper samples [KPa.m^2/g]*

4.3. Tear resistance

The parameter tear resistance depends primarily on the strength and the nature of the fibers, which formed the obtained paper. As it is shown on Fig.7 the lowers effect of the flotation, over this parameter, is when using the enzyme cellulase, xylanase and the combinations of four enzymes. Most likely, this is due to the shortening of the cellulose chain and the length of the fibers.

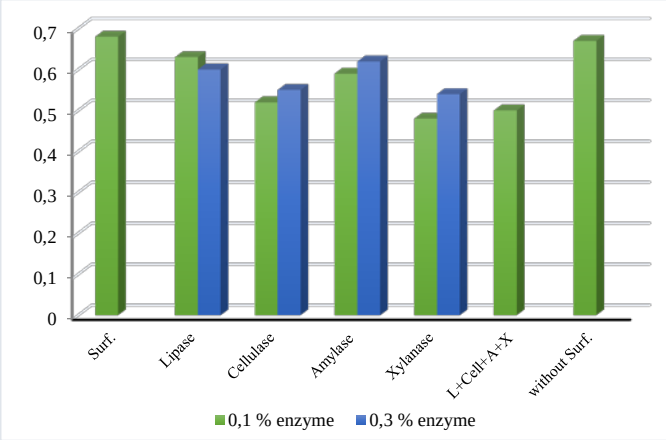


***Fig. 7**. Tear resistance of the paper samples [mNm2/g]*

5. Deinked ability

The results of the calculated deinking ability are shown on Fig.8. All the samples are with positive deinking ability. Lowest deinking ability has the enzyme lipase with consumption of 0.1% - 0.58%. With the increasing the enzyme consumption, the positive effect over the deinking ability is enhanced. Most significantly, it is observed when is used the enzyme lipase (0.58%-4.87%) and xylanase (2.95%- 4.87%). With best deinking ability is the sample which is in combination with the four enzymes - 6.78%. For the samples treated only with one enzyme, it is visible that most effective is the enzyme amylase. The samples treated with the enzyme lipase and xylanase is observed same deinking ability at a concentration of 0.3%.

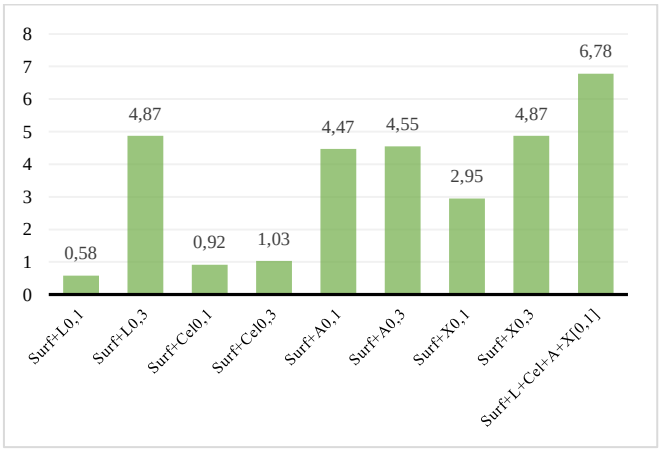


***Fig. 8.** Deinking ability, %*

4. Conclusion

On the basis of the experiments, which were carried out through the deinking of waste paper with offset printing, by flotation in the presence of enzymes - amylase, cellulase, xylanase, lipase, and combinations of them with surfactants, we can make the following conclusion: The results show that the usage of different enzymes do not change significantly the physical-mechanical properties of the paper, although the best results are obtained with the enzyme amylase at a consumption of 0,1%. The study over the optical properties of the paper samples shows that the highest values for the brightness are obtained during the flotation with a combination of the four examined enzymes. The obtained and examined secondary fibrous material can successfully be used in the composition of various types of paper.

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ANALYSIS OF THE STRIP TILLING TECHNOLOGY – PART I

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Abstract: *The degradation of soils is due to a combination of factors. One of them is the annual deep plowing. In this way the soil is left exposed to the vagaries of nature for a few months. Precipitation presented by the rain drops and their energy, destroys the soil structure and activates anthropogenic erosion processes. With intensive tillage, involving reversing of the plow layer, a number of processes are initiated, leading to oxidizing and burning of organic matter and, hence, to its continuous decrease. The extensive use of large quantities of mineral fertilizers and the additional commercialization of crop rotation also have a negative effect in the form of soil degradation. With the purpose of reducing the number of passages of tractor units on the field surface, a new type of tillage is proposed, without reversal of the plow layer, but with retaining a large part of the plant residue on the surface instead.*
Key words: *strip tillage; deep plowing; soil degradation; precipitation; strip till machine (ripper stripper); tractor units*

Materials and method

According to some research, the perennial grasses create good conditions for soil structuring while the annual crops do not have a positive effect on it. The different influence of perennials and annual crops on the soil structure is due not only to the biological characteristics of the plants, but also to the type of tillage that precedes and/or accompanies them.

Due to the fact that the fields with perennials are not plowed every year, the organic matter from the plant residues decomposes under anaerobic conditions, thus improving the soil structure. A new organic substance is formed (humus), which connects the mechanical soil particles in structured aggregates.

With the annual deep plowing of annual crops, the root mass of plants decomposes in the presence of anaerobic organisms leads to its complete mineralization, but without the formation of humus. Therefore, the first task is to create such conditions that will favor the formation of organic matter with the annual (row) crops.

In practice, this can be achieved by changing the type of tillage and creating anaerobic conditions for decomposition of the root system, similar to those of decomposition of organic perennial grass residue. With deep plowing, about 40% of the volume of plowed soil is mixed and enriched with oxygen. With subsoiling of the whole area, this percentage is about 16%. An essential feature of the construction of these machines is treatment of the whole surface, with plant residues remaining on the surface between 2 and 14%.

There exists a great variety of machines, working with soil layer reversal (plows), as well as those that work without such a reversal (subsoilers, rippers), which till the whole area. To reduce the number of passages on the soil surface and the tillage, we can successfully apply the strip till machine, Fig.1.

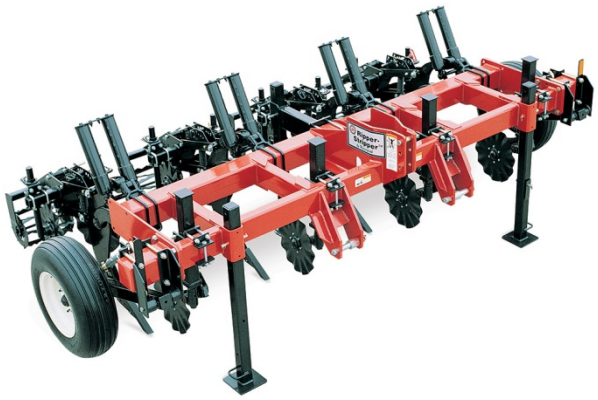


Fig 1. Strip till machine.

Such machines are already in use in the USA with great success, and in Europe they are being tested in Germany and Bulgaria. Experiments with such a strip till machine are actively being carried out at the University of Rise "Angel Kanchev". To this construction has been added a unit for introducing mineral fertilizers, developed here, Fig.2.

Technical characteristics of the machine:

- Working width 4,2, m
- Number of rows tilled simultaneously – 6
- Tilling depth – stepless up to 0.60 m
- Optimal tilling depth – 0.25 – 0.45 m
- Required power of the energy machine - from 40 to 60 hp/working body, depending on the tilling depth and the soil density
- Width of the strips tilled – 0.35 m
- Percentage (%) of plant residue on the soil surface – 48 - 53%
- Working speed – 7-11 km/h



Fig. 2. Strip till machine with a possibility for mineral fertilizer introduction, depending on the tilling depth set

Conducting the field experiments

The field experiments have been conducted in different farmers' fields, whose soils have various physical and mechanical properties, (Fig.3)



Fig.3. A map of field experiments conducted

The methods of field experiments have been agreed on with PIONEER (DuPont) and YARA, and the experiments have been conducted after the diagram presented on Fig. 4.

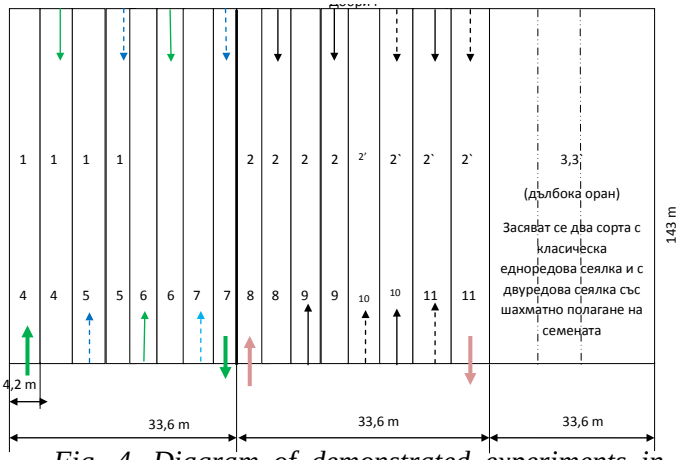


Fig. 4. Diagram of demonstrated experiments in the villages of Lozenets, Krushari Minicipality, Dobrich Region, agreed on with PIONEER and YARA

The unit for introduction of fertilizers with the strip till machine allows the introduction of both identical and different fertilizer doses in every three rows tilled. According to the methods adopted, when the machine is adjusted at a certain depth, the unit for introducing fertilizers is respectively adjusted so that it would introduce 25 kg/dka mineral fertilizer in the first three rows and 20 kg/dka – in the remaining three rows. Example: According to Fig.4, the fields marked as columns 4 to 7, are tilled simultaneously at a depth of 0,35 m. Each of them has 6 rows. In the first three rows of each strip (4, 5, 6 and 7) the mineral fertilizer dose is 25 kg/dka, and in the other three rows (of the same strips 4,5,6 and 7) – the mineral fertilizer dose is 20 kg/dka.

In the spring of 2016, on the so tilled area in fields 4 and 5 two identical corn (or sunflower) varieties will be sown, marked as 1 and 1' with a six-row classic seeder, placing the seeds in a row with a certain density of sowing. Nitrogen fertilizers will be introduced during the planting in the required quantities.

In the fields marked 6 and 7, the soil is tilled to the same depth (0,35 m) and the same varieties 1 and 1'(of corn or sunflower) will be sown, but with a six-row seeder, placing the seeds in two staggered rows.

Nitrogen fertilizers will be introduced during the sowing in the required quantities. The choice of varieties will be made by the representative of PIONEER.

The area tilled for the sowing of variety 1 – 0,484 ha.

When the strip till machine leaves field 7, it will be adjusted for depth of tilling 0,25 m. The same activities of stripping, introducing of mineral fertilizers and sowing will be repeated.

Parallel to the field, tilled by the strip till machine, similar experiments will be conducted, including primary tillage by plowing, ceteris paribus, such as mineral nutrition, plant protection, sowing rate, etc. (Fig. 4). Next to them a parallel experiment with Horsh Tiger subsoiler will be held, but without introducing mineral fertilizer in the soil, Fig. 8, Fig.9.

Equipment used

In essence, the equipment used to conduct the field experiments is unique. Advanced power generating machines are used, equipped with the latest achievements of automated guidance field systems TRIMBLE. The soil hardness gauge, measuring the data at every 1 cm, allows for wide application and interpretation of the data obtained. The same holds true for the remaining equipment.

Table 1.Equipment used for field experiments with strip till machine

No:	Description of equipment	Brand	Notes
1	Tractor, equipped with three-point linkage and navigation (GPS) system for automatic guidance „Trimble"	Fendt, 270 hp	ST „Renaissance", hendov Жендов
2	Tractor, equipped with three-point linkage and navigation (GPS) system for automatic guidance „Trimble"	CASE, 340 hp	"Lazarov 6" LtD
3	Strip till machine with a unit for introducing mineral fertilizers in the adjusted depth of the tines	R 320	UR „A. Kanchev"
4	Mineral fertilizers, NPK		YARA
5	Soil hardness meter for measuring soil hardness in the range of 0-80 cm recording the data every 1 cm		UR „A. Kanchev"
6	Hygrometer for determining soil humidity		UR „A. Kanchev"

7	Analogue soil hardness meter for comparative determining the soil hardness		UR „A. Kanchev”
8	Portable set for express measuring of the nutrient content, pH and organic matter in the soil		UR „A. Kanchev”
9	Scales for measuring the mass of plant residue per unit area		UR „A. Kanchev”
10	Tape measure, poles	-	UR „A. Kanchev”
11	Camcorder for filming the experiments		UR „A. Kanchev” PIONEER
12	Drone for filming the field from a height		PIONEER
13	Truck for transporting the equipment		UR „A. Kanchev”

Preconditions:

- Climatic conditions – continental steppe.
- Soil type - Low Haplustoll. Profile – characterized by well-formed humus, характеризира се с добре оформени хумусен, transitional and carbonate horizons;
- Mechanical structure – sandy clay to slightly clayey.
- Structure of soil aggregates - atomized;
- The area chosen is flat, aclinic;
- Direction of tillage – east-west;
- Previous crop – wheat;
- State of field: Stubble without pretreatment;
- Height of harvest – 0.15 – 0.20 m;
- Presence of plant residue: - scattered on the soil surface by the cutters of the harvesters, with accumulation of larger quantities, due to stopping for unloading, etc.



ФиFig. 5. State of the field after repeated passage of heavy machinery

Conducting the experiments

Measurements before passing of the strip till machine over the soil surface

- Adjusting the tillage depth to 0.35 m;
- Absolute soil humidity – 17 %;
- Soil density before tilling in the range of 0.01 to 0.80 m (before passing of the strip till machine) – 1,62 t/m^3; (Fig. 6).
- Heavy soil compaction observed at the depth of 0.18 to 0.43 m.
- Thickness of plant residue layer on the soil surface – 0.04-0.06 m;
- Degree of uniform dispersion on the soil surface – 84-97%;

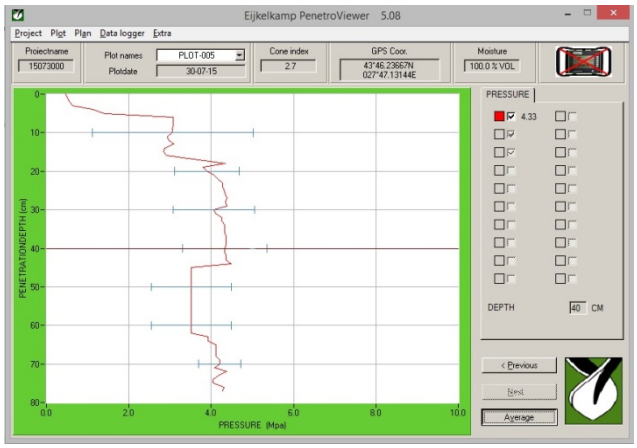


Fig.6. Diagram of soil hardness after harvesting of production

The measurements conducted show that the soil hardness grows up to 3.2 MPa at the first 0.08 m of depth and this value is preserved to about 0.16 m. After that it rises sharply and at 0.18 m of depth it reaches values of 4.7-4.8 MPa, which are preserved to the depth of 0.42 m. Consequently, in the range of 0.18-0.42 m there is an over-compacted soil horizon, which hampers the development of the plants in real conditions.

Results from measurements after the passage of the machine on the soil surface

The summarized results after the passage of the strip till machine show that there is a considerable improvement of the physical and mechanical properties of the soil, (Fig.7). In the depth of tillage resistance decreases to 0.7-0.8 MPa.

After tillage, bigger values of resistance in the strips tilled (max 4,2 MPa), are observed at a depth of 0,48-0,53 m.

Where the plot is not tilled, i.e. in the strips with plant residue, a reduction of the resistance is also observed at the depth of 0,48 - 0,42 m. In these strips macro cracks are formed, which help improve the water and air regime of the soil.

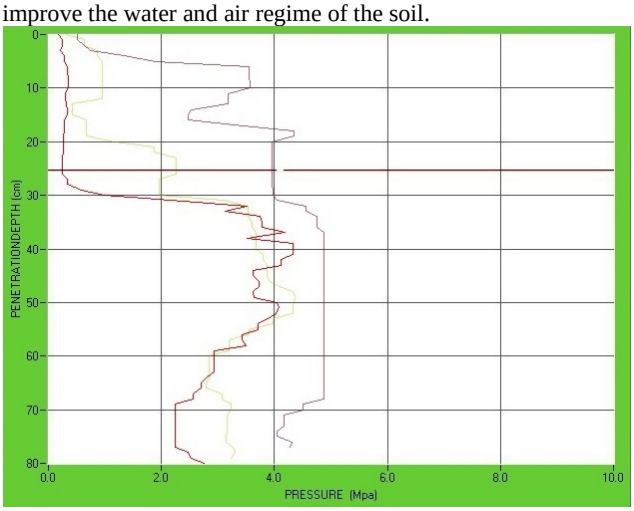


Fig. 7. Pivot table of soil resistance before and after passing of the strip till machine

COMPARATIVE STUDY WITH RIPPER FUSION TILLER

An experiment was conducted with Horsh Tiger ripper with 5 tines, working the full width of the front (Fig.8) with simultaneous alignment of the area tilled, Fig. 9. The results from the measurements are shown in Table 2.



Fig.8 General view of a ripper, tilling to a depth of 45 cm



ΦFig.9. Shredder and soil aligner with hydraulic pressure on the frame of the aligner.

During this kind of tillage the percentage of plant residue, left on the soil surface is about 8%.

The measurements conducted show that in soil that has not been tilled, the highest values measured at the penetration of a solid body have been measured in the range of 0.18 – 0.43 m, more specifically, from 3,8 to 4,3 MPa, wherein the soil compaction is in the range of 1,62 t/m^3. After the passage of the ripper the soil compaction changes drastically, falling to 1.1 – 1.2 t/m^3, (Table 2).

Table 2. Results from the measurements after the passage of the machine over the soil surface

No:	Indicators	Values		Units of measuring
		First experiment	Second experiment	
1	Depth of tillage	0,35	0,25	m
2	Working speed	7- 8	10-11	km/h
3	Fuel consumption	2,6--2,8	1.8-1.9	kg/dka
4	Degree of formation of strips from the plant residue	95	95-97	%
5	Soil density in the strips of the cultivated soil layer	1,1-1,2	1.1 – 1.2	t/m^3
6	Soil density in the uncultivated strips	1,28-1,34	1.25-1.29	t/m^3
7	Subsoil density	1,54	1.50	t/m^3
8	Skidding of the chassis at a work depth of 35 cm	12-14	6 - 8	%
9	Introducing mineral fertilizers in the tillage depth	12,50	10,0	kg/dka
10	Percentage of the surface soil, covered with plant residue after tillage	51- 53	51-53	%
11	Area of the experiment conducted	0,4804	0,4804	ha
12	Quality of the strips formed (on a scale from 2 to 6)	5	5 - 6	-

Due to the heavy soil compaction and the strong tractive resistance, it is not possible for the machine to work at a depth bigger than 0.35 m on its first passing. In this case, in the 0.35 – 0.45 m range a compacted zone still remains, Fig.10. Similar compaction values are characteristic for most soils, which have not undergone any loosening of the subsoil. After the loosening, the compaction decreases significantly, reaching values of 1.1 – 1.2 t/m^3 in the cultivated strips, Table 3.

Gradually, with increasing the tillage depth in the subsequent years and when the depth of tillage reaches 0.45 – 0.50 m, it will be possible for the root system to have normal development in a sufficient volume of soil.

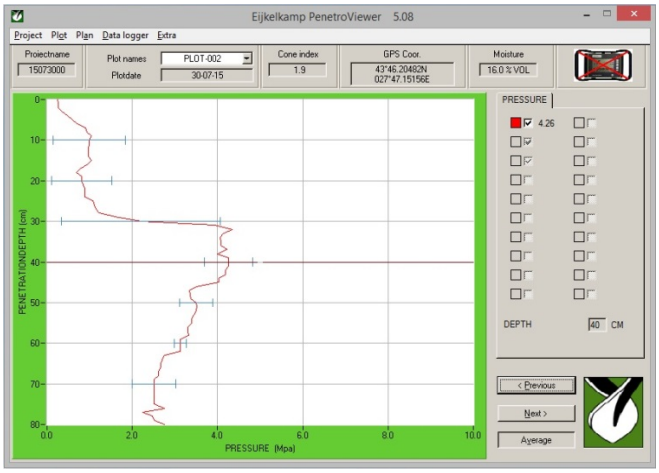


Fig. 10. Soil hardness values measured after the passing of the strip till machine

The following conclusions stand out for the work of the strip till machine at a depth of 0,35 m:

- The machine works very well on plots where the harvesters have spread the plant residues evenly on the soil surface, (Fig.11, Fig. 12, Fig. 13). Evaluation grade on the quality scale – 5.
- At low speed of movement accumulation of plant residue before the second discs is observed in the cases, when the harvesters have stopped for unloading and a big quantity of plant mass has accumulate at one place. In such cases, it is advisable to walk through the plot and such accumulations to be dispersed, Fig. 13 Evaluation grade on the quality scale - 4.
- In the experiments conducted at a depth of 0,25 m the stripper works well on plots, where the harvesters have spread the plant residue evenly on the soil surface.
- Due to the higher speed, plant residue is hardly accumulated before the second discs in the cases, when harvesters have stopped for unloading and a big quantity of plant mass has accumulated at one place.



Fig. 11. Strip till machine at work. Working at a depth of 35 cm. Introducing of mineral fertilizers according to the tillage depth set



Fig. 12. Field tilled with a strip tilling machine, with mineral fertilizers introduced. Accumulation of plant residue due to stopping of harvesters



Fig.13. Field tilled with a strip tilling machine, with mineral fertilizers introduced. This type of tillage is appropriate also for slopes with well-expressed snow-water retention effect

For soils with severely damaged physical and mechanical structure such as those in the village of Cherven, Ruse Region, a special adjustment of the tines must be performed. The soil density after the passing of the stripper decreases to 1,2 -1,4 t/m^3, which is an indicator of quality performance. At the depth of 0,25 m, when the working speed is higher, the density decreases even more. The results from the measurements are shown in Table 4.

Table 3. Results from the measurements after the passage of the machine over the soil surface

No:	Indicators	Values		Units of measuring
		First experiment	Second experiment	
1	Depth of tillage	0,35	0,25	m
2	Working speed	7- 8	9-11	km/h
3	Fuel consumption	3,6 - 4,2	2,9 - 3,6	kg/dka
4	Degree of formation of strips from the plant residue	90	92-93	%

5	Soil density in the strips of the cultivated soil layer	1,2-1,4	1.2 – 1.3	t/m^3
6	Soil density in the uncultivated strips	1,29-1,36	1.27-1.33	t/m^3
7	Subsoil density	1,54	1,59	t/m^3
8	Skidding of the chassis at a work depth of 35 cm	11-13	7 - 9	%
9	Introducing mineral fertilizers in the tillage depth	25,00	20,00	kg/dka
10	Percentage of the surface soil, covered with plant residue after tillage	48-51	49-51	%
11	Area of the experiment conducted	0,4804	0,4804	ha
12	Quality of the strips formed (on a scale from 2 to 6)	4	4 - 5	-

The machine works well on plots, where the harvesters have spread evenly the plant residues over the soil surface.

At low speeds of movement, breaking up of the compacted soil layer into large soil aggregates with a size of 0.18 – 0.25 m has been observed. In such cases the last tines need to be adjusted for heavy duty work.

Comparing the tillage technologies

For classical wheat tillage (disking) the machine passes over the soil surface 5-6 times, leaving up to 10% plant residue, which would preserve the soil from degradation.

The technologies used in the USA for soil preservation show a smaller number of passages – 4-5, leaving up to 30-33% of plant residuepастителни остатъци. The technology of the University of Ruse has yielded the same results.

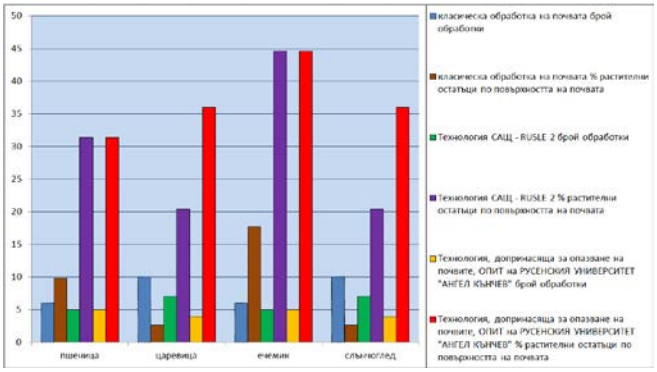


Fig. 14. Comparing the various tillage technologies

With the classical tillage for row crops, mainly corn and sunflower, a large number of passages is observed – around 10, the percentage of plant residues is 2-3. The technologies applied in the USA have 5-7 passages, but the percentage of plant residues is over 20. At the same time, when using the strip till machine from the technological complex of machines that belongs to the University of Ruse "Angel Kanchev", the number of passages is 3-4, and the percentage of plant residues left on the soil surface – 37.

Snow-retentive capacity of the strip tillage technology

The first snowfall shows another advantage of strip tilling. The strips of plant residues left on the soil surface show snow-retentive and snow-accumulating effect, Fig. 15. The thickness of snow cover in the strips is 0.18 m while in the vicinity, where there isn't snow micro retention, its depth is 0.12 m.



Fig. 15. Snow-retentive capacity of the strip tillage technology

Conclusions

The advantages of strip tilling to deep plowing are as follows:

1. Creating conditions for the formation of organic matter. Through changing the type of tilling and creating anaerobic conditions for decomposition of the root system and the plant mass introduced into the soil, the organic substance humus is formed in the same way as with the decomposition of organic matter, left by perennial grasses.
2. Reduced number of tillages. When working with strip till machines, there is one-time passing over the soil surface only. With the classical way of tilling for row crop growing, four or five passages are necessary.
3. It is possible to introduce minerals and/or organic fertilizers directly into the depth of the soil layer tilled, for better decomposition. With the classical way of tilling, the minerals and organic fertilizers are spread on the soil surface and then plowed into the subsoil.
4. There is a reduced risk of water and wind erosion when growing row crops on sloped terrains. The availability of sufficient plant residues on the soil surface and their formation into strips help the water retention at the point of its fall and its movement in the soil. It leads to reducing the surface runoff.
5. Possibility for increasing the water retentive and water absorptive capacity of the soil. The presence of plant residues on the soil surface (over 52%) decreases the kinetic energy of water drops when they meet the soil and protect soil aggregates from destruction. The presence of macro cracks in the deeply tilled soil layer allows the water to move through the soil and to fill the empty spaces. No crust is formed on the soil surface.
6. There is greater snow-retentive capacity along the whole area tilled. The plant residue strips form ridges and troughs with a height of about 20 cm and width of 30 cm. In this way, the speed of air close to the soil surface is almost nil. The fallen snow settles and accumulates

evenly on the soil surface. The bigger part of arable land in Bulgaria are not surrounded by wind-belts.

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THE EDUCATION IN ENTREPRENEURSHIP AND INNOVATION-A BASIS FOR SUCCESSFUL REALIZATION OF THE STUDENTS FROM THE UNIVERSITY OF MINING AND GEOLOGY "ST. IVAN RILSKI"

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Abstract: *Introduction of training in entrepreneurship, innovation and project management is one of the most discussed topics in the field of education as a whole. Particular attention is paid to this education in the field of higher education and is one of the priority objectives of the Europe 2020 strategy.*

According to the European Commission study, carried out in the Member States of the EU and 15 other countries in the period 2015-2015 [5] students received training in entrepreneurship and innovation be implemented most successfully. They are the best paid in the labor market, employment is almost maximum, the more likely they are to start their own business and their companies are the most innovative and creative.

This article presents the experience in entrepreneurship education, innovation and project management of the students from the UMG "St. Ivan Rilski”, Sofia.

An essential point in this education is the acquisition of knowledge and skills that link higher education with the requirements of the business and the labor market.

Keywords: EDUCATION, ENTREPRENEURSHIP, INNOVATION, PROJECT MANAGEMENT, STUDENTS, BUSINESS IMPLEMENTATION

1. Introduction

University of Mining and Geology "St. Ivan Rilski "prepares specialists in unique specialties in Bulgaria for the needs of geology, mining and the mining industry, underground construction, extraction and transport of oil and gas, management of natural resources and the recycling of raw materials.

Students who have completed university succeed in enterprises of the sector in the country and in leading international companies in the field of mining and processing industry, developing its operations on four continents.

The education of students in entrepreneurship and innovation launched in 2010 with educational programs for the management of project activities, and by 2014-2015 and to entrepreneurship and innovation.

The main purpose of this education for students of the University is the opportunity to develop your knowledge through a private training, active dialogue with the teacher and individual and team work in set projects and case studies. Practical training process is based on the latest software tools and distributed in these areas.

2. Training in the field of management of project activities

Since many of the specialties in MGU "St. Ivan Rilski "are unique to the country was made an analysis of the curricula of similar courses in universities abroad and was found in many of the last 10 years have introduced disciplines related to innovation, entrepreneurship and project management. As a University, MGU was always in close contact with companies, users of the footage out of the country, and taking into account their needs and dynamics of the labor market in 2010 the Department of Informatics starts education in disciplines related to software project management activities.

To launch a successful training in this area have been undertaken following a number of successive steps.

The decision was made by management training project activities, entrepreneurship and innovation to be fought entirely in the educational qualification degree "Master" as the students at this stage of his training are more motivated and have a clear vision for your career development.

The first discipline that was introduced in the training of students included the management, monitoring and reporting on project activities, taking into account the need for the preparation of the so-called Project managers.

In the beginning this discipline was included in the curricula of the three specialties of the University – Computer Technologies in Engineering, Industrial Management and Engineering Safety.

The criterion by which these specialties were chosen was based on the fact that the students in the educational qualification "Bachelor" stolen have studied Economics, Corporate and Business planning, and has the necessary basic knowledge. As a complementary criterion in this choice was reported and the fact that the graduating students are most often these specialties makes it necessary to draw up and monitor projects in their specific job.

The theoretical training includes materials on the establishment, management and monitoring of projects, the establishment and sustainability of project teams, the different ways of visualizing the projects, calendars, schedules, etc. Students learn and the basics of business planning.

Practical training in this discipline is based on the software product MS Project [6]. As part of its preparation and assessment students develop project related to their particular work or their interests. The choice of MS Project is based on the fact that the software product has advanced analytical capabilities. It provides tools to analyze and optimize the volume of planned activities, necessary resources, finances, time spent and the risks for the implementation as a separate task, and all the activities implemented in the specific company, regardless of its sphere of activity.

The selected software product is intuitive to operate and in the first two years of teaching about 40% of students say they are beginning to use it in specific work in planning and monitoring (or choose similar software products with open source or those with a subscription fee).

Chosen by us for teaching MS Project offers the option to merge all project activities implemented in a specific company's server, which provides job opportunities and monitoring

simultaneously on several projects and, where necessary, sharing resources and finance and teams in carrying out specific tasks.

After the second year of teaching interest in teaching this discipline have shown four more specialties in educational qualification degree "Master". At present, the discipline is taught on 7 different specialties of the UMG "St. Ivan Rilski ". The interest in this subject is large and due to the fact that in the mining industry the mining conditions are unique to any particular field, with the development of excavation and having dynamic planning and monitoring of activities. [1, 3]

According to the study from the last year, about 50% of students present projects that are associated with specific project activities in their company that will actually be implemented. An example of a specific project, which is in the process of implementation, is shown in Figure 1 and Figure 2.

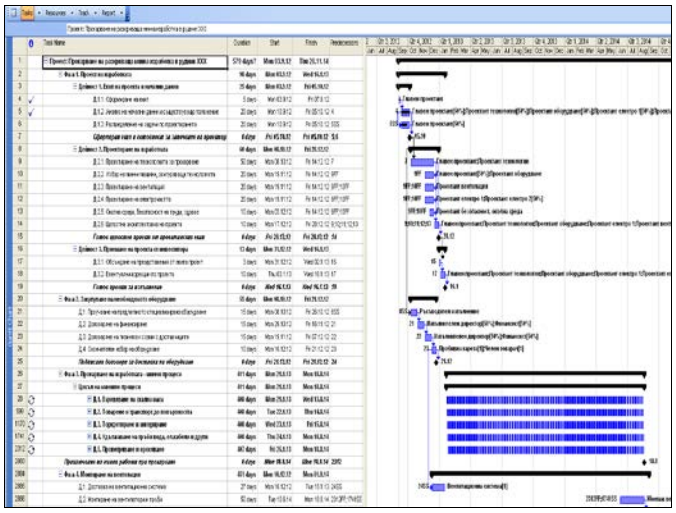


Fig. 1 *A fragment of the presented student's project.*

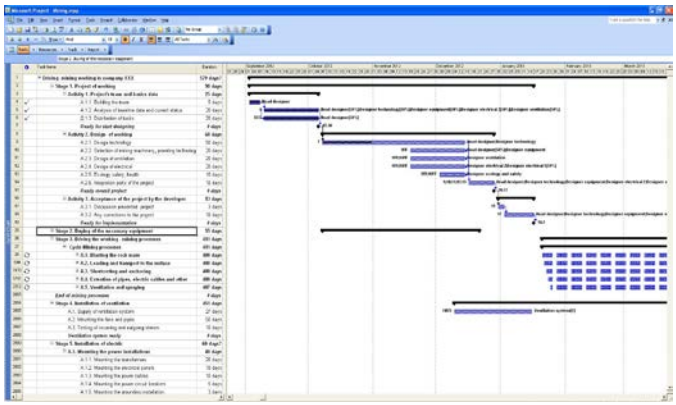


Fig. 2 *The Gantt chart (of mining working)-a graphical view.*

Over 70% of the students, who occupy managerial positions in companies; already use MS Project or equivalent product in their daily work, which clearly speaks about the benefits of training in the field of management of project activities. This contributes to the fact that the information can be updated practically continuously with the help of these software products, it offers a high level of detail of each activity and there are opportunities to generate different graphical or text reports on different indicators or elements of the project.

Over the past two years in the practical training of students was added and software MS Visio [2], which is a powerful application for creating professional diagrams with dynamic data. Product version Premium [7] offered as additional templates for use by different engineers and abilities as intelligent rules, validation and dismantles the activities of subprocesses.

In the process of training in the discipline for plan and manage project activities require a finding that a majority of students need a basic knowledge in the field of entrepreneurship, as they do not acquire the standard syllabus of engineering disciplines economic disciplines.

3. Training in the field of entrepreneurship and innovation

The lack of knowledge in this area feels particularly harshly by the students of the specialty "Computer Technologies in Engineering" due to the dynamics of the development of information and communication technology. Although a small part of them still in the educational qualification degree "bachelor" want to get involved in different initiatives in entrepreneurship, generating and implementing innovative ideas on the kind of "Junior Achievement", and some of the graduates degree master's wish to develop their business. Characteristic for both groups of students is that, in their opinion, they need additional expertise in the field of entrepreneurship and innovation.

In response to this need by 2014 for specialty "Computer Technologies in Engineering" started training in the discipline "Entrepreneurship in the field of Information Technology".

It aims to give the students' knowledge about:

- ✓ The technology and methods for generating ideas;
- ✓ Popular business models applied in the field of information and communication technologies;
- ✓ Product-oriented methodologies when creating a startup;
- ✓ Key components in templates for business modeling; - prototyping;
- ✓ Expert evaluation of market and survey of business-model;
- ✓ Indicators for assessing startup;
- ✓ Skills for the formation and management of the team;
- ✓ Attraction of investments and introduction to the market of venture capital;
- ✓ Skills for public presentation of ideas and projects to potential investors.

In the practical work in the discipline students apply theoretical knowledge by starting from the generation of an idea, create a business-model, do market research, form a team and create a plan for implementation and presented his idea created in order to attract investors.

In the process of training in the field of entrepreneurship and innovative technologies the students evaluated the effect of creating your own innovative development or technology transfer existing depending on the needs of a particular product or company. [4]

Still the experience in teaching this discipline is not large and is not at present carried out survey for assessing the effect of learning, but the fact is that the interest of students to entrepreneurship is present, as they actively participate in practical work when generating business ideas, the realization and presentation.

4. Conclusion

The dynamics of the labor market require students, students in engineering majors, have extensive knowledge in their particular subject area. In order to achieve as successful managers, even at the lowest level of management, they must possess additional knowledge in the field of project management, entrepreneurship and innovation.

Training in this area is particularly important for students of higher education institutions, since according to the statistics, about 20% of them in developed countries to create their own companies in the field of high technology and services. [5]

Among the students, graduates of University of Mining and Geology "St. Ivan Rilski "only about 2% to start their own business after completing his higher education, which may explain both their lack of preparation, and with the specifics of the mining-mining and processing industry.

The feedback that the University maintains continuous with the users of engineering personnel for this specific sector shows that students received training in entrepreneurship and project management are more successful and creative executives in the implementation of innovative technologies in companies.

This gives us the confidence to continue and expand training in entrepreneurship and innovation, which is crucial for the development of modern technological undertakings.

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INNOVATIONS IN THE PUBLIC FINANCE CONTROL - NECESSARY AND REQUIRED

ИНОВАЦИИ В ПУБЛИЧНИЯ ФИНАНСОВ СЕКТОР – НЕОБХОДИМИ И ЗАДЪЛЖИТЕЛНИ

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Abstract: *The innovations in the public sector follow those in the business sector. The reasons are at least two - the necessary conservatism of the sector and setting-out of the initiatives of the "top". However, the introduction of innovations in the public organizations is not only necessary, but also mandatory, as it is directly related to the administrative capacity to perform effectively and efficiently their inherent functions.*

The operations with the public finances has always been the focus of public attention, which is sensitive to the way of spending taxpayers' money. Therefore, innovation in this field should be directed towards greater transparency, control, efficiency and effectiveness. Opportunities for that exist in areas such as financial analysis, financial planning and forecasting, development of program budgets, and application of the financial management and control.

Innovative models of public finance management are presented in the paper, with emphasis on the use of cloud technologies for ex-ante control over the spending of budget funds. Such cloud structure was probated in some Bulgarian municipalities and its effectiveness and efficiency was proven in terms of facilitation the work of financial controllers, implementation of rapid control activities, generation of checkups and reports and upgrading the confidence in the operation of control systems.

Keywords: INNOVATIONS IN THE PUBLIC SECTOR, ARIS, BUSINESS PROCESS MANAGEMENT, FINANCIAL MANAGEMENT AND CONTROL SYSTEM (FMCS)

1. Introduction

The democratization of the public sector management is associated with adherence to principles and values such as transparency, stakeholder participation in the process of decision-making, awareness that public funds are spent in a lawful and appropriate manner and that goals are set effectively. Although democratic governance implies decentralization, if it is not supported with a sufficient administrative capacity for self-governance, it can impede rather than support the democratic process.

One of the most important aspects of the public sector organizations that had to be changed during the transition from authoritarian to democratic governance in our country was the management of public spending. It had to become not only more open, but also fairer and more efficient. This is why one of the conditions for Bulgaria's accession to the European Union was the implementation of efficient systems for financial management and control in public organizations. This requirement was stated in Negotiation Chapter 28 "Financial control" and was transposed to our national legislation. During the negotiations the overall system of organization and internal control was modified and the external audit standards were improved.

Today, more than fifteen years after the beginning of implementation of changes in the regulatory framework of financial control and financial management and control system (FMCS) in public sector organizations, the results are not exactly what we expected. Some organizations have implemented effective systems that are regularly updated and enhanced. Others did implement such systems only formally, either because they were not aware of their function or because they underestimated the need for such systems. Still others did not implement such systems at all. External audit bodies seem to have neglected their obligation to inspect these systems and impose administrative sanctions to those managers who do not comply with the regulatory requirements. Their annual reports on the status of the FMCSs submitted to the Ministry of Finance often do not correspond to the actual situation. Accordingly, the consolidated annual report on the internal control in the public sector in the Republic of Bulgaria published by the Ministry of Finance is an accurate summary of findings that are not quite accurate.

The above conclusion is based on the author's extensive experience in development and implementation of financial management and control systems in a number of organizations. More than half of the municipalities in the country as well as and some ministries and central authority bodies have implemented FMCSs developed by a team of specialists under his supervision. However, 15 years ago FMCSs were developed using certain methods and equipment while the advancements in the ICT today provide new opportunities for their enhancement and improvement of their efficiency.

2. General characteristics of the control function and the COSO model

Control is one of the managerial functions. It is the last phase of the management process because it measures actual performance and sets corrective action, i.e. it checks current performance against pre-determined standards contained in the plans, with a view to ensure adequate progress and satisfactory performance. Management control supports the strategic decisions of the management.

Ever since people began to set goals, i.e. to plan (another management function), they have sought to ensure that the goals set will be achieved despite the impacts of external factors or the activities of other people. This is why they started monitoring the activities related to the achievement of these goals and thus established the first form of control - the **direct control (behaviour control)**. We have all seen movies about slaves working while whipped by their overseers who try to make them more productive. Such methods, though more refined, are still used in management practice today. Most often they may be observed in paramilitary structures, but also in some production units where workers are constantly watched by their foremen (in person or via CCTVs.).

The advantage of direct control is that by using it managers can be fully aware that activities are carried out according to the requirements and will achieve the set objectives. Its main disadvantage lies in the obvious fact that such control does not encourage the employees to commit themselves to the set goals and to strive for quality. They are forced to achieve a certain amount of output and are inclined to breach their obligations whenever they are not overseen. A typical example are the performance measurement systems based on set workloads within the implementation of plans in planned economies. Production units set lower objectives in order to outperform and receive bonuses at the end of the year although the excess quantities of output cannot be sold and will be kept in stock.

The disadvantages of direct control have led to the realization that production systems must be allowed to organize themselves and while managers monitor only the outcomes of their activities (performance). **Performance control**, also known as output control, is efficient because it provides the employees with the incentive to perform better. Its implementation resulted in the creation of the so-called "quality control officers" at the end of the process chain, who were responsible to inspect the quality of output. Thus they ensure that only quality products are supplied to the consumers since all substandard products are returned for re-processing or are discarded. However, the percentage of rejected

products directly affects the performance since it increases the marginal cost of production. It is even more unacceptable when it comes to provision of public services by budget organizations because such services cannot be re-processed or rejected.

This led to the implementation of **process control**. It is a component of the Business Process Management (BPM) - a managerial approach that was established after 2000 and did not become popular until 2003. It focuses on improving corporate performance by managing and optimising a company's business processes. For a long time the most common business management approach was the functional approach, i.e. control over separate business functions rather than the entire process. In such an organization the workflow processes (workflows) are not considered and the focus is put on the various functions and activities. Conversely, the process approach focuses on a series of interrelated and interdependent activities. Thus managers have to consider the entire process rather than separate fragments of it. Process management is included in varying degrees in all management concepts that have emerged over the last twenty years. It is based on business process modelling and standardization, performance monitoring and correction whenever any deviations are found. Compared with the post-factum performance control, the process control encompasses the whole process, be it production of goods, rendering of services or routine administrative activities known as general business processes. This means that it is **preventive** in nature and may be defined as a **preliminary control**.

The concept of preliminary control based on the process approach was proposed in 1985, when five organizations specialized in the field of finance established the Committee of Sponsoring Organisation of the Treadway Commission[1] headed by James Treadway. In 1987 the Commission published its first Report of the National Commission on Fraudulent Financial Reporting, which provided the managers of public companies with recommendations for improving the internal control in their organizations. This model became popular as the COSO model and introduced various terms and concepts adopted in our legislation, such as "tone", "integrated internal control framework", "rational awareness", etc. It also defined the five elements of internal control - control environment, risk management, control activities, information and communication, and monitoring. Special emphasis is put on managers' attitude to internal control (known as "tone"), the role of the ethical codes of conduct and their importance for establishing favourable control environment and the role of control in the public sector.

3. Characteristics of FMCS

Like any new concept, FMCS were initially interpreted unambiguously that led to the error of many heads of public organizations that they have systems in place without the case. In many organizations incorrectly under FMCS understood internal legislation, which regulates the responsibilities and obligations of employees related to financial management and control

FMCS are defined in Art. 1, Para. 8 of the Additional Provisions of the Public Internal Financial Control Act (PIFCA) as: "*all procedures and the overall internal organization of planning activity performance and execution of internal control, which contribute to achieving the auditee's goals*".[2] This definition has three main implications: first - that systems are **procedures;** second - that they apply to the **overall internal organization;** and third - that they contribute to achieving the auditee's **goals**.

The 2005 edition of the Economic Encyclopedia defines the term "procedure"as „*A permanent plan containing a series of related steps (measures) to be implemented under certain recurring circumstances. The well-established and formalized procedures are called "standard". They do not allow much flexibility and deviations. Breaches of the prescribed steps are known as non-compliance.*"[3]

Therefore an FMCS:

- is not an internal operational manual;
- is not a manual describing the responsibilities and obligations of units and individual employees;
- is not a description of processes with details of their integral parts and prescription of who, when and how should undertake a certain activity;
- does not provide for the control over the compliance with the established standard procedures.

Therefore, FMCS should not be limited to any internal rules, regulations, instructions and orders no matter how detailed they may be, as these documents do not describe procedures but regulate rights and obligations. We know that even if the employees who work in conditions of perfect legislation breach the performance of their duties on a daily basis by non-complying with the legal provisions due to various reasons such as insufficient information, different interpretation of individual texts, personal experience in implementation of activities, emotions, etc. Here comes the FMCS, which does not provide written rules, but written procedures that must be followed and can be accessed by the employee at any time.

The similarities between FMCS and the Total Quality Management Systems (TQMS) are obvious. The latter are also built on process logic, implementation of standard procedures (ISO), control of the compliance thereof and action in cases of non-compliance. However, there are certain differences between the FMCS and TQMS, the most notable of which are that TQM is customer-oriented while FMCS deals with the internal processes of an organization as well as that TQM controls quality-related processes while FMCS controls processes related to the achievement of organization's goals.

The FMCS and the TQMS should interact. The simultaneous implementation of the two systems has certain advantages such as synchronization of overlapping or interdependent processes of FMCS and TQM as well as the fact that the detailed procedures of the FMCS supports the ISO certification of the organization. Both systems should ensure transparency of processes, documenting of all actions, traceability of operations, rational allocation of responsibilities, control and possibilities for improvement.

The abbreviation FMCS implies that these systems deal mainly with the financial processes of an organization. Such a limited scope was provided for by the old PIFCA, which provided that "Public Internal Financial Control is the control over the financial activities of spenders of budget appropriations" (Art. 2) and that "Public Internal Financial Control shall include financial management and control systems, internal audit and preventive control" (Art. 18.) Its scope is much broader according to Art. 3 Para. 1 of the new Financial Management and Control in the Public Sector Act (FMCPSA), which provides that "*the heads of the [public] organisations … shall be responsible for the execution of financial management and control in* ***all structures, programmes, activities and processes managed by them*** *in compliance with the principles of legality, sound financial management and transparency."*[4] This definition shows the process nature of the control exercised through a FMCS. The word "process" has a Latin origin (*processus*) and means "a natural phenomenon marked by gradual changes that lead toward a particular result". This shows that the word "financial" in the FMCS abbreviation is not quite accurate and limits the scope of these systems. They are increasingly seen as Management and Control System (MCS) that go beyond the purely financial activities and include all management processes in an organization.

[1] For more details see Николов, Н. Моделът „COSO": библията на вътрешния контрол. Сп. Вътрешен одитор, no.1, 2005, pp. 3-12.

[2] Ibid.

[3] Икономическа енциклопедия, С., 2005., p. 661.

[4] Financial Management and Control in the Public Sector Act. SG, no. 21, 2006.

4. Process modelling tools

Workflow processes can be described in several ways:

- verbally, in a table;
- graphically, as diagrams;
- both verbally and graphically.

The methods for creating diagrams are an important part of the approach for process description and analysis. The modelling method (aka "notation") is a specific language for describing the real world using a special syntax that contains graphic symbols, attributes and relationship links. The main notations to create detailed diagrams of business processes are:

- BPMN (Business Process Model and Notation);
- EPC (Event-driven Process Chain).

The BPMN (Business Process Model and Notation) provides a graphical notation for specifying business processes with different levels of detail.

The EPC (Event-driven process chain) notation provides a detailed modelling of business processes and can be used as an addition or as an alternative to BPMN. It represents a sequence of functions (activities) and events that create value for the organization. The EPC diagrams include several types of objects: events, functions (activities, tasks), logical operators, resources (organizational units and positions, applied systems, data and information.)

Business process modelling is an integrated approach to documentation, analysis and optimization of the organization that covers steps, stages, data, application systems, organizational structures. Such a model provides both the management and the employees with a comprehensive overview of the activities performed and the final result. A good process model can be accepted as a standard and thus facilitate the control over the compliance of the processes to the standard requirements. It should include control mechanisms in terms of control procedures implemented at certain stages of the workflow in order to ensure that standard quality requirements are met.

The workflow of the main business processes is represented in terms of main procedures that describe the main steps, the required information, the desired outcomes and the related documents. The main procedures also serve as a basis for allocation of rights and responsibilities among the employees responsible for the performance of the activities.

There are many technical means for graphical representation of processes. For example, the Microsoft Office package includes applications such as Word, Excel and Power Point, which have the "Flowchart" function that can be used for drawing process flowcharts. Different characters are used for representing the steps, the incoming and outgoing documents and information as well as the decision-making points. In addition to the Flowchart function to describe the business processes, we can use some more powerful tools for process modelling that will not only provides us with process visualization flowcharts, but will also include the connections between processes on different hierarchical levels and the organizational structure, have a payroll function, show where documents are generated and their flow, generate reports on deadlines, employee participation, etc. Such tools are the Casewise Corporate Modeler and the ARIS Business Architecture. They are innovative software solutions for description, analysis and optimization of business processes. These software products allow monitoring of main processes and sub-processes to the required degree of detail, provide details about each step of the process, visualize the documents that must be generated at a certain stage and their flow.

ARIS screens allow visualization of the interaction and relationships of the selected item (module, process, action, step, position, etc.) and other processes as well as its impact on other elements and processes included in the model and the system as a whole.

Depending on the information that is required and the selected object, the application can provide reports, charts and graphs of the following relationships (also known as links):

- Process - process link. Shows the hierarchy and the relations between processes;
- Process - sub-process link. Shows the sequence of process execution;
- Process - information system link. Shows the database that supports the execution of the process;
- Process - organizational unit link. Shows which unit is responsible for the process.
- Specific action/step - organizational unit/employee link. Shows the rights, responsibilities and obligations of a specific unit or employee with regard to the specified action/step.

ARIS can be used to visualize the separate steps of the development and implementation of a FMCS in an organization and to specify:

- The required resources, input information, and data processing;
- The hierarchy and subordination relationships of those involved in the implementation of the steps as well as their affiliation to organizational units (directorates, departments, units) in the performance of individual actions;
- Critical performance factors, controls and preventive measures, corrective measures in cases of non-compliance.

The following pages describe several ARIS screens related to the processes of undertaking financial liabilities and execution of payments as integral parts of a FMCS.[5] The navigation panel serves as a fast connection between the individual modules. It lists the names of the individual elements of the IFMCSs, the related standard documents, a legend of the used symbols, the organizational structure and other specific information for the particular module.

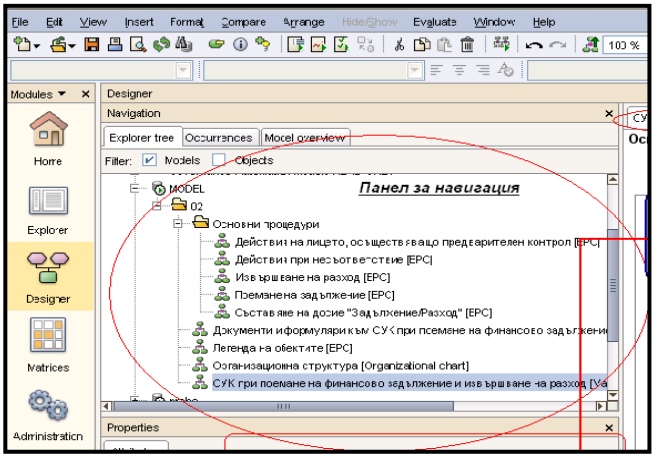


Figure 1. Navigation panel of FMCS

This particular screen shows not only the main procedures ("Liability Undertaking"; "Execution of Payment"; "Liability/Payment File Creation"; "Preliminary Control Action"; "Action in case of Non-compliance") but also the auxiliary modules, such as "FMCS Documents and Forms" (Liability Undertaking Requests, Payment Execution Request, Control Checklists, etc) and information regarding the organizational structure (the Organizational Chart module.)

[5] The screens are in Bulgarian because this particular FMCS was developed for Bulgarian users.

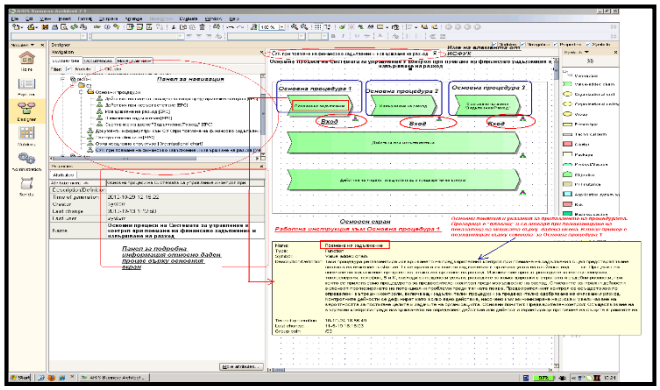


Figure 2. Visualization of the process panel of FMCS – general view

The "Organizational Chart" model is unique for each organization and provides details about the relations of:

- its administrative hierarchy, i.e. the relations between its structural units (directorates, departments, units, sections, etc.);
- its employees and their rights, responsibilities and obligations;
- the groups of employees with similar "roles" (the position - organizational unit link), including their names.

The information panel contains detailed information regarding a given main process, element or symbol. This information includes not only the name, creation date, last updated or edited and description data, but also the main functions/tasks of the process, its interaction and links with other processes, the impact it has on other elements and processes covered in the module and the system as whole.

Visualization of the interaction and the links of the selected element (module, process, action, step, position) with other processes, the impact it has on other elements and processes covered in the module and the system as whole.

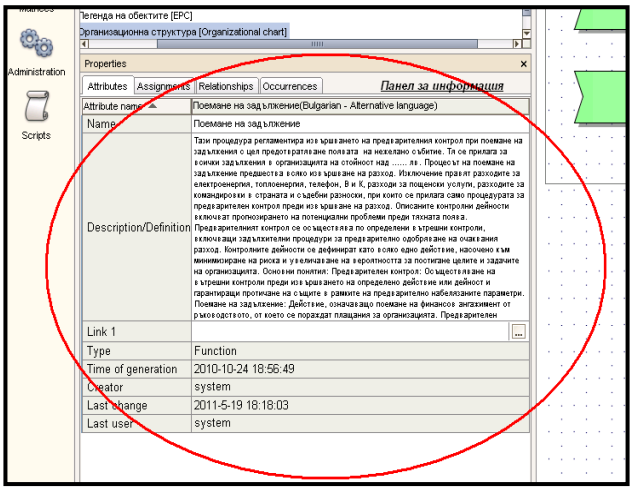


Figure 3. Information panel of a specific step from an FMCS process

5. Cloud-based FMCS

The implementation of FMCS is associated with some difficulties related to the large amounts of documents that are created and processed as well as the participation of different employees who may be located at geographically remote locations. The workflows are often described in bulky manuals that are difficult to navigate. Some of these problems may be resolved by using the innovative modelling tools described in the previous paragraph, but they in turn give rise to additional problems such as the need to purchase the required software and hardware and to employ specialists who can work with them. The modelling of business processes with Casewice or ARIS shall not solve the problem of the large amounts of documents unless appropriate specialized products for data exchange and referencing, document processing and transfer, etc are developed. Such possibilities are provided by the cloud technologies, which can save a lot of money to an organization - the money it should otherwise spend on purchasing and maintaining appropriate infrastructures and software.

The budgets of public sector organizations are limited and the creation and maintenance of electronic documents using designated FMCS servers and platforms is expensive. By using a cloud infrastructure (cloud computing) these organizations can significantly reduce their costs. Cloud computing provides an ubiquitous and convenient network access to a set of identified computing resources configured by communication networks, servers, data storage devices, applications and services, jointly and separately, which can be used with minimal operating costs.

Cloud computing users can significantly reduce their infrastructure costs (in the short and medium run) and respond flexibly to changes in computer and network needs, thus benefiting from the computing elasticity function (elastic computing) of cloud services. According to some rough estimations, such costs can be reduced about 10 times.

Considering the above findings, a team of specialists headed by the author developed a WEB-based electronic FMCS models and a software application called CROSS Control. They provide:

- Complete control over the internal document flows;
- Inclusion of all level of the organizational structure, including remote units;
- Complete electronic archive, i.e. storage, retrieval and copying/scanning of documents, safekeeping of the original documents, exchange and processing of certified electronic copies;
- Easy access to databases;
- E-mail exchange of documents;
- Intuitive and simple interface with network and local scanning and printing devices;
- Fast retrieval and referencing of registered documents;
- Up-to-date information regarding the flow and stage of all documents at each stage of the process with levels of access authorization;
- Additional information in various formats, accessible at each stage of the process;
- Generation of various reports required from spenders of budget appropriations.

Conclusion

The challenges faced by public sector organizations are no different from those that are typical for the private sector enterprises. At the same time business enterprises are much more flexible and adapt more quickly to changes in the environment. The increased competition due to globalization and the dynamics of market relations makes them constantly look for new management approaches and methods, while the typical and somewhat justified conservatism of the public sector makes it more irresponsive to changes.

In today's dynamic and globalized world the importance of unconventional resources such as information, know-how, outsourcing, networking, etc. has increased tremendously. This applies not only to private enterprises but also to public organizations that are spenders of budget appropriations. This is why the latter should keep abreast with their private-sector counterparts in the field of modernization. This article proposes some possible innovations in the field of financial management and control of public organizations based on the use of advanced software for managing business processes and the use of cloud technologies. These innovations are fully compliant with the regulatory requirements and the public expectations for transparency, effectiveness and efficiency in the spending of public funds.

INNOVATIVE ENTREPRENEURSHIP – THE EXAMPLES OF IMPLEMENTATION IN BUSINESS PRACTICE

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Abstract: *The process of creating innovative entrepreneurship is conditioned largely by endogenous factors of organizations and their ability to implement innovative solutions into business practice. This paper presents innovative interactive ICT-solutions offered by technology companies belonging to the SMEs sector. Considerations have been focused on the innovative devices (holographic pyramids, multimedia tables, and fog screens) and services dedicated to the needs of individual customers in the B2B area.*

Keywords: INNOVATION, ENTREPRENEURSHIP, ICT, HOLOGRAM, FOG SCREENS, INTERACTIVE COMMUNICATION

1. Introduction

Information and communication technologies (ICT) today constitute one of the most important factors shaping the way knowledge on business activities and offers is created and diffused. In the era of media convergence the activities of enterprises are permanently inscribed with a need for innovation and commitment to the target audience in the communication process. Information technology changed the relationship of the communication channel participants from "separation" to "crosslinking", and the distances between them are no longer relevant. Solutions tailored to individual customer needs have become an indispensable condition for the development of competitive advantage. Innovative entrepreneurship involves processes through which organizations generate value from their intellectual capital and knowledge-based assets. An important problem in the process of developing and increasing the competitiveness of companies is the level of technological innovativeness and uniqueness of products and services. The process of creating innovative entrepreneurship is conditioned largely by endogenous factors of organizations, including primarily the qualifications and expertise of employees and their ability to implement innovative solutions into business practice. A significant impact on the development of innovative entrepreneurship is also made by business ecosystem covering a wide spectrum of cooperation with business environment institutions (Badzińska 2014a, p. 28) and by external factors that influence the formation of technology firms (Bailetti 2012, p. 6). It is undeniable that entrepreneurship and the accompanying innovativeness have been and will be the driving forces of economic development.

The main objective of this paper is to present innovative interactive technologies and ICT-solutions in promoting images and products offered by technology companies belonging to the SMEs sector. Considerations in the area of the object of study have been focused on the identification and analysis of innovative devices (holographic pyramids, multimedia tables, and fog screens) and services dedicated to the needs of individual customers, particularly in the B2B area. For the purpose of achieving the goal of this paper a qualitative multiple case study analysis (Yin 2003) of technology firms Alpha Vision, Glip and Holomi have been conducted. Moreover, the owner and the co-founder of Glip Ltd. have been interviewed directly. The application of the empirical method of case studies has made it possible to characterize the essence of innovative entrepreneurship and illustrate the studied phenomenon in business practice. The examples of practical implementation of new ICT solutions were selected with a purposeful sampling technique (Merriam 1998; Maxwell 2005). The purposeful selection resulted from the clarity of the explained phenomenon and was aimed at identifying cases relevant to the research objectives.

The purpose of the business of analyzed companies is to create and promote innovative projects that will explore new opportunities and offer unique business solutions with the support of ICT. The products offered by the technology firms are dedicated for business customers, cultural and educational institutions and local government units. They are used in sales promotion, marketing activities, e.g. as parts of exhibition stands, surfaces for the promotion of sports clubs, hotels and showrooms. They are also widely used in entertainment, tourism and culture as interactive guides, sources of information and places of interactive fun.

The article is of an analytical-research character and can constitute a contribution to the discussion on the issues and as the starting point for deeper empirical research. The examples presented in this article regarding expert knowledge and the skills of its application in business practice can act as an inspiration for other businesses.

2. Conceptual background

The multidimensionality of entrepreneurship raises a number of difficulties in assessing its size and effects, hence literature and business practice have both adopted different criteria and measures for entrepreneurship (Dyduch 2008). This is also evidenced by widely described kinds, types and models of entrepreneurship. Entrepreneurship is manifested in innovative actions, in introducing new products and technologies and in unconventional problem solving. This is a creative and innovative ability of knowledge-based companies and an adaptation response to the real business environment (Nacu and Avasilcăi 2014). The term is also used to determine people's attitude towards the surrounding world and other individuals. This is expressed in creative and active improvement of existing states of affairs and readiness to take up new activities. It can be argued that entrepreneurial activity is the enterprising human action in pursuit of the generation of value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets (Ahmad and Seymour 2015). All the activities of this phenomenon relate to the identification of potential entrepreneurial opportunities arising from technological developments, and the exploitation of these opportunities through the successful commercialization of innovative products (Petti 2012, p. xi).

Following the Oxford Handbook of Innovation (Fagerberg, Mowery and Nelson 2005), the concept of innovation refers to the putting into practice of inventions. An important distinction in the innovation literature is between innovations that are new to the world, innovations that are new to the domestic market or innovations that are new to the firm (Fagerberg 2005). A strictly technological approach focuses specifically on product and process innovations, or technological innovation, as a result of knowledge-intensive entrepreneurship. A broader approach refers to innovation as the development of new products, new processes, new sources of supply, but also to the exploitation of new markets and the development of new ways to organize business (Szirmai, Naudé and Goedhuys 2011, p. 5).

A process approach to entrepreneurship is popular in literature. It involves identifying and implementing opportunities arising in the environment (Glinka and Gudkova 2011). Entrepreneurship is seen as a process of searching for market opportunities and organizational resources necessary to exploit these opportunities in

order to gain results on a long term. It can be distinguished as independent risk taking ability to achieve the biggest gains in the market (Nacu and Avasilcăi 2014, p. 229). The creativity, capabilities, dynamism, and innovativeness of the entrepreneurs in a country are important aspects of the absorptive capacity, which is such a distinctive characteristic of successful development experiences (Szirmai, Naudé and Goedhuys 2011, p. 10).

The dominant theme of world articles on technological entrepreneurship focuses on small technology firms and on external factors that influence the formation of technology firms (Bailetti 2012). Another theme addresses the consequences of technology based business and engineering entrepreneurship (Nicholas and Armstrong 2003). Important theme is the interdependence between small-firm initiatives and the external infrastructure that contributes to science and technology advances. This theme describes the systems that support the foundation of new technology firms, establishment of a new technology venture and different types of technical entrepreneurs (Jones-Evans 1995). Liu et al. (2005) represent ways in which entrepreneurs draw on resources and structures to exploit emerging technology opportunities. Entrepreneurial opportunities often have to be 'created' by using the entrepreneurial imagination to embody human aspirations in concrete products and markets (Venkataraman and Sarasvathy, 2001).

Innovative entrepreneurship focuses on investing in and executing the firms' projects, not just recognizing technology or market opportunities (Lindenberg and Foss 2011). The firm's owners and employees have no way of knowing or predicting the relevant attributes of all the assets. Asset attributes need to be created by the whole team. Innovative entrepreneurship identifies, selects, and develops new attributes for the purpose of creating value for the firm and for customers. Inventions, discoveries and new technologies – as a result of the implementation and development of the commercial market – form technological innovations that determine further development of products and processes.

3. Innovative interactive technologies and IT-solutions – practical implementation

3.1 3D hologram effect

Holographic pyramid is one of a few devices that so reliably reflect the effect of the hologram and at the same time is a very interesting form of advertising and visual presentation. It can display three-dimensional objects, logos, graphics, or play a 3D movie. It is well known that commercially available devices rely exclusively on illusion and hologram delusion. Regardless of whether the hologram is obtained by the so-called Pepper Ghost effect – that is, stopping the image on the projection foil stretched at 45 degrees, or using the display on a specially woven mesh – we never really look at a clean hologram; it's just an illusion deceiving the brain. The biggest drawback of these two solutions is the number of conditions (e.g. illumination, adequate room size) that must be met in order to apply them. In the case of the holographic pyramid, it is not a problem (see Fig. 1).



Fig. 1 *Holographic pyramid of HOLOMi*[1].

It is a device that can be used anywhere, without any adaptation to the environment. The holographic pyramid enables exceptionally attractive presentations of products, objects or phenomena that are visible on each side of the device. Realistic animated 3D hologram effect and a personalized design are important characteristics of this innovative solution.

A 360 holographic pyramid, constructed by Alpha Vision Event Engineering (see Fig. 2), is an interesting 3D hologram concept. Its functionality allows for presenting animations on all four walls of the pyramid while still retaining the ability to place an object in the middle of the device. Minimalist design and advanced technology combined in one product offer a perfect whole. Pyramids vary in their resolution of the display material.



Fig. 2 *Holographic pyramid – campagne MasterCard "Fly with MiG"*[2].

Holographic Pyramid XL (dimensions: 100 x 64 cm at the base and 40 cm high) is the largest of Alpha Vision's holograms available, ideally succeeding in presenting objects in the middle of a hologram or an animation for a larger group of people. It is a device designed for presentations in open spaces, and allows for free movement around the pyramid.

3.2 Fog screens Leia Display S-95 and X-300

Fog screens belong to a group other innovative technologies, which allow one to view an image in the air. It is a holographic revolution making presentations. An example of such a solution is Leia Display System (LDS) – a screen designed and patented by Polish entrepreneurs. LDS Screens have been in mass production since October 2014. This innovative technology – based on solutions in the field of aerodynamics and computer science – allows the projection of any media content on a thin layer of water vapor, which is virtually invisible to human eye. The streams of steam form a medium for the image and their laminar (straight, non-curled) structure allows the image to be high quality. The patented way to produce laminar airflow for very long distance from the output makes Leia Display the most steady midair screen on the market. Small details of the picture are visible even 250cm away from the output. Very thin projection surface (about 6mm) makes possible to project hi definition pictures. Moreover, Leia screens actively respond to touch. An ability to pass through picture, touch it, or even to interact with it using movements and gestures, provides new possibilities in the area of promoting and building a brand image (see Fig. 3).

[1] www.holomi.com (accessed: 20.01.2016).

[2] www.alphavision.pl (accessed: 20.01.2016).



Fig. 3 *Leia Display S-95*[3].

Earlier projection solutions based on steam used a curtain of dense smoke, on which it was possible to display an image, but it has been smudged and unreadable. Leia Display screens, on the other hand, make use of enhanced technology, so that the image quality is incomparably better.

The following two sizes of Leia Display screens have entered mass production: S-95 and X-300. LDS S-95 is a screen with dimensions of 95cm x 65cm mounted on a mobile base, so the picture remains at viewer's eye level. The screen blows vapor from the bottom and it is possible to display i.e. a virtual assistant, a 3D model or an interactive game. S-95 is primarily addressed to the advertising market, where innovative formulas of communication are particularly appreciated. This innovative solution perfectly complements the offer of interactive devices used at trade fairs, promotion of products or cultural events at museums. In turn, Leia X-300 generates a screen size of 3 x 2.5 m, which is suspended from the top and blows vapor downwards. This is a screen through which one can literally walk and drive out of it with a car by smashing a virtual glass pane (see Fig. 4). But this is not a three-dimensional projection. LDS X-300 screens can be combined with each other using their shorter side and in practice form infinite surfaces. This allows an extensive use on event, entertainer, and theater markets and other events related to new technologies.



Fig. 4 *Leia Display X-300*[4].

As mentioned above, the projection surface is composed of water vapor, and demineralized water is used for its production. Leia S-95 consumes approximately 400ml of water per hour, and in the case Leia X-300, it is 4l per hour. Projection surface is protected by special curtain airbags, but it is not recommended to use the device in drafts or directly under air blowers. The image becomes visible using rear projection. There is no single recommended type of projector. Its type and capacity depends on the brightness of the place where it is to be used. The projector should be turned in the direction of the viewer. The image can be seen from both sides, but for this purpose two projectors must be used.

Leia Display System constitutes the next step in the evolution of interactive technology. The adaptation of such solutions as Kinect and Leap Motion, which read the movements of the human body, provide Leia Display screens with a completely new dimension. By using this type of interface the user can interact with the screen using gestures and movements, which provides unlimited possibilities of presentation. A person passing through the screen may become surrounded by desirable animation – flash fire, butterfly wings or stars (see Fig. 5). Depending on the sensitivity of sensors, a signature can be made in the air or something can be drawn.



Fig. 6 *Interaction with the Leia screen*[5].

3.3 Glip Multitouch Solutions

The products offered by Glip are innovative, created on the basis of expertise and integrated devices supporting a variety of applications – ready-made or manufactured according to individual orders. GlipTable has to 82-inch touch-sensitive surface with an ability to track more than 30 points of touch and a sound system, built-in Wi-Fi and Bluetooth. The device interface is based on Windows 7 and Android operating systems and allows several people to use it simultaneously. It allows comfortable surfing of the Internet, view images, specially prepared multimedia presentations and browse the detailed programs of events. The new solution of Glip is dedicated to companies managing public transport. The concept of a modern media bus stop is an innovative ICT product with GlipTable at its core (see Fig. 6).



Fig. 6 *Multimedia bus stop with GlipTable*[6].

The company has introduced several modifications to its touch surfaces, providing them with new functionalities and adapting them to modern urban spaces. Touch screens installed in the shelter and authorial applications developed by Glip are the first such solutions in Poland in the area of public transport. In the opinion of its makers the purpose of the designed solution is to optimize the distribution of information for travelers and information regarding fleet management in public transport.

5. Results and discussion

The analyzed technology firms use a wide range of ICT to provide other entities with new technological, information and communication solutions. They offer equipment based on the technology of touch, motion detection and holographic projection, and also copyright software created per requests of different groups

[3] www.leiadisplay.com/pl/ (accessed: 20.01.2016).
[4] www.leiadisplay.com/pl/ (accessed: 20.01.2016).
[5] www.leiadisplay.com/pl/ (accessed: 20.01.2016).
[6] www.glip.pl (accessed: 20.09.2015).

of consumers, freely customized and designed in accordance with customer's colors and company logo. The potential of innovative solutions such as 3D holograms, fog screens, interactive iWall, iFloor and iTable media, as well as gesture control systems, all offer a completely new dimension of multimedia presentation. The products from the world of the latest technologies increase the attractiveness of the media and of events. They are the ideal solution wherever viewing experience counts and where businesses want to be distinguished by the originality of their media and engage their customers – at fairs, premieres, fashion shows, shopping centers and cultural and sporting events. Due to their originality and uniqueness, Leia screens allow brands to differentiate themselves in a competitive environment and among the audience build a sense of communing with the technology of the future. This technological solution can find numerous applications in the promotional activities of companies. In turn, the use of modern ICT solutions as the multimedia bus stop of Glip combined with telematic systems, which allow the processing of data or instance available via GPS make it possible to more effectively manage enterprise communication. The continuous increase in demand for advanced, specialized services and modern e-business solutions creates an opportunity for new innovative companies.

The teams of entrepreneurial, ambitious and creative people who constitute the analyzed companies believe that understanding customer needs, partnership in business relationships and offering customized solutions tailored to the specifics of a particular industry is the basis for the value and effectiveness of each action. Devices and applications created by Alpha Vision, Glip and Holomi – individually adapted and modified – support interactive and engaging business communication and take into account the realities of a rapidly growing B2B market. The companies have been working on developing new products and would like to implement innovative solutions based on the latest technologies. Transforming the concept into a coherent and valuable application, service or devices, created on the basis of professional consulting and support for the project in this phase of its implementation is a challenge faced by the young entrepreneurs.

Innovative entrepreneurship which must be combined with innovativeness is an ability to allocate resources efficiently. It can be argued that competitive advantage of technology firms is derived from their employees' unique knowledge, skills and especially the ability to implement them in practice, as well as specific organizational competencies and research experience. These companies successfully bridge the gap in the creation of innovative business solutions with the support of ICT and, above all, seek to obtain market acceptance for their offer. However, it is necessary to skillfully combine innovative ideas with effective governance and relevant funding sources.

6. Conclusions

The modernity of products and services provided by Polish enterprises depends largely on the creating of entrepreneurship culture, which is the basis for the development of innovativeness by people with funds, who are able to take risks. The key competences of technology firms are undoubtedly located in the resources of knowledge, research experience and skilful use of these resources to create added value and value for customers. Moreover, expert knowledge is a fundamental resource that controls the processes of reconfiguration and multiplication of other resources, constitutes a platform of shared values and is fundamental for building trust in a company.

Technology firms represent the mainstream of innovative entrepreneurship and one of the active mechanisms of the commercialization of research results. The owners and employees of these enterprises are able to put into practice interdisciplinary knowledge, to perceive gaps and market opportunities, forward-looking, searching for change and responding to it and using it to implement innovative solutions in various areas of socio-economic life. Current expertise and interdisciplinary knowledge in conjunction with the skill to develop them constitute a basis to build core competencies of a company, allow one to design an appropriate organizational structure and the division of responsibilities, and make the right decisions, thereby reducing business risk (Badzińska 2014b, p. 17). The development and implementation of innovations require cooperation with the institutions of business environment, including those that provide funding for such projects.

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SELECTED ASPECTS OF PATENT PROTECTION IN SMALL AND MEDIUM-SIZED ENTERPRISES: A LITERATURE REVIEW

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Abstract: The aim of this paper is to show the importance of patent protection in small and medium-sized enterprises and to identify the major challenges for intellectual property management faced by this group of companies. The study provides a literature review on patent activity in small and medium-sized enterprises. On this basis, it can be concluded that small firms may be disadvantaged by their size in the use of patent protection. Consequently, most companies prefer informal appropriation mechanisms, such as secrecy, lead time advantage or complexity of product design. The reasons for the relatively low patent activity of small and medium-sized enterprises is the lack of sufficient funds and knowledge on the management, as well as the limited capacity of exercising their intellectual property. The article also identifies the most promising directions of further research and articulates a number of recommendations both for managers as well as for policy makers.

Keywords: INNOVATION, INTELLECTUAL PROPERTY, PATENT PROTECTION, SMALL AND MEDIUM-SIZED ENTERPRISES

1. Introduction

There is no doubt that small and medium-sized enterprises (SMEs) play an important role in the European economy. As shown by Eurostat data, they constitute the overwhelming majority (99.8%) among all business entities. SMEs also provide around two thirds of jobs and account for nearly 60% of value added (Key figures on European business, 2011).

The primary advantage of SMEs is their high flexibility, which allows - to a greater extent than large corporations – the identification of changes in the environment and the use of emerging opportunities. Therefore, innovation seem to be the best way to build competitive advantage for this group enterprises. Innovation activity, however, is very expensive and risky. Moreover, even in a case of successful implementation, there is a real danger of imitation by competitors. Companies wishing to succeed must, therefore, not only to innovate, but also effectively protect their innovation.

The most obvious way of protecting the innovation are legal instruments, in particular patents. Patents give exclusive right to use the invention for commercial purposes, which means that patented invention cannot be made, used, distributed, or sold by others without the patent owner's permission. Such inventions, however, have to meet a number of rigorous criteria: to have novelty in worldwide domain, to embody a significant inventive step (be nonobvious, even to experts in the field), and be capable of industrial application (Greenhalgh and Rogers, 2010).

The aim of this paper is to show the importance of patent protection in small and medium-sized enterprises and to identify the major challenges for intellectual property management faced by this group of companies. There is a fairly broad consensus among scholars, policy makers as well as business practitioners that the modern patent system meets the needs of small and medium-sized enterprises only to a small degree. The study provides a literature review on patent activity in small and medium-sized enterprises. In the following section the most important barriers to the patent activity of SMEs have been identified. Subsequently, the possibility of using patents for strategic purposes (ie. not related to the protection against imitation) has also been indicated. In conclusion, the most promising directions of further research and a number of recommendations both for managers as well as for policy makers have been indicated.

2. Firm size and patent propensity

A number of studies have shown that the patent propensity in SMEs is lower than in large companies. For example, Mol and Masurel (2012) based on the data from Dutch 2006 Community Innovation Survey (CIS) found that the firm size positively influences the use of patents. Interestingly, a similar relationship has not been confirmed for other forms of legal protection like registered designs or copyright.

A study of 211 innovative Argentinian companies belonging to five industries (apparel, boats, agricultural machinery, oil services, and vehicle parts) also showed that firms with more than 90 employees use patents as a means of appropriation in a much more extent than firms with fewer number of employees (Milesi, Petelski, and Verre, 2013).

Furthermore, a detailed analysis of nearly 1.2 milion patent applications revealed that SMEs patent less at the international level than their larger counterparts. SME patent applications also cover a smaller number of patent offices on average (Frietsch, Neuhausler, and Rothengatter, 2013).

On the other hand, Jensen and Webster (2006) based on a sample of Australian enterprises demonstrated that SMEs file more patents, trade marks, and design usages per 1000 employees than large firms. In turn, a study carried out on a sample of 534 German manufacturing firms showed positive and statistically significant correlation between firm size and the number of patent applications. However, a deeper analysis proved a U-shaped relationship between firm size and the patent output of a company. This means that the large as well as small companies apply for more patents per employee than medium-sized firms (Neuhausler, 2012). SMEs are also more active in patenting in emerging fields like nanotechnology, biotechnology or renewable energy (Frietsch, Neuhausler, and Rothengatter, 2013).

Many authors investigaded the use of a wide range of informal protection instruments as an alternative to patents. For example, Galie and Legros (2012) concluded that firm size affects the type of IP protection. Large firms prefer formal methods like patents and trademarks whereas small firms prefer rather informal means like complexity of design or lead-time advantage over the competitors.

The majority of existing works have confirmed that small and medium-sized firms do not consider patents as the most important appropriation mechanism. In addition, a study conducted on a sample of 559 Italian companies showed that a greater number of patents is not associated with higher profitability of SMEs (Agostini, Nosella, and Soranzo, 2015). In contrast to these findings, however, Andries and Faems (2013) provided evidence that not only large companies, but also SMEs can benefit from patent protection. Moreover, their study based on the dara from 526 Flemish manufacturing firms showed that patent activity increase

the ability of SMEs to license out knowledge assets to external partners. These activities, however, do not generate short-term financial profits.

Many authors have noted that SMEs are not a homogeneous group and individual companies can implement entirely different patent strategies (Thoma and Bizer, 2013; Hsueh and Chen, 2015). Especially, patents seem to be highly useful for research-oriented firms (Gans and Stern, 2003; Leiponen and Byma, 2009). Other sudies have shown that appropriation strategy depend on such factors as industry sector (Brouwer and Kleinknecht, 1999; Galie and Legros, 2012), type of innovation (Arundel and Kabla, 1998; Cohen et al., 2000), cooperation with external entities (Olander, Vanhala, and Hurmelinna-Laukkanen, 2014) or export activity (Mol and Masurel, 2012).

It is belived that lower patent propensity among SMEs are caused by presence of numerous obstacles which particularly affect on smaller firms (see next paragraph). Kitching and Blackburn (1998) argued that small business owners prefer informal ways of appropiation, because these methods are more familiar, cheaper, less time-consuming and frequently as effective as more formal rights. Another explanation to this phenomenon could be incremental character of innovation introduced by a significant part of SMEs (Thoma and Bizer, 2013).

3.Obstacles to patenting

The basic problem encountered by firms applying for patents is associated with the high cost of such form of protection. The total costs of patenting include, among others, a number of procedural fees, patent attorney remuneration, translation costs (while patenting abroad) and maintaining costs (fees paid to the patent offices at regular intervals to maintain patent). It is not surprising that this factor particularly affects smaller firms due to their limited financial resources needed to protect patents (Galie and Legros, 2012; Neuhausler, 2012).

Another well-known problem is a very long period (in some cases reaching up to five years) of pending application by the Patent Office. This puts into question the desirability of requesting such form of protection for products and technologies with a relatively short life cycle. Lengthiness of patent procedures, coupled with uncertainty about their final result is certainly a big disadvantage especially for companies planning to license their intellectual property or using them to strengthen the bargaining power in negotiations with business partners (Gans, Hsu, and Stern, 2008).

Moreover, small and medium-sized enterprises may not be able to detect and fight against infrigements their intellectual property rights. Davis and Kjaer (2003) indicated several reasons of such situation:

- in the cases of patented processes it may be impossible to check whether the patent has been infringed (eg. when imitator restricts access to its plant);
- it may be too costly to detect infringments on foreign markets, even for product innovations;
- the patent holder may be affraid to enter into litigation with firm commiting infringement due to the enormous expenses arising from lawsuits.

Patent protection also requires to disclosure a number of detailed information about the innovation (Holgersson, 2013). Through patent databases (also available via the Internet), the information can reach out to practically all interested parties. Especially competitors might take advantage of this to "invent around" or to identyfy strategic directions of the inventor's activities. On the other hand, small and medium-sized enterprises do not use the existing patent information to a sufficient extent, which may lead to a severe loss to compete in the future (Hall, Oppenheim, and Sheen, 2003).

4. Motives to patent

Apart from the most obvious reason (ie. protection against imitation) companies might apply for patents from various strategic motives. It is worth noting that previous studies have indicated that the importance of particular motives varies significantly depending on such factors as firm size or sector of activity (Blind et. al., 2006). The data from a survey among applicants at the European Patent Office (EPO) confirmed significant differences in patenting motives among particular applicant types: individual inventors, small firms, universities, and large companies (Veer and Jell, 2013).

Many authors have indicated that patents may be used not only to protect innovation but also to block competitors in their development activities. This motive is potentially more benefitial for large companies as they have sufficient financial resources needed to maintain an extensive patent portfolio and to patent broadly. Similarly, large companies more often use patents for cross-licensing negotiations or trade with other firms (Neuhausler, 2012). Patents may also be useful as an internal performance indicator and instrument for encouraging the creativeness of employees (Gilardoni, 2007).

Although patents may reveal important information to competitors, however, in many cases inventors can reap a number of benefits through such disclosure. This means that patents may also be used for strategic signalling (Gick, 2008). It seems to be particularly important for smaller firms which very often use patents for improvement technological image or attract the attention of potential customers as well as co-workers (Holgersson, 2013).

SMEs can leverage their intellectual property rights to obtain investors, such as business angels and venture capital funds. For such investors patent may be a sign of firm's technological advancement and innovation capability. Patent disclosures also facilitate the assessment of the quality of the project and estimate it's business risk (de Rasenfosse, 2012; Haeussler, Harhoff, and Mueller, 2014). Moreover, Fischer and Ringler (2014) indicated tha patent may facilitate access to debt financing, serving as the required collateral. This concerns especially new ventures, which usually lack substantial tangible assets.

Patents establish the legal basis for obtaining royalities through licensing intellectual property to other parties. This reason might be particularly applicable to small firms, which often suffer the lack of resources needed for indepenent commercialization of new goods (Davis and Kjaer, 2003). Patents and other formal means of protection can also act as one of mechanisms for coordinating innovation-oriented inter-firm cooperation. This reduces the fear of opportunistic behavior and encourages partners to share knowledge. Moreover, patent protection helps to identify which rights belong to each of the parties. This should prevent problematic situations, unwanted conflicts and thereby reduce time-consuming negotiations (Olander, Vanhala, and Hurmelinna-Laukkanen, 2014).

5. Conclusion

The study provides a literature review on patent activity in small and medium-sized enterprises. On this basis, it can be concluded that small firms may be disadvantaged by their size in the use of patent protection. Consequently, most companies prefer informal appropriation mechanisms, such as secrecy, lead time advantage or complexity of product design. The reasons for the relatively low patent activity of small and medium-sized enterprises is the lack of sufficient funds and knowledge on the management, as well as the limited capacity of exercising their intellectual property.

Due to the existing barriers in the access to patent protection, policymakers should pay more attention to provide public support for small and medium-sized enterprises. Such support, however, should include not only grants (especially for patenting abroad) but also professional services to obtain, defend, and enforce intellectual property rights.

From the practical point of view, managers of small and medium-sized enterprises should be very cautious when choosing the best form of protection innovation. As patents are very expensive and time-consuming form of protection, SMEs need to use their intellectual property rights more actively than larger firms (including strategic goals, eg. for improvement technological image or obtaining external funds).

Although the patent activity of SMEs has already been the subject of numerous papers there are still a number of under-recognized areas. As the most promising directions for further research should be pointed following:

- intenational patent strategies of SMEs,
- the most effective forms of public support for SME patent activity,
- interaction between formal (legal) and informal (strategic) means of protection,
- the role of patent protection in boosting innovation-oriented cooperation of SMEs.

Such studies cannot be limited to firms from developed countries (eg. USA, Japan, United Kingdom or Germany), but to a greater extent should also include enterprises from developing and transforming economies.

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SYSTEMATIC COMPARISON OF EXISTING AND NEW APPROACHES FOR MONITORING COMPLIANCE RULES OVER BUSINESS PROCESSES

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Abstract: *The body of literature on business process compliance is large and approaches specifically addressing process monitoring are hard to identify. Moreover, proper means for the systematic comparison of these approaches are missing. Hence, it is unclear which approaches are suitable for particular scenarios. The goal of this paper is to define a framework for Compliance Monitoring Functionalities (CMF) that enables the systematic comparison of existing and new approaches for monitoring compliance rules over business processes during runtime. To define the scope of the framework, at first, related areas are identified and discussed. The CMFs are harvested based on a systematic literature review and five selected case studies. The appropriateness of the selection of CMFs is demonstrated in two ways: (a) a systematic comparison with pattern-based compliance approaches and (b) a classification of existing compliance monitoring approaches using the CMFs. Moreover, the application of the CMFs is showcased using three existing tools that are applied to two realistic data sets. Overall, the CMF framework provides powerful means to position existing and future compliance monitoring approaches.*

Keywords: BUSINESS PROCESS MANAGEMENT; BUSINESS PROCESS COMPLIANCE; COMPLIANCE MONITORING

1. Introduction

The need to check for compliance of business processes based on a set of constraints may emerge in different phases of the process life cycle [1],[2] ,[3]. During design time, the compliance of a process model with a set of constraints is checked. At runtime, the progress of a potentially large number of process instances is monitored to detect or even predict compliance violations. For this, typically, terms such as compliance monitoring or online auditing are used. Finally, processes can be diagnosed for compliance violations in a *post mortem* or offline manner, i.e., after process instance execution has been finished.

This paper is dedicated to compliance monitoring as this is crucial for the timely detection and prediction of compliance violations as well as for the provision of reactive and pro-active countermeasures on compliance violations [4], [5], [6]. Further, in realistic settings, the existence of a complete process model for compliance checks cannot always be assumed. In fact, business processes are often implemented in a rather implicit manner and executed over different information systems (e.g., Enterprise Resource Planning (ERP) or Customer Relationship Management (CRM) tools) as depicted in Fig.1. Although there are similarities between design time/*post mortem* analysis and compliance monitoring , this paper will focus on the latter in order to provide a clear scope.

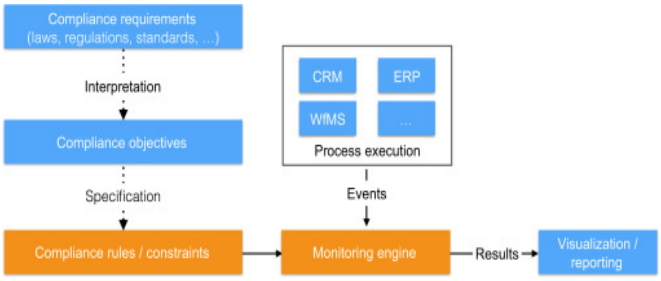


Fig.1 *Process model for compliance*

Typically, compliance requirements on business processes stem from different sources such as laws, regulations, or guidelines that are often available as textual descriptions. An important task towards compliance monitoring is the interpretation of these requirements as compliance objectives and the subsequent specification as compliance rules or constraints (note that, in this paper, we will use both terms interchangeably). As shown in Fig. 1, the specified compliance rules will be verified over the process execution events. The results of compliance monitoring can be visualized and reported back to users in different ways, ranging from notifications on violations to fine-grained feedback on reasons for violations, or even the prediction of possible and unavoidable future violations.

In general, compliance monitoring approaches are driven by two factors: (1) the *compliance rule language* that is used to specify the compliance requirements and (2) the *event format* the compliance checks are based on. Due to the possible heterogeneity of the data sources employed, an integrated target event format is desirable.

2. Research methodology

Hence, the main challenge tackled in this paper is to provide proper means for comparing approaches for compliance monitoring in business processes in a systematic way. This challenge will be addressed by the following four research questions: *How to identify compliance monitoring approaches?; What are functionalities that are essential for compliance `monitoring approaches in business processes?; How can we demonstrate the appropriateness of the identified compliance monitoring functionalities?;How can the compliance monitoring functionalities be applied in existing tools?*

The goal of this paper is to define a framework for Compliance Monitoring Functionalities (CMF) that enables the systematic comparison of existing and new approaches for monitoring compliance rules over business processes during runtime. Specific challenges for eliciting the CMFs are the multitude of existing approaches in the area of business process compliance and the decision of which functionalities are required in real-world scenarios. In order to address these challenges, we apply the methodology depicted in Fig. 2

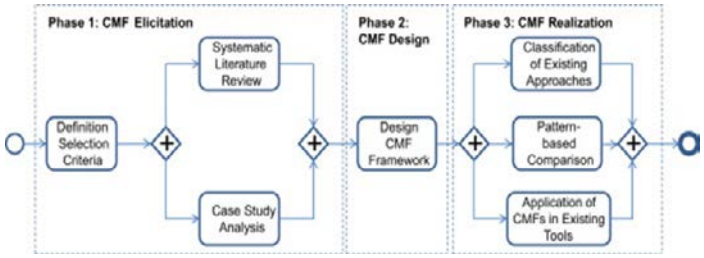


Fig.2: *Research methodology*

The methodology consists of three phases, i.e., *elicitation*, *design*, and *realization* of the CMF framework.

***Phase1—Elicitation*:** The elicitation phase follows the research methodology described in the context of elicitation of process change and time patterns[7], [8], [9], [10]. First of all, *selection criteria* are defined that scope the research done in this paper. As overarching selection criteria, we focus on:

a. *functionalities that are relevant for process compliance monitoring*, i.e., the observation and enforcement of compliance constraints that are imposed over business processes during *runtime* and

b. *constraints that are imposed at the process level*, i.e., we exclude, for example, integrity constraints [6], [11], [10], [17].

The elicitation phase includes a systematic literature review and an analysis of five case studies from different domains. The CMF identification is based on the results of the systematic literature review and the case study analysis and possibly illustrated by additional examples.

Phase 2—Design: The CMF design itself is presented in *Section 4*. Each CMF is described using a CMF template and illustrated by examples taken from literature or case studies.

Phase 3—Realization: In order to demonstrate the appropriateness of the CMF design, existing approaches are classified along their support for the CMFs (cf. *Section 4*). Moreover, constraint patterns as suggested by the literature are compared to the CMFsproposed in this paper. Finally, to illustrate the application of the CMF framework, compliance rules are extracted from two realistic and publicly available data sets.

Based on the extracted rules and the data sets we showcase the application of compliance monitoring for business processes in existing tools (*cf. Section 5*). Note that the data sets for CMF application are different from the case studies utilized for CMF elicitation.

3.Compliance Monitoring Functionality (CMF) elicitation

After defining the selection criteria, the first input for the elicitation of CMFs is compiled from a systematic literature review.The search was conducted using scholar.google.com. In a first step, keywords were searched in the titles of the papers, excluding patents and citations. The list of references resulting from the horizontal search was evaluated in a first round excluding papers that: are clearly geared towards design time aspects; do not refer to requirements on the compliance specification language;do not refer to constraints at the business process level, but to more low level integrity constraints such as Service Level Agreements (SLAs) or calculating Key Performance Indicators (KPIs).

Obviously, the first filter criterion led us to loose design-time approaches that can be potentially lifted to runtime analysis. The results from the first and second round of the literature review were analyzed in two rounds; first of all, by assigning each paper to a researcher, followed by a group discussion on all 83 papers. For each paper, it was checked whether it *provides a compliance monitoring approach for business processes* [5],[8]; *includes studies on process compliance patterns* [9], [10], *provides enabling technologies and related techniques for process compliance monitoring, e.g., conformance checking* [11], [12], [13]; *provides frameworks for compliance monitoring infrastructure* [14], [15], [16] or *contract monitoring* [6], [7], or *features domain-specific approaches such as from health care, providing requirements, examples, and case studies* [13], [16].

4. Compliance Monitoring Functionality (CMF) design

This section presents our CMFF, i.e., the framework of *Compliance Monitoring Functionalities* (CMFs). Following the methodology set out in *Section 3*, we derived CMF candidates from a systematic literature review and five case studies. Based on several rounds of discussions, these candidates were then cleaned and aggregated into the ten CMFs proposed in this paper. Each CMF is described using the following template listing the *name*, a brief *overview* on the CMF, a *description*, guidelines about the *evaluation criteria*, *examples*, and *implementation* hints of compliance rules illustrating their functionality. Whenever possible we directly borrow the examples from literature or the projects. Sometimes we also provide new examples to highlight specific features of the CMFs.

Moreover, the following requirements for CMFs were identified that also serve as basis for classifying the ten presented CMFs . Such requirements tackle the three main dimensions of any CMFF: (a) modeling of compliance constraints, (b) analyzing the raw data at runtime, and (c) generating compliance monitoring results to be returned to the end users.

1. *Modeling requirements.* A compliance monitoring approach has to enable the specification of compliance constraints can be monitored The CMFs of this class refer to the ability of compliance monitoring approaches to express constraints not only on the control flow of a business process, but also on other, equally important, perspectives. This helps in classifying CMFFs with respect to their modeling capabilities, and to position their adequacy in a specific domain with its own compliance constraints to be formalized. The following three CMFs refer to the ability of a compliance monitoring approach to deal with constraints that address aspects beyond control flow*: time, data, and resources.*

2. *Execution requirements.* Compliance monitoring approaches should deal with execution-based information attached to the events of the event stream to be monitored. In general, an event is always related to an activity in a business process, but further information can be also provided. There are several requirements imposed on compliance monitoring approaches by the domain. The following CMFs enable the assessment whether or not a compliance monitoring approach meets these requirements: *Supporting non-atomic activities,Supporting activity life cycles; Supporting multiple instances constraints.*

3. *User requirements* The third dimensions focus on the ability to return the compliance assessment to the end users. Specifically, *advanced diagnostics and recommendations* relate to the ability of a CMFF to provide advanced, meaningful information to end users that go beyond violation detection and explanation. The CMFs described in this section refer to the ability of a compliance monitoring approach to address user requirements: *Ability to reactively detect and management; Ability to pro-actively detect and manage violations;Ability to explain the root cause of a violation; Ability to quantify the degree of compliance.*

5. Compliance Monitoring Functionality (CMF) realization

This section is concerned with *Phase 3 CMF Realization* of the methodology depicted in Fig. 2. Phase 3 consists of three building blocks, i.e., a pattern-based comparison of CMFs related to language aspects with compliance patterns set out in the literature, a classification of existing monitoring approaches using the CMF framework and the application of the CMFF in selected tools.

The authors of this paper proposed three approaches, namely *MobuconEC (cf. Section5.1), MobuconLTL (cf. Section5.2)* and *SeaFlows (cf. Section5.3)* , that make use of different techniques to enable compliance monitoring. In the following, we showcase the application of the ten CMFs in these three tools. As these are the tools we know best, it is ensured that we are able to correctly apply the tools in a case study for discussing the implementation of CMFs.

In order to analyze tools using the CMFs, a data set consisting of compliance rules covering the CMFs to be investigated and process instances (or process logs for replaying process instances) are necessary. We selected the Business Process Intelligence Challenge (BPIC).

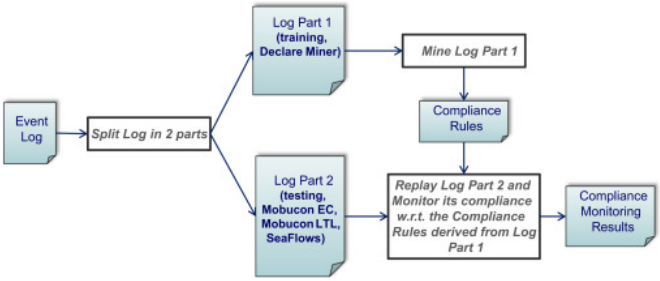


Fig.3.*Methodology of implementation of CMFs in the selected tools*

In this section, we illustrate the methodology we have followed to show how the CMFs have been implemented in the selected tools. We started from the data sets described in Fig. 3. illustrates the methodology. We have split the logs in two parts (Log Part 1 and Log Part 2). For the hospital log, in the first part, the first 571

cases are considered. In the second part, the rest of the cases (572 cases) are included. For the financial institute log, in the first part, the first 6543 cases and, in the second part, the rest of the cases (6544 cases) were considered. Then, we have mined Log Part 1 (training log) to extract a set of compliance rules. To do this, we have used the *Declare Miner* component of the process-mining tool ProM [1], [2], [17]. This allows us to automatically discover compliance rules related to control-flow, data and resources based on the mainstream observed behavior, i.e., frequent behavior is converted into a collection of *Declare* constraints. *Declare* is a declarative language based on an extensible set of constraints [12], [13], [14] , [15]. *Declare* supports most of the modeling constructs and hence a good candidate to evaluate and illustrate the CFMs. The compliance rules have been used as a reference model to monitor a stream of events coming from the replay of Log Part 2 (testing log).

5.1. Compliance monitoring with MobuconEC

MobuconEC is a compliance-monitoring framework based on a reactive version [12] of the Event Calculus [13]. As described in [2] and [6], the approach has been exploited to formalize the extension of Declare described in [3] and [4]. This extensions support: • Metric time constraints, which can be directly formalized (together with qualitative time constraints) using the *explicit approach* to time provided by the Event Calculus ; •Data and data-aware conditions, leveraging on the first-order nature of the Event Calculus ;• Resources, which are considered as special data;• Non-atomic activities, which can be encoded in the Event Calculus using additional data and dedicated rules, as shown in [7] .Notably, the formalization in [1] directly support the possibility of monitoring the lifecycle of activitie.The high expressiveness of compliance rules in *MobuconEC* has the main drawback that only reactive management of violations can be tackled: proactive management would require to reason on the possible future continuations of the current, partial trace by considering also data and metric timestamps, which is undecidable.

5.2. Compliance Monitoring with MobuconLTL

MobuconLTL is a compliance-monitoring tool implemented as a provider of the operational support in the process-mining tool ProM. It takes as input a reference model expressed in the form of Declare rules. More generally, every business constraint that can be expressed as an LTL formula can be monitored using *MobuconLTL*. A stream of events encoded using XES can be monitored with respect to the given LTL specification.



Fig.4. *MobuconLTL supports metrics for quantifying the degree of compliance*

MobuconLTL monitors finite-trace LTL constraints through deterministic finite state automata. Therefore, it does not tackle constraints referring to data and resources (ranging over finite state) because of the state space explosion problem. *MobuconLTL* implements reactive monitoring . It is possible, at runtime, to detect that a state of affairs is reached such that two or more compliance rules become conflicting (conflict state); the presence of a conflict means that no possible future course of execution exists such that all the involved constraints are satisfied. In this sense, *MobuconLTL* also supports a pro-active management of violations and root cause detection. The automata-based approach allows *MobuconLTL* to provide the user with detailed diagnostics about which activities can be executed and which ones are forbidden at any point in time during the process execution. This is possible by evaluating which transitions can be fired from the current state of the automaton and which ones bring the automaton in an inconsistent state. The tool only supports simple metrics for quantifying the degree of compliance of a case (Fig.4.).

5.3. Compliance monitoring with SeaFlows

SeaFlows is a compliance checking framework that addresses design and runtime checking. It aims at encoding compliance states in an easily interpretable manner to provide advanced compliance diagnosis. The core concepts described in [3] , [4] [5], [6] were implemented within the prototype named *SeaFlows Toolset.* With *SeaFlows*, compliance rules are modeled as *compliance rule graphs* (CRG). *SeaFlows* enables to monitor a stream of events encoded in a predefined event format. It further enables the import of logs in XES standard format.

Qualitative time constraints are well-supported by *SeaFlows*. In particular, the CRG approach is not restricted to predefined compliance constraint patterns but allows for constraints that are more complex. However, *SeaFlows* does not address quantitative time .

SeaFlows only partially supports CMF 2. This is because it provides only limited support for constraints with non-unary data conditions. Resource-aware compliance rules are only supported if the resource conditions can be expresse

For this case study, the logs were automatically replayed and checked against all modeled rules. For each violation, a violation file was created. Fig.5 illustrates how compliance with R5 is monitored by replaying the log of a specific case.

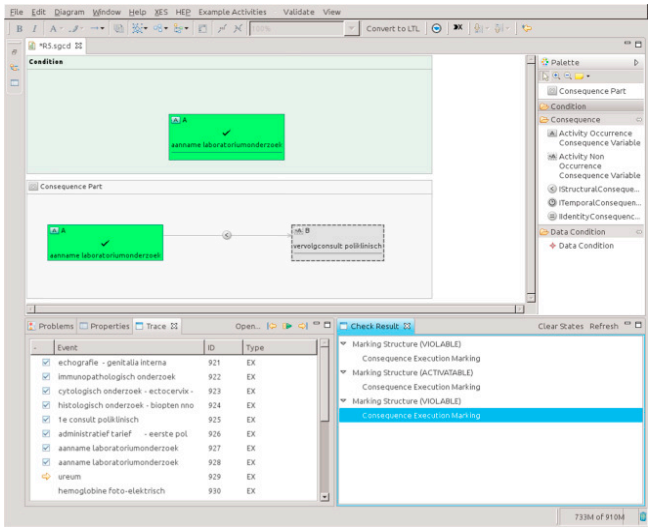


Fig.5. *SeaFlows monitoring of compliance by replaying the log*

As compliance with a CRG is checked by executing it against the event trace using well-defined rules, the compliance state is represented through markings of the CRG. When a violation is observed, it is reflected in the markings of the CRG.

When the last event of the case is executed, both instances become violated as shown in Fig. 6. The marked CRG serves as basis for deriving explanations for violations. That is the reason why the corresponding node is marked with red color. Once violated, the instance of a compliance rule cannot become satisfied in the further process execution. This is because the violation is already manifest in the log. However, monitoring can still be continued for the compliance rule (i.e., future possible violations of the rule in the process instance can also be detected). Thus, *SeaFlows* supports reactive compliance management.

As the compliance monitor of *SeaFlows* was implemented as a proof-of-concept for the reporting features for compliance

monitoring. Although the compliance states of multiple compliance rule instances can be aggregated to provide an overall compliance level, the framework does not support a more detailed analysis of the individual metrics. In addition, *SeaFlows* does not detect violations caused by the interplay of two or more constraints. Hence, the conflicts among some of the rules in the case study remain undetected.

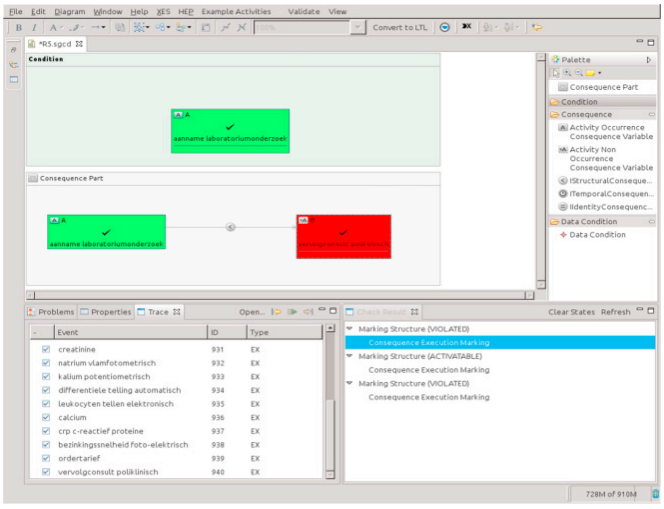


Fig.6. *SeaFlows monitoring of compliance by replaying the log*

6. Conclusion

This paper presents a framework for the systematic comparison of compliance monitoring approaches in the business process management area. The framework consists of *ten Compliance Monitoring Functionalities* (CMFs) and includes requirements for the constraint modeling notation (e.g., supporting time and data), requirements with respect to the execution (e.g., supporting multiple constraint instances), and user requirements (e.g., providing fine-grained feedback). The CMFs are harvested based on a systematic literature review as well as from five case studies from different domains (health care, food and diary manufacturing and maritime safety).

The appropriateness of the CMFF is shown in two ways. First of all, the CMF framework is compared with existing compliance patterns in the business process management area. Secondly, existing compliance monitoring approaches are classified based on their support for the CMFs. The comparison with compliance patterns supports the importance of the four constraint-related CMFs, i.e., those CMFs that relate to language and expressiveness aspects in the constraint specification. The classification of existing approaches pointed out that none of them supports more than seven CMFs and most approaches are not supported by publicly available software tools.

Here we have to note that for some approaches several of the CMFs could not be evaluated based on the literature. It seems that several approaches focus on a specific language aspect rather than integral monitoring support. Less attention has been devoted to user requirements, i.e., the provision of fine-grained feedback or even the proactive indication of compliance violations. Nevertheless, it is crystal clear that users play an important role in compliance monitoring, e.g., to interpret deviations.

In order to demonstrate the applicability of this CMF framework, two realistic data sets from the BPIC 2014 and 2015 were applied using three compliance monitoring tools, i.e., *MobuconLTL*, *MobuconEC*, and *SeaFlows*. The data sets consisting of process execution logs from patient treatment and the financial domain were divided into training and testing data sets. Compliance constraints were harvested based on the training set, implemented within the three tools, and monitored over the testing data set. The application of concrete tools to these data sets nicely illustrates how compliance monitoring works in practice and shows what the interaction with users looks like.

The work can be further extended in several directions, e.g., to cross-organizational or configurable processes. An interesting area of adaptation/extension of the CMF framework here presented naturally arises when there is the need of a comprehensive compliance evaluation not just within, but also across process cases. Traditionally, business processes are monitored in a case-by-case manner. However, compliance rules may span across cases, e.g., because they focus on resources independently from the specific case in which they operate, or because they need to compare and combine data produced inside different cases.

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INFORMATION MODELING OF ONLINE AIR TICKETS RESERVATION SYSTEM

ИНФОРМАЦИОННО МОДЕЛИРАНЕ НА СИСТЕМА ЗА ОНЛАЙН РЕЗЕРВАЦИЯ НА САМОЛЕТНИ БИЛЕТИ

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Abstract: *Modern society brought high demands on the quality of information systems, which require the use of modern methodologies and software to automate the process and reduce development time of the project and raise its quality. One of the most promising approaches in this direction is the Model Driven Development (MDD), that is an innovative approach for development of different software applications using models at different levels of abstraction and applying model transformation to code generation. The main objective of this paper is to present an approach for model-driven development of online air ticket reservation system based on UML.UML use case diagrams and class diagram are used to model the main requirements and data model of the system respectively in order to achieve reusable and portable models of the system. The developed UML conceptual data model is implemented in a MySQL based database. Finally, some conclusions are made.*

Keywords*:* INFORMATION SYSTEM, DATABASES, MODEL DRIVEN DEVELOPMENT, MYSQL, UML, TICKET RESERVATION

1. Introduction

Nowadays, the Internet is very popular all over the world. Information systems are evolving very rapidly and dynamically. It should be noted that with the development of information technology, the use of e-commerce increases considerably [1]. For majority of people, e-commerce began to occupy an integral part of their lives. In addition to ordinary goods, the shopping list includes also trips, insurance and tickets. In recent years, new factors began to change the structure of sales in the ticketing process. Modern society is plunged into the world of information technology, which contributes to the emergence of various technological solutions. That is why information systems are gaining momentum and becoming more popular. With the progress in communications there is a need of such information systems as online ticket reservation systems. The desire to travel and explore the world is inherent to people. The main task of online reservation system is to provide the possibility of buying tickets without outside help.

The development of information systems is impossible without carefully consideration of an effective methodological approach. For successful project implementation, the subject of design should be adequately described. Recent research and experience on modeling information systems show that it is logically difficult, laborious and lengthy task. For qualitative modeling, it is very important to use Model Driven Development (MDD) approach, where the model becomes the primary development artifact from which code can be automatically generated in the future [2, 3]. This method is highly effective and reliable for the development of such information systems as an online reservation ticket system. The Model Driven Architecture (MDA) [4] is one of the most successful implementations of MDD, based on Unified Modeling Language (UML) [5] and is offered as standard by the Object Management Group (OMG).

The main aim of the paper is to present an approach for application of MDD and MDA to the development of online air ticket reservation system. The paper is organized in 5 parts. After the introduction, in part 2, the requirements to the developed system are proposed. Part 3 illustrates a short review of the applied techniques. In Part 4 of the paper the suggested approach is described based on the UML use case and class diagrams. Finally, some conclusions are made.

2. System requirements

With the development of information technology, the requirements to the electronic reservation systems are getting higher. Reservation is the act of reserving a place or passage, or engaging the services for a person or group. First of all, the ordinary purchases go to online mode and the same is situation with the travel products. Online reservation of tickets is carried out with a view to reserving a certain category of tickets for a specific date, a specific customer request, transmitted through the Internet. After using reservation system, customer gets the electronic ticket (e-ticket), which is an electronic document certifying the contract of carriage between the passenger and the airline. Unlike paper ticket, e-ticket is a digital record in the airline database. Passenger receives confirmation by e-mail with receipt, which contains all the information about the purchased ticket. It is not necessary to print it, as the airport employees have a reliable database. For identification and payment confirmation the passenger is only required to provide a passport.

It is worth pointing out that there are plenty of advantages in booking ticket online. One of the main advantages of this process is time saving, which means that customer can book an air ticket from any place, such as home or office. What is more, booking ticket online allows customers to see all the information about all possible flights and fares. Airline reservation system makes it possible to get a ticket not only for themselves but also for their loved ones. Customer can visually check the correctness of the data entered. Another advantage of this purchase is the fact that a person does not need to carry large sums to pay. Booked tickets can be redeemed online through credit card or electronic money. Those who trust only paper money, after the reservation can pay for the ticket in the nearest terminal. Each of these advantages makes online reservation system convenient and unique of its kind. It goes without saying that nowadays there are a lot of ticket offices, but the human factor becomes a negative point in buying there. Of course, booking office manager is interested only in quick sell of tickets. The sellers are not interested in client's needs, like lower price ticket or more convenient connections. Through the online booking, the customer can see all available flights per day. Customer can choose the best offer, airline ticket price, departure time, a place in the cabin, as well as to determine the type of food. Due to the lack of office purchase, the online one will be cheaper. The practice shows that more and more people prefer online flight booking. Internet users consider

that online booking system is the best solution for acquisition of tickets.

3. Short review of the applied techniques

3.1. MDD and MDA

Model-driven development (MDD) is an approach that is changing the way of software development, through moving the center of gravity from the direct writing of source code to using models, reflecting different perspectives and levels of abstraction [2, 3]. In [6] the MDD is considered as architectural meta-programming in which models are values and transformations map models to models. One of the most popular and successful technology for MDD is the Object Management Group (OMG)'s Model Driven Architecture (MDA) standard providing a powerful conceptual framework for development and transformation of three interconnected types of models - Computation Independent Model (CIM), Platform Independent Model (PIM) and Platform Specific Model (PSM) towards executable applications as shown in Fig.1 [4]. The main features of the models are:

- CIM – is also known as business or domain model that uses vocabulary to present the basic expectation from the system and to bridge the gap between domain experts and developers. This abstraction hides all specifications connected to the system implementation.
- PIM – is a view of the system without any details about implementation. Basic tasks of the PIM model are to model logical data, to establish dependencies and defining workflows and processes. Furthermore, PIM models must be sufficiently complete and accurate to ensure a higher degree of automated implementation of the models in the next layer (PSM).
- PSM – combine the PIM specifications with concrete platform information needed for enabling system execution, i.e. the basic role of this model is to ease the code generation using PIM and selected execution platform.

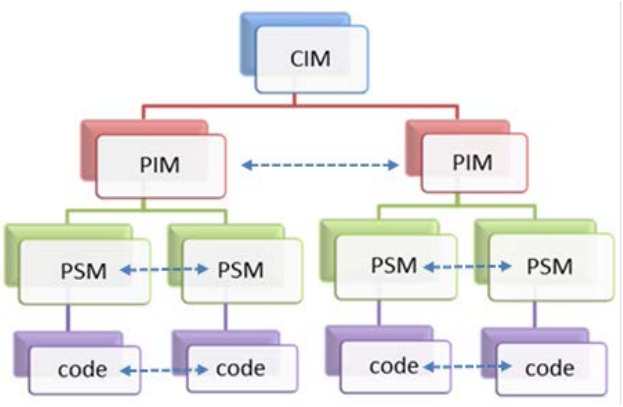


Fig.1: *MDA conceptual framework*

3.2. UML and UML diagrams

In order to achieve the goals of MDD and MDA, Unified Modeling Language (UML) is used. UML is a general purpose graphical modeling language for specification, visualization, design and documentation of artifacts created in the development of software systems [5]. A comprehensive UML modeling tool like "Visual Paradigm" is an ideal way to take control of a software or a business project. UML diagrams are used for displaying models and their components [7]. UML 2.0 contains 13 types of charts, grouped in the following groups:

- **Structural diagrams** emphasize the structural elements that must be presented in the modeled system. These diagrams are frequently used to document the architecture of software systems. Class diagrams, object diagrams, component diagrams, composite structure diagrams, package diagrams, and deployment diagrams all fall under the umbrella of structural diagrams. Class diagram shows the classes, their attributes and relationships between classes (Fig.2). Component Diagram shows the components and their relationships. Block diagram shows the internal structure of the classes and the communications with the outside world. Deployment Diagram shows how the software is placed on hardware (servers, workstations). Object diagrams show the structure of the system, objects and their attributes at a particular time. Package Diagram shows how the system is expanded to major components and the connections between these parts.

- **Behavior diagrams** visualize, specify, construct and document the dynamic aspect of the modeled system. They are often used to describe functionality of software systems. Use case diagrams, activity diagrams, and state machine diagrams are all subsets of behavior diagrams [8]. Activity diagram shows the flow of information in the system. State diagram is a state machine illustrating the flow of an object from one state to another. Use Case Diagram shows the operation of the system in terms of users and use cases.

- **Interaction diagrams**, which are technically a specialized type of behavior diagrams, emphasize the flow of control and data throughout the modeled system. Sequence diagrams, communication-, timing-, and interaction diagrams are kinds of interaction diagrams. Diagram of cooperation shows the structural organization of the objects involved in the interaction. Interaction diagrams show the interactions between objects and their relationships. Sequence diagram shows the time ordering of events. Timing diagram is associated with the timeframe of the project.

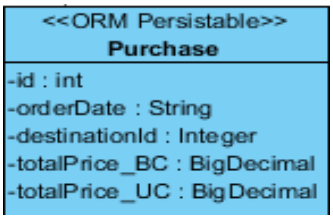


Fig.2: *Example of a class in Class Diagram*

3.3. Databases and MySQL

As it was noted earlier, all the information that is used in the site is taken and stored in a database. A database is an organized collection of data [9]. It is a collection of schemas, tables, queries, reports, views and other objects. The data are typically organized to model different aspects of reality in a way that supports processing the required information. Database management system (DBMS) is a combination of language and software, which provides access to the data, allowing the user to create, change and delete data, provides data security, etc. Data can be accessed using Data Manipulation Language (DML) such as SQL (Structured Query Language). SQL is Structured Query Language, which main task is to provide a simple way to read and write data to the database.

The proposed e-commerce application for online ticket reservation requires dynamic web pages providing interactive features with the customers. The web program, executed on the middle-tier web server, as shown in Fig.3, must submit a query to the database through the DBMS (MySQL) resided on the bottom-tier database server, retrieve the required information and display it. For this purpose, different techniques may be used. In our case the open source scripting language PHP [10] is used. The PHP interpreter provides a hypertext preprocessor executing PHP commands, creating the corresponding HTML and sending it to the client-tier. MySQL is used as DBMS and is one of the most popular and widely used DBMS over the Internet. An important factor is that this DMBS is open-source and is distributed under the general license GNU (GPL, GNU Public License). MySQL has good speed, reliability, flexibility and is not difficult to work with it.

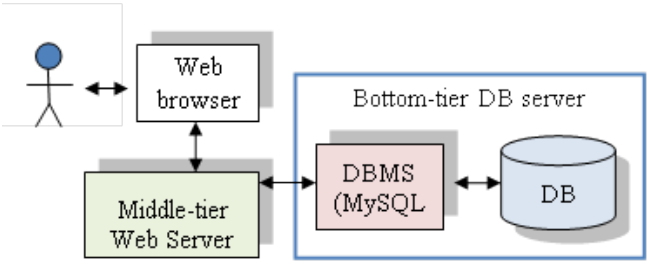


Fig.3: *Scheme of database work*

The task of long-term storage of information is very common in development of Web-based applications: visitor's count in the counter, holding posts in the forum, remote management of information content on the site, etc. The volume of code is greatly increased as well as the chance to make a mistake. All these problems can be solved by the use of a database. Databases take care of data security, modeling of data, and information can be retrieved or updated using a single line of code. Retrieving data from a database is much faster than from a file.

4. Description of the suggested approach

The development of an online air ticket reservation system is chosen as an example of the suggested approach, based on the idea of Model Driven Development. The operation of the system in terms of actors and use cases is represented in Fig 4 and Fig 5.

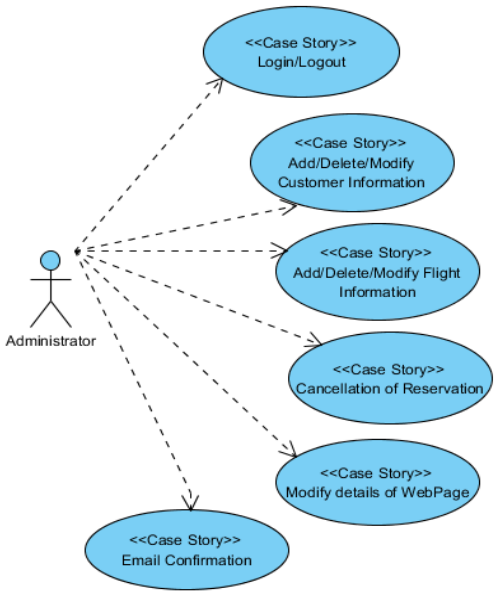


Fig.4: *Use Case Diagram in respect to Administrator actor*

The static description of the system (in terms of its design) and its structure are represented through class diagram shown on Fig.6. To build the class diagram, special software, named “Visual Paradigm” was used. “Visual Paradigm” is software design tool, tailored for agile software projects. The diagram describes in detail the process of ticket reservation. The process, where the customer reserves the air ticket, chooses the cities of departure and arrival, fares and company is illustrated in this class diagram.

The next step after modeling is to generate the database. The database stores all information about flights, schedule, destinations, departures, arrivals, customers, planes, companies. In this project MySQL Workbench was used, which is a visual database design tool that integrates SQL development, administration, database design, creation and maintenance into a single integrated development environment for the MySQL database system. MySQL Workbench provides the opportunity to create the "entity-relationship" model which main components are entities (elements) and relationships between them. As shown in Fig.7, the "entity-relationship" diagram clearly shows the main relations between tables. For instance, the table "reservation" is related with many other tables, which means that they depend on each other. The table "reservation" stores the data about customer, prices of tickets, and seats.

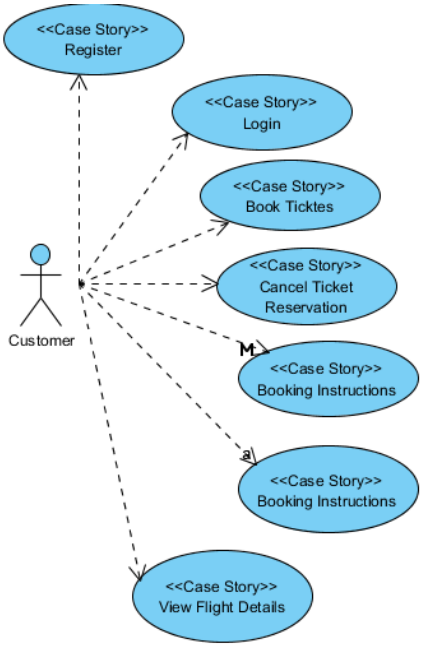


Fig 5: *Use Case Diagram in respect to Customer actor*

5. Conclusions

The transition from approaches based on a directly code creation to model-driven software development poses the modelling as one of the first most important things in all field of engineering. Ticket reservation system is an embodiment of information technologies which is connected with the needs of nowadays society, where the need to travel is integral part of life. With regards to the development of a reservation system, it should be mentioned that one of the most important parts of the project is the modeling of the process, which was successfully demonstrated in this article using UML and MySQL. It should be noted that in future, the represented information model can be implemented on different platforms, which makes this project relevant and fast-growing.

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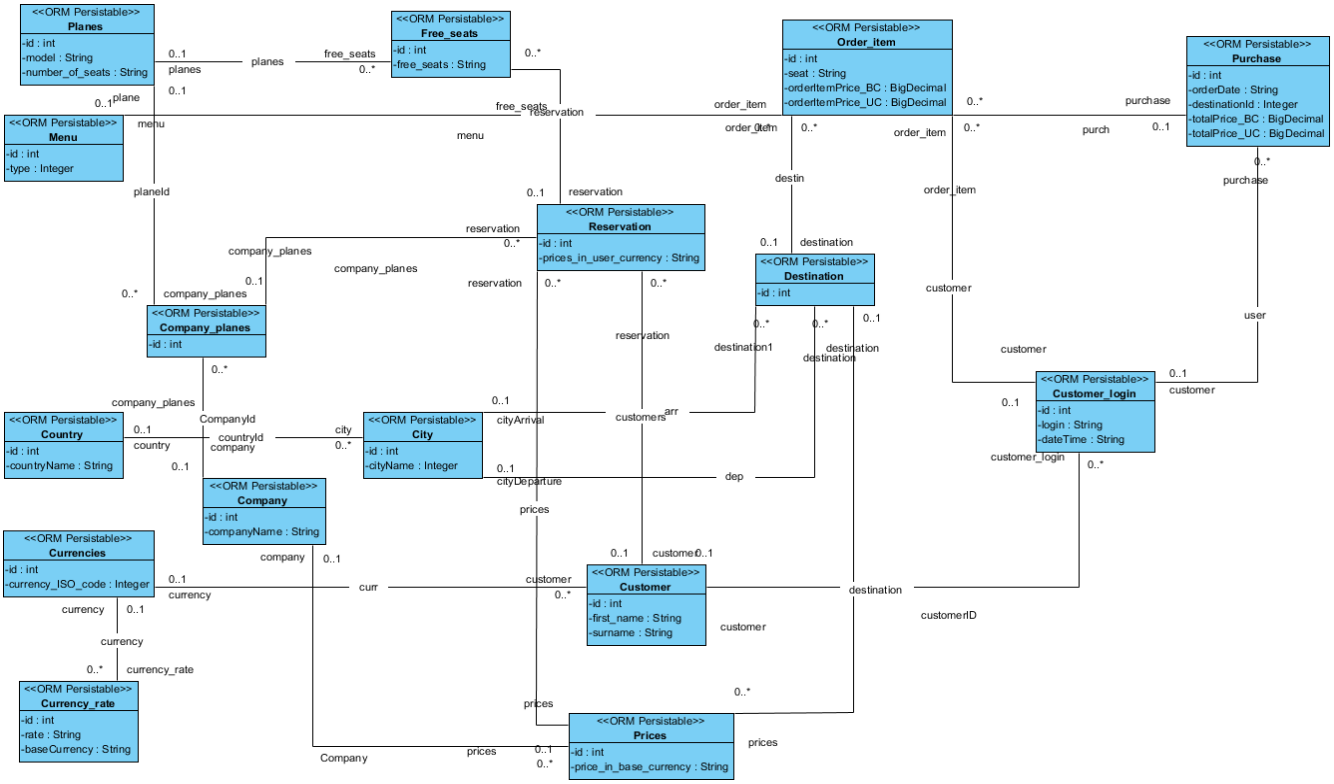


Fig.6: *UML class diagram*

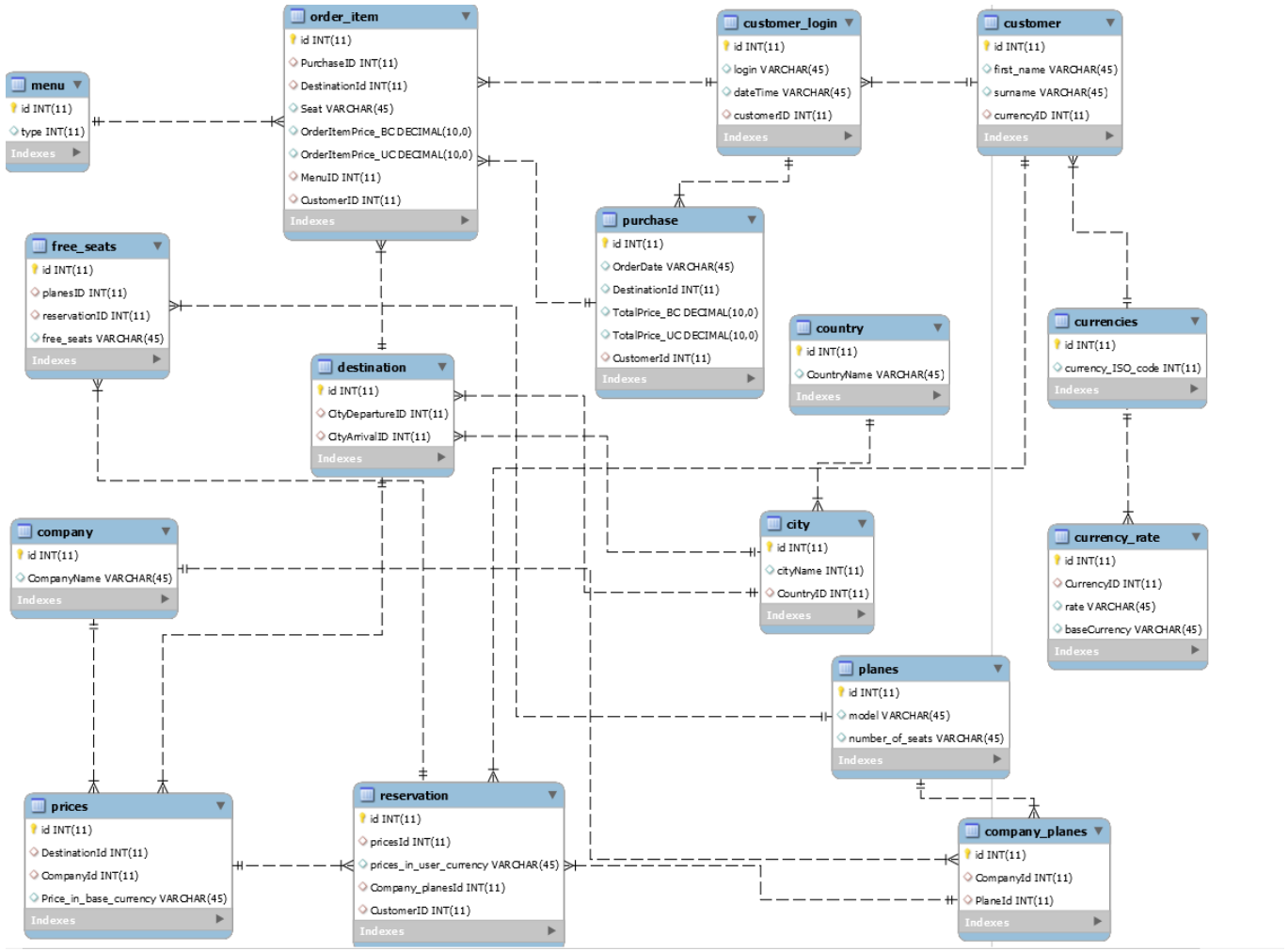


Fig.7: *ER – model of Database*

MODEL-DRIVEN DEVELOPMENT OF ONLINE SYSTEM FOR E-COMMERCE

МОДЕЛНО-УПРАВЛЯВАНА РАЗРАБОТКА НА ОНЛАЙН СИСТЕМА ЗА ЕЛЕКТРОННА ТЪРГОВИЯ

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Abstract: *Nowadays E-commerce is gaining more and more popularity, it contains all possible financial and trade transactions which are made via computer networks. Model-driven software development (MDSD) is the key to create the exact and accurate software application. All the necessary information is taken from a database. The most widely used database management system is MySQL. The latter is an open-source relational database management system, which is written in C programming language. In order to clarify the working process of an organization, a UML class diagram is created. The UML (Unified Modeling Language) is used for making graphical visual models for all the business processes. The paper presents the main stages of e-commerce transaction, using E-shop as an example.*

Keywords: ELECTRONIC COMMERCE, MODEL-DRIVEN SOFTWARE DEVELOPMENT, DATABASE, MYSQL, UML.

1. Introduction

Internet becomes more attractive environment for business development. It offers attractive methods and tools for implementation of marketing, advertising and commerce. Business on the Internet is gradually becoming an integral part of economic life and becomes a daily routine for everyone. The reason for this is that networks have changed the way of communication for millions of users having access to the Internet and there are no limits caused by time and space. Online shopping has become an integral part of the economy of any country. Recent researches show that external trade has grown around 18,3 % in comparison to 2014, which means, that money turnover has measured up 1,35 trillion US dollar in 2015. [1]

Model-driven development (MDD) is a paradigm for writing and implementing computer programs quickly, effectively and at minimum cost. The methodology is also known as model-driven software development (MDSD) and model-driven architecture (MDA) [2]. Stages of creating model in MDD: defining boundaries, structuring solution, designing the domain model. MDD operates using UML (Unified Modeling Language). It is a standardized object-oriented language for graphical modeling of the architecture and functionality of software applications. It is a family of graphical notations, united by a common meta-model that support the description and design of Object Oriented software systems. Based on unified symbolic names and semantics, UML defines a set of diagrams and notations for modeling object-oriented systems [3, 4]. The unified language can be used for modeling of different in types, volume and destination systems, hardware and /or software, technical and /or public, real and /or virtual. Based on the development and use of different types of diagrams different viewpoints and aspects of states, functioning, relationships and interactions of these systems can be modeled.

The main aim of the paper is to apply an MDD approach for development of on-line system for e-commerce. The paper is structured in 5 parts. After the introduction, in part 2 a short analysis of E-commerce structure and business processes involved are proposed. Part 3 describes the main features of databases, MySQL, UML and class diagrams. In Part 4 the suggested approach is represented. At the end, some conclusions are made.

2. Short analysis of E-commerce structure and involved business processes

E-commerce is a continuous cycle of data processing and exchange, realizing a unified and integrated information support of all participants in the overall commercial transaction, whatever their field of activity, sector, country, and so on. More formally, it focuses on digitally enabled commercial transactions between and among organizations and individuals carried out in real time via telecommunications networks [5]. The term “e-commerce” is widely used, as it includes virtual examination of goods, selecting products to purchase and choice of payment methods. In e-commerce there is no prior agreement between the parties - client and vendor. It is performed over the Internet using a technology developed for sharing, access and data storage. E-commerce covers out open processes with customers, suppliers and external partners. These include: marketing, taking orders, shipping, customer service, purchasing of raw materials for the production and supply.

Applications for e-commerce from type “business-customer” are similar to business operations, supporting e-commerce from type “business-business”, but are usually associated with retail trade, i.e. purchases by end users. As a type of economic activity, E-commerce consists of different business processes. A business process is a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers [6]. The basic processes related to electronic commerce are shown in Fig.1 and are the following:

Visiting the website: Main objective of this process is to attract potential customers to the site by using Internet. Banner ads sending targeted emails, giving away prizes and other activities have an important role in the trade cycle. A new trend is the creation of societies whose goal is the formation of environment for attracting visitors through discussion forums, surveys, chats and others. Customers in e-commerce are served by a website i.e. customer e-shop is a member of the global network. User is an individual whose goal is to pay by credit or debit card and receive the goods at home.

Review of electronic catalog: Unlike traditional trading after the initial visit, the client began building their profile, i.e. draw in opinion about goods interested at. The process then continues with the examination of electronic catalogs containing information on individual goods and services. What's important at this stage is the customer interest at the application or e-commerce site to offer sales, advertising campaigns, new or improved goods.

Selection of goods and services: This phase of e-commerce includes the selection of goods by the customer. The e-commerce must have a well developed management system that preserves the current status of the order (usually in the form of shopping cart), which contains information about the quantity and price of goods.

Placing an order. The next stage is the shaping of the order. In the model business-customer, purchaser enters address data for delivery and shapes the way of payment. It can introduce additional requirements of the customer in the form of a note (packing the purchase as a gift, time delivery and more. ancillary services).

Shaping of payment and delivery. After receiving the information about the place of delivery and payment, e-shop determines the value of goods and delivery costs. The program can be improved by developing opportunities for international contracts (regarding distance in determining the value of the supply).

Payment. After calculating the value of goods and delivery costs, presents bill payment from the buyer. Depending on the customer's wish credit, debit cards or cash can be used. There is a protection when transferring data over the network between the buyer and the online store in order to protect personal data and verify their authenticity.

The next steps are **order processing**, **order execution**, and its **delivery**, which is the final stage of e-commerce type of business.

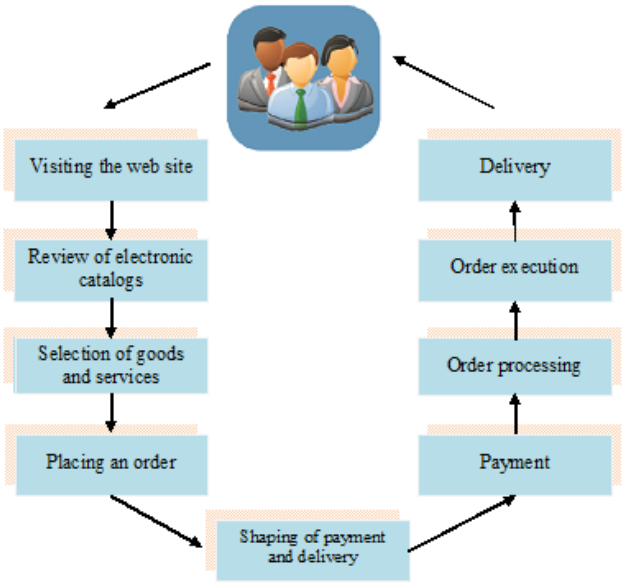


Fig.1: *Main processes in an e-commerce application*

3. Short review of the applied techniques

3.1. Unified Modeling Language (UML)

In order to apply MDD, the Unified Modeling language (UML) is used. It is a standardized modeling language enabling developers to specify, visualize, construct and document artifacts of a software system [3]. Thus, UML makes these artifacts scalable, secure and robust in execution. It uses graphic notations to create visual models of software systems. UML is designed to enable users to develop an expressive, ready to use visual modeling language. In addition, it supports high level development concepts such as frameworks, patterns and collaborations. UML presents different types of diagrams, used for different purposes. The variety of UML diagrams is shown on Fig.2 [8].

A class diagram is at the heart of UML. It represents the core purposes of UML because it separates the design elements from the coding of the system. UML was set up as a standardized model to describe an object-oriented programming approach. Since classes are the building blocks of objects, class diagrams are the building blocks of UML. The diagramming components in a class diagram can represent the classes that will actually be programmed, the main objects, or the interaction between classes and objects. The class diagram is composed of three sections [9] (an example of a class “order” from an UML class diagram is presented on Fig.3):

- Upper section – includes the name of the class. This section is always required whether you are talking about classifier or an object.
- Middle Section – contains the attributes. They are variables which describe the qualities of the class. This is only required when describing a specific instance of a class.
- Bottom section – contains the operations (methods) which describe how a class can interact with data.

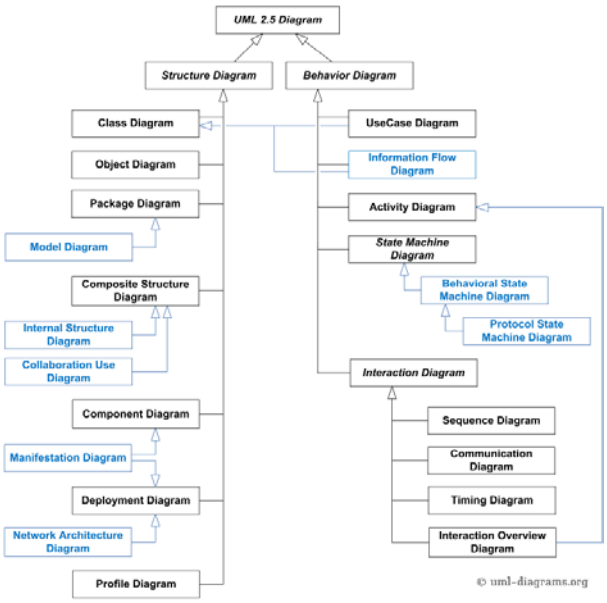


Fig.2: *The structure of diagrams which could be made using UML [8]*

All classes used in the diagram are connected between each other via relationship. In UML there are different types of relationships, the main types of them are as follows [9]:

- Dependency – the basic type among the objects;
- Association - represents a family of links;
- Aggregation - a variant of the "has a" association relationship;
- Composition - a stronger variant of the "has a" association relationship;
- Generalization - indicates that one of the two related classes is considered to be a specialized form of the other;
- Realization - is a relationship between two model elements, in which one model element (the client) realizes (implements or executes) the behavior that the other model element (the supplier) specifies.

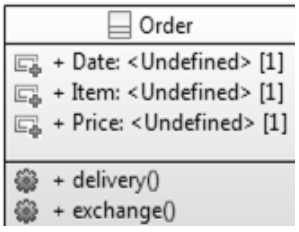


Fig.3: *The example view of the Order class in the created class diagram*

3.2. Database management system MySQL

An information system for e-commerce is a system that implements automated collection, processing and manipulation of data and includes technical resources, software and maintenance labor force [10]. It includes a computer system, one or more databases (DB), a database management system (DBMS) and a set of applications (software). The database provides information

storage and it is a renamed set of information sorted by certain rules, including the general principles of description, storage and manipulation of data. A database management system is a selection of software and a variety of language resources designed for creating, maintenance and using of database [10]. The main functions of DBMS are as follows [11]:

- Information storage and protection;
- Changes (updating, adding and deleting) of the stored data;
- Information search and selection according to users' requests;
- Processing the information and displaying the results.

The development of e-commerce applications is based on a variety of technologies, according to the specific characteristics and complexity of application. The combination of PHP programming language and database management system MySQL is widely used in the development of professional web applications, since both products are highly compatible.

PHP programming language is placed on a web server and can be installed in addition to the most widespread software packages to serve web applications (Apache, Internet Information Server, TomCat and others). One of the biggest advantages of this language is that it is platform independent - a program written in this language can be performed on almost all operating systems (Windows, Linux MacOS and others).

Since the application requires a database to store product information, photos of products, customer information, order information of customers and others the use of DBMS is needed. One of the most versatile DBMS is MySQL, which is a freeware DBMS. One of the main advantages of MySQL is that there is very good support. Furthermore, the use of this non-commercial database management system does not require a license. Another advantage is that it supports client-server mode and embedded into the database procedures and triggers (a procedure that is performed automatically in the case of data change). But the biggest advantage is that the system is open source, which allows bugs to be removed immediately. This leads to much greater stability of the software – i.e. this is due to the good reputation of this software.

4. Description of the suggested approach

Throughout the working process on the paper, on-line clothes renting system was chosen as an example of E-commerce.

In order to follow the MDD type of creating software application, the developer's focus was drawn to the model. In this case, the UML model was created in the Visual Paradigm tool. Class diagram was chosen from the variety of UML diagrams. Class diagram helps to make the visual implementation, shows the relations and operations between classes. It is commonly used for modeling of business processes. In this particular example, on Fig.4, the model of on-line clothes rent system is built. The main classes are: customer, clothes, and purchases. All other classes are secondary - they provide appropriate function of the whole system. Currency and currency rate make the purchases more individual for each customer. Class of sizes, and designers spread the variety of goods which are offered to users. Customer's login and purchases delivery help developer to monitor and control the working process of the system. All the components are connected and have their particular role.

To describe one of the business flows inside the system, activity diagram was created using the "Visual Paradigm" tool, and is shown on Fig.5. The process begins with the customer's request for purchase, in this case the order is made, after the system receives the order form, it sends a message about order processing. Next step is receiving payment from the customer and closing the order process. Order process connects to delivery process which connects to the customer, and the cycle begins.

All the data which is used and will be used during the development of the exact working process is stored in the database. MySQL was chosen for this purpose as one of the most protected type of DBMS. Using extended entity–relationship model (EER-model) gives opportunity to show results of the work in more structured view than making list of tables. The EER model in computer science is a high-level or conceptual data model incorporating extensions to the original entity–relationship model, used in the design of databases.

The ER diagram is shown below on Fig.6. This diagram represents all the tables which are used in the database and shows all the relationships between them. The diagram shows the relationships between tables. Tables contain the main information about type of clothes, sizes, designers, prices, delivery and customers. It is quite important to have all of this data and to make the correct correlation between them. For instance, table "designer_clothes" has information about one specific type of clothes and designer who made the goods. Moreover, this data is used for table 'prices' and it is connected to purchases. Thus, it is clearly shown that all information is correlated. All connections have to be predicted and measured.

5. Conclusions

The main purpose of the work was to start developing of a software application using model-driven development approach. This means that the great attention was devoted to models. UML was used as the more common and automatized graphical implementation of models. Class diagram was chosen to represent classes and relations between them. Activity diagram was created to give an example of possible business process within the system. Also important stage of the development is creating database as storage for all useful information which is used and will be used in further expands of the system. For convenience, database is presented as ER-diagram, which shows all tables and correlations between them. E-commerce development is now becoming even more relevant and MDD is widely spread for developing different types of software. The paper is a base for further researches in the field of on-line commerce, such as amplification and making company's web-site.

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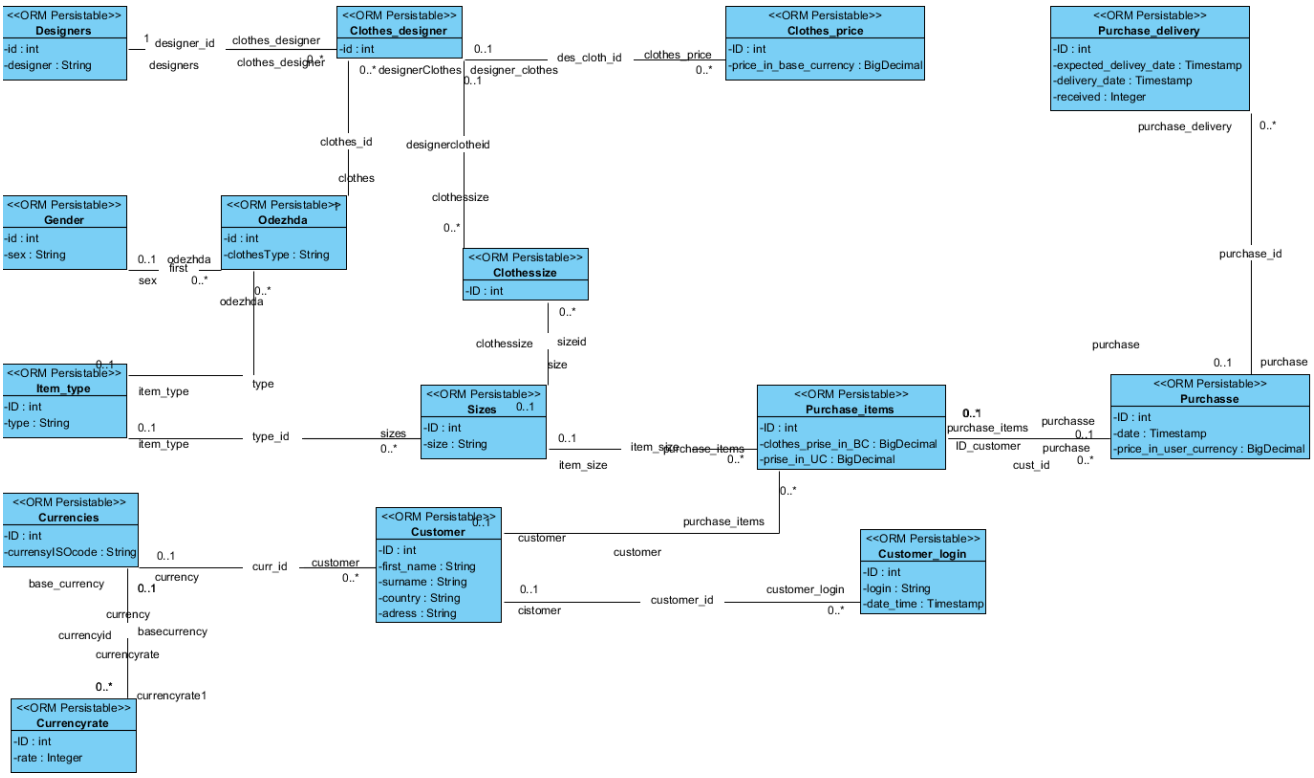


Fig.4: *UML class diagram of the on-line rent clothes system*

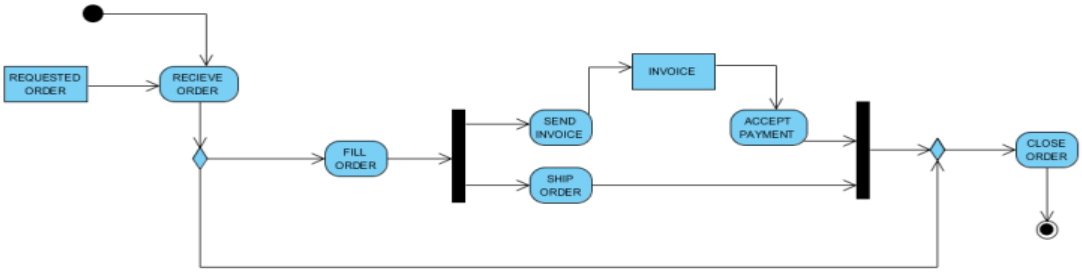


Fig.5: Activity diagram of the Order making process

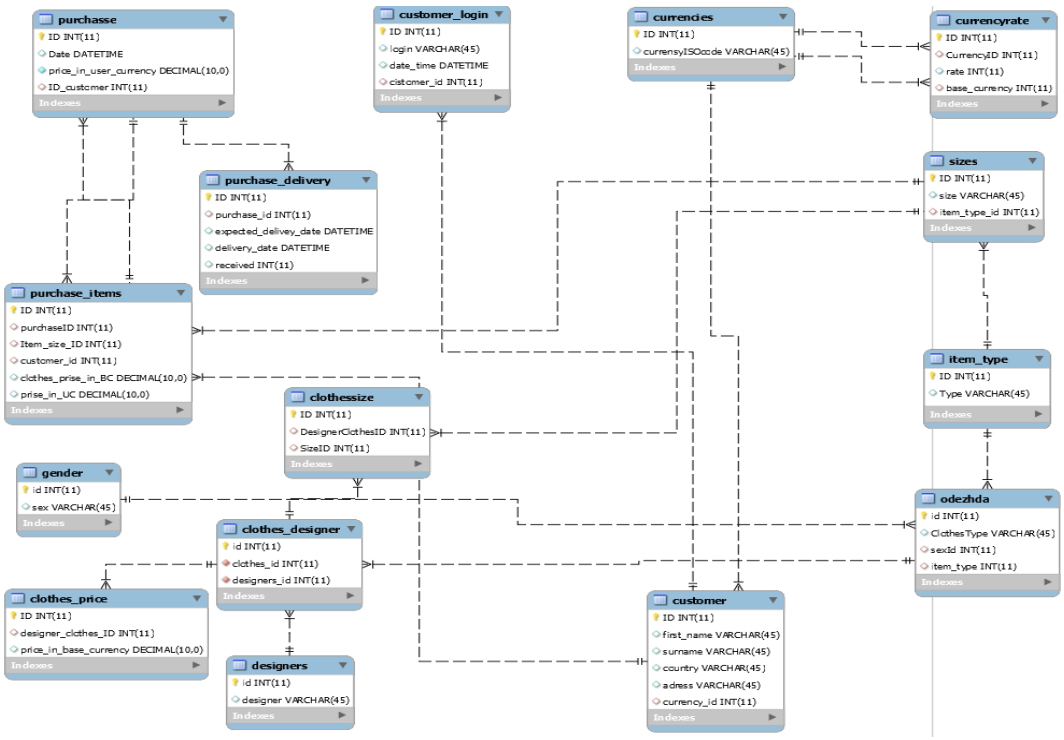


Fig.6: *ER diagram of the on-line rent clothes system*

THE ROLE OF THE MOBILE APPLICATIONS FOR DEVELOPMENT OF THE EXECUTIVE FUNCTIONS FOR THE CHILDREN WITH LEARNING DISABILIY

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Abstract: *The article interpretes the possibilities of the mobile applications to favorably influence the development of the executive functions in pupils with learning disability. There are options for the use of different mobile applications in school and therapeutic activities as well as in the results of the empirical research.*

Keywords: *MOBILE APPLICATIONS, EXECUTIVE FUNCTION, SPECIFIC LEARNING DISABILITIES.*

1. Introduction

To the infringements of the ability to learn are included general and specific violations. Common distortions of the learning ability is present in the behavioral plan, while to the specific disorders of the ability to learn /specific learning difficulties/ are referred dyslexia, dysgraphia and dyscalculia. These infringements are not only a problem of primary school age. The problems do not occur solely at the level of higher mental functions and mental processes, and in the integrity of cognitive functioning, which includes the implementation of executive functions:

The term executive function is used to describe the capacity that allows us to control and coordinate our thoughts and behaviour (Luria, 1966; Shallice, 1982). There is no universally accepted definition of executive function. Executive function (EF) has been defined as a multifaceted construct that involves a variety of high-level cognitive abilities (De Frias, Dixon, &Strauss, 2006).

According to Brown (2006) „executive function as the management system of the brain's cognitive functions. The conductor of a symphony orchestra. Each musician has the potential to play his instrument very well but it is the conductor's ability to synchronize the different parts into a perfect whole, that makes the music great."

The term "eexecutive function" is an umbrella term for a brain-set of high-level mental processes that control and regulate other abilities and behaviours. Although there is no common understanding of the executive functions, students with EF deficits have difficulty: getting started and finishing work, remembering chores and assignments, executing rote memory tasks, writing essays, remembering what is read (comprehension), accurately judging the passage of time, being organized, using self-talk to guide actions, controlling emotions, analyzing and problem solving, planning for the future (Burgess, Veitch, de Lacy Costello & Shallice, 2000).

Executive functions can be categorized into two main groups:

- ✓ *core executive functions*: inhibitory control (self-control), working memory, cognitive flexibility;
- ✓ *higher order executive functions*: problem solving, reasoning, planning, мmetacognitive strategies, time management, positive reinforcement to motivate.

2. Prerequisites and means for solving the problem

Usually in therapeutic and educational practice for students with specific learning difficulties, are applied methods, linked to improving the efficiency of the cognitive processes. Relatively less attention and time is spent on the formation and improvement of the executive functions. In case of insufficient efficiency in executive functions there is a tendency for a lower productivity and success in school and in life. Students with specific learning difficulties are experiencing difficulties in the implementation of executive functions and often have problems with:

- Solving problems not only from the educational content, but also from everyday life;
- with the organization, motivation and performance of the tasks of different order and a different context of the environment.
- Behaviors in unstructured situations and others.

They accept the failures as a disappointment as difficulties or began to reject activities because they begin to perceive them as not as interesting and unattractive. They begin to lose interest in learning and school.

Today's generation of students with specific learning difficulties are born in the digital era. Their preferences for exchange of information are related to the use of computers, tablets, mobile devices. However, in some cases, are realized partial models of electronic training and therapy. Despite the availability of mobile applications for the development of cognitive processes and executive functions and preferences of students with specific learning difficulties, usually in the school space they find no application. Special teachers and resource teachers do not show interest in their application. In this plan, appeared the general question: "What is the role of mobile applications for development of the executive functions in children with specific learning difficulties" addressed to the professionals working with students with specific learning difficulties. Important for effective practice is the understanding of experts - therapists and educators.

Tasks:

- ✓ Approbating a questionnaire on the feasibility of the mobile applications in the educational and therapeutic practice for children with specific disorders of learning ability.
- ✓ Check the hypothesis of application of the mobile applications for the formation of executive functions in children with specific learning difficulties.

Hypothesis:

If the special teachers and resource teachers demonstrate understanding that the use of cognitive mobile applications will contribute to the development of the executive functions in pupils with specific learning difficulties, the development and implementation of mobile applications in working with students with specific learning difficulties will be effective.

Method of research

Participants in the survey were 37 students from the master program "Communication disorders" aged from 20 to 40 years.

Tools:

Method involving a questionnaire with 30 items, exploration and evaluation of freely selected mobile applications from study participants.

Procedure of the study.

A questionnaire comprising 30 questions is offered, 29 from which are answered with "yes" or "no", 30 - Your question is given the opportunity for open response.

The items are united into three groups:

⇒ First group with 6 items related to knowledge of the types of mobile applications suitable for educational and therapeutic work with children with specific learning difficulties.

After the results from the items from the first group a task is given: "to download, study and analyze free mobile applications, suitable for the development of executive functions in children with specific learning difficulties."

Prior guidance is not given for a specific mobile application.

⇒ Group Two with 10 items are aimed at knowledge of the specifics of mobile applications - rules and instructions mechanism, the effect of learning, hyper sensitivity to individual incentives and movements of characters, extreme responsibility to change objects, facts and models with or without the possibility of realization of creative approaches, etc. .;

⇒ A third group of 13 items are aimed at evaluation of the mobile applications against criteria - development of executive functions.

3. Results and discussion

Data from the first group of items shows that study participants known mainly mobile applications associated with encoding, decoding and processing information with different stimulus material.

- In Bulgarian: BG alphabet; BG words; Letters, numbers, colors; Children's songs; Animals for children; Animal sound and vocabulary; Easy reading; Mathematics - games for children; Mathematics for children; Musical instruments; Fairy tales and books; Stories and songs; they learn games to;

- English: Animal sounds; AutoMath; Math tricks; How to draw. Only 1.5 percent of survey participants know Brainwave Studio and Limosity.

Study participants accept that the marked mobile applications are suitable for use of children with specific learning difficulties. Another result is that 75% of survey respondents believe that mobile applications with English names are not available in Bulgarian and are not affordable i.e. free. Actually the marked mobile applications in almost all the series are universal in linguistic terms.

In the following of task: "to download, study and analyze free mobile applications, suitable for the development of executive functions in children with specific learning difficulties" 8 mobile applications are preferred by the study participants : Brain Studio, Limosity, Memory Training, Memory Trainer, Brain Test HD, Math Tricks, Sound of Relieve Stress и NeuroNations's.

Participants in the study noted, mobile applications that are narrowly focused on executive functions in specific learning disabilities, but are paid. In this sense, mobile applications from this group do not meet the condition of the task and were not analyzed. To this selection are included: Homework /Mango, LLC/, Homework Tracker w/Reminders, Kids Calendar /ConSept/, 4KidCal /4KidCal LLC/, Think Tree /mind mapping/, Popplet /Notion/.

It is clear that the investigated and referred mobile applications can be divided into three groups:

- Mobile applications for relaxation and stress relievetion /Brain Studio, Sound of Relieve Stress/;

- Mobile applications related to solving cognitive tasks and suggesting support cognitive functions /Limosity, Memory Training, Memory Trainer, Brain Test HD, Math Tricks/;

- Mobile applications relating specifically to the development of executive functions /NeuroNations's/.

This brief taxonomy is conditional because it is not possible to solve cognitive tasks without realization of executive functions such as:

- Understanding of the rules, regulations and enforcement;
- The involvement of working memory;
- No emotional- control skills;
- Without focusing attention;
- Without partially demonstrated organizational skills;
- Planning skills, etc.

After study of mobile applications survey was conducted with the second and third group items. The results of the responses of the second group of questions are presented in Table 1.

Table 1. Knowledge of the specifics of mobile applications

	participants positions	% of responses to allegations on 8 selected mobile Applications	
		yes	no
2.1.	clear instructions and delivery mechanism	99 %	1 %
2.2.	suitable and convenient design	86 %	14 %
2.3.	probability of hypersensitivity to separate incentives and their movements	36 %	64 %
2.4.	without the possibility of realization of creative approaches	93 %	7 %
2.5.	extreme responsibility to change objects, facts and models	94 %	6 %
2.6.	opportunities to scientific data, facts and skill to be transferred in real environment	29 %	71 %
2.7.	effect of coaching learning	96 %	4 %
2.8.	settlement of default time limit performances.	38 %	62 %
2.9.	requirement of a period for adjustment	12 %	88 %
2.10.	allowing time synchronization for students with specific learning difficulties and professionals working with them	96 %	4 %

It is obvious that the participants in the study assessed aspects of the mobile applications that affect the effective work with children and students with specific learning difficulties. Categorically it is assumed that there are suitable and convenient design as well as clear instructions and mechanism of implementation and time synchronization performance between students and professionals.

Particularly impressive are the answers to items 2.3., 2.4, 2.5., 2.6. where to look for effects in behavioral plan for students with specific learning difficulties of implementation of tasks in the respective mobile applications. The third groups of items are presented in Table. 2.

Table 2. Evaluation of the mobile applications

№	participants positions	% of responses to allegations	
		yes	no
3.1.	MAPs mace the formal measurement and evaluation of student performance more difficult.	94%	6 %
3.2.	MAPs are not made for individual subgroups - dyslexia, dysgraphia and dyscalculia.	99 %	1 %
3.3.	MAP serve only for fun.	78 %	22 %
3.4.	MAPs can be used as therapeutic interventions with students with specific learning difficulties.	51 %	49 %
3.5.	MAPs contribute to the formation of better alertness in carrying out educational tasks and activities.	96 %	4 %
3.6.	MAPs limit the development of social skills.	98 %	2 %
3.7.	MAPs support encoding, decoding and processing information with different stimulus material.	86 %	14 %
3.8.	MAPs assist the training and development of the working memory.	93 %	7 %
3.9.	MAPs limit the frustrations tolerance for behaviors of others.	76 %	24 %
3.10.	MAPs enhance the skills for planning.	96 %	4 %
3.11.	MAPs can improve flexibility.	92 %	8 %
3.12.	MAPs support to overcome the extreme disorganization of materials, incentives and facilities.	74 %	26 %
3.13.	MAPs assist in regulating the emotional control in the implementation of educational and test tasks	76 %	24 %

*Note: MAPs - Mobile applications

The table shows that survey participants gave positive responses to the items. While items 3.1, 3.2., 3.3 and 3.6 present limits of the selected mobile applications, other items displayed positive aspects of the mobile applications and the relevance of their therapeutic application. Many executive functioning tasks have very low ecological validity (Ardila, 2008). The students have argued that these tasks are poorly correlated with daily life activities.

Items 3.5., 3.7., 3.8., 3.10., 3.11., 3.12. present positions of approval to the development of individual components of the executive functions. Each of these executive functions has a role in cognitive control, for example filtering out unimportant information, holding in mind a plan to carry out in the future and inhibiting impulses. According to Baddeley (1992), working memory is the brain system that temporarily provides storage and manipulation of information. Set-shifting is referred to as the ability to flexibly switch back and between tasks, operations, or mental sets (Miyake et all., 2000). Prospective memory is the ability to hold in mind an intention to carry out an action at a future time (Ellis, 1996), for example remembering to make a phone call at specific future time. Prospective memory is associated with frontal lobe activity (Burgess, Veitch, Costello, & Shallice, 2000) and has been shown to develop through childhood as we develop our future-oriented thought and action (Ellis & Kvavilashvili, 2000). The result of the item 3.10. is explane that planning is a complex construct, making it difficult to narrow down a specific set of brain regions or networks underlying this ability. For example, planning has been defined as a large category of responses and processes including, but not limited to, decision-making, judgments, and evaluation of one's own behaviors and the behaviors of others (Das & Heemsbergen, 1983).

Answers to items 3.9. and 3.13. demonstrate the positive opinions of the participants in the study on the possibilities of the mobile applications for the formation of the emotional component of the executive functions in children with specific learning difficulties.

Despite the positive attitude towards the development of executive functions through the use of mobile applications, from items 3.4. shows the manifested skepticism for implementation of the mobile applications as therapeutic interventions for specific violations of the learning ability.

The last 30th question is "QR code, Barcoo mobile applications are not suitable for specific violations of the learning ability, because... Please complete by answering the question: "Why?".

In the responses received from participants manifests the insufficient knowledge of augmented reality and in this context is the presence of explanatory models such as: ..."We need specific training for them, a lot of them are complex, and require specific reliance and thy can not be measured, can not be used in the school ... ". There are also direct inquiries and findings: "what are these applications, I do not know these applications, I do not know what it is, etc." Such situations are not curious. Mumba & Zhu (2013) share that some teachers are not even aware of the existence of a lot of useful applications. If they are familiar with them, then they should take the time to learn how to use and apply them in the classroom, and to devote the necessary time to train their students to use them effectively (Douglas et all., 2012).

Cognitive models typically describe executive functions as higher-level processes that exert control over elementary mental operations (Luu and Tucker, 2000).

The tasks in MAP are complex. The complexity supports the development of executive functions. Along with the prefrontal cortex, Bunge et all.(2000) detected increased activation in the lateral prefrontal cortex (DLPFC) when participants were engaging in complex task (e.g., reading sentences and trying to retain target words). Moreover, executive functioning tasks that are commonly used not only tap into a particular executive function but also other abilities such as general cognitive skills (Barkley, 2011) or nonexecutive skills (Collette et all., 2006).

As noted Nordness, Haverkost, and Volberding (2011), research in the areas of study of the contents and effectiveness in the use of mobile devices and applications are in the process of the birth. Undoubtedly, the mobile applications as a relatively new technology should not be adopted without a solid theoretical basis and pedagogical justification. Participants in the study after analyzing the authenticity of the tasks, the design, the instructions and more. Adopt mobile applications are relevant in the specific educational context for development of the executive functions in children and students with specific learning difficulties.

There is evidence that the mobile applications can help children and pupils with specific learning difficulties and other students who have problems with the development of executive functions and learning (Twyman & Tyndall, 2006; Rappolt-Schlichtman and others, 2013).

4. Conclusion

In conclusion, this article presents the understanding of professionals working with children with specific learning difficulties for the role of the mobile applications for the development of executive functions. Limits and advantages of the use of mobile applications in specific learning difficulties are marked.

Children and students with specific learning difficulties have problems with executive functions. Each task operation and activity that requires focusing of the attention, memory, planning, organization, time management and flexible thinking become challenging. The more information there is about the challenges the more efficiently the development of the executive functions in children and students with specific learning disabilities will be supported, including specially created mobile applications. Executive functions are important for successful social functioning and performances in school and for real life situations.

In general aspect, the article offers a survey of the attitudes of professionals that can be used both to build the methodology of application of mobile applications as therapeutic interventions in specific learning difficulties students, and for didactic and therapeutic structured mobile applications for children with specific learning difficulties.

5. Acknowledgements

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MODEL AND METHODOLOGY FOR ERGONOMIC STUDY OF E-LEARNING

МОДЕЛ И МЕТОДИКА ЗА ЕРГОНОМИЧНО ИЗСЛЕДВАНЕ НА ЕЛЕКТРОННОТО ОБУЧЕНИЕ

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Abstract: *The model for ergonomic research includes an analysis and evaluation of a number of factors arising from:*

1) the human factor (the trainer and the trainee) the organization and the results of his operations (assessment of effectiveness, efficiency, and satisfaction)

2) the level of the management and improvement of the electronic environment -hardware and software;

3) the conditions in the school premises, laboratories, auditoriums, offices and others. The paper presents results from a study with university teaching staff and students from UCTM using a methodology specifically designed for an ergonomic study of e-learning.

Keywords: EDUCATIONAL ERGONOMISC, EDUCATIONAL ASSESSMENT, EFFICIENCY, E-LEARNING, ICT, ISHIKAWA DIAGRAM

1. Introduction

Ergonomics (or human factors) deals with an understanding of the interaction between humans and other elements of a system to optimize human well-being and the overall system performance. Dul and Neumann [1] indicate that ergonomics must have both a social purpose (prosperity) and an economic objective (total system performance). Performance is linked to work performance, effectiveness, efficiency, quality, innovation, flexibility, security and safety, reliability and sustainability. Welfare deals with health and safety, satisfaction, pleasure, training and staff development. Ergonomic quality is a combination of effectiveness, efficiency and satisfaction when carrying out an activity.

Joseph Juran and Kaoru Ishikawa are two of the architects of Quality Management. The first developed a roadmap for quality planning and was one of the founders of TQM. As consumers are inextricably linked with the working organization, efforts should be aimed not only at satisfying the needs of the workforce, but also to the expectations and satisfaction of users of a service or product. Ishikawa constantly defended the position that quality management could only be achieved if we follow national and international standards. These standards must be considered, but the goal of total quality must be higher, i.e., to respond to user requirements. Unlike those who have understood the term in a narrow sense, as "production quality" Ishikawa examined quality in a broader sense, namely: "In a broader sense, quality means quality of work, quality of service, quality of information, processes, people, including workers, engineers, managers and operational managers, quality of systems, quality of companies, quality of objectives, etc. "[2].

In this paper are presented:

-Models for the study of ergonomic quality of e-learning;

-Methodology and results of an investigation of ergonomic quality.

2. Methodology

The assessment models of ergonomic quality are constructed employing the fish-bone of Ishikawa.

Fig.1. shows a constructed model “fish bone”, which presents indicators of effectiveness, efficiency and satisfaction with E-learning at UCTM evaluated by the faculty.

Fig.2. shows the constructed model "fish bone", which presents indicators of effectiveness, efficiency and satisfaction with E-learning at UCTM evaluated by the students.

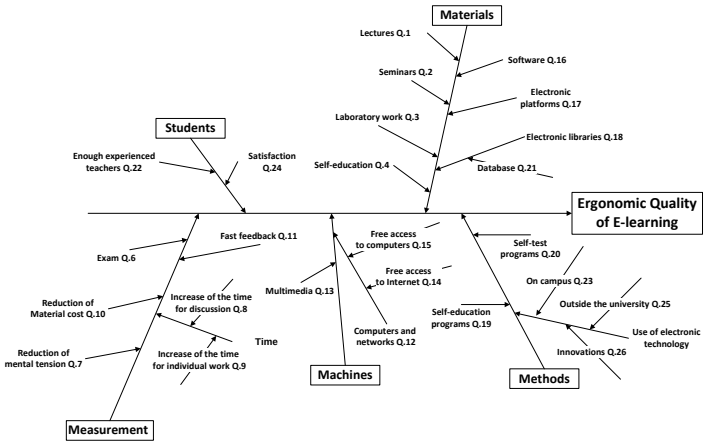


Fig. 1. *Model for the assessment of ergonomic quality of E-learning at UCTM, Sofia by the students (after Ishikawa)*

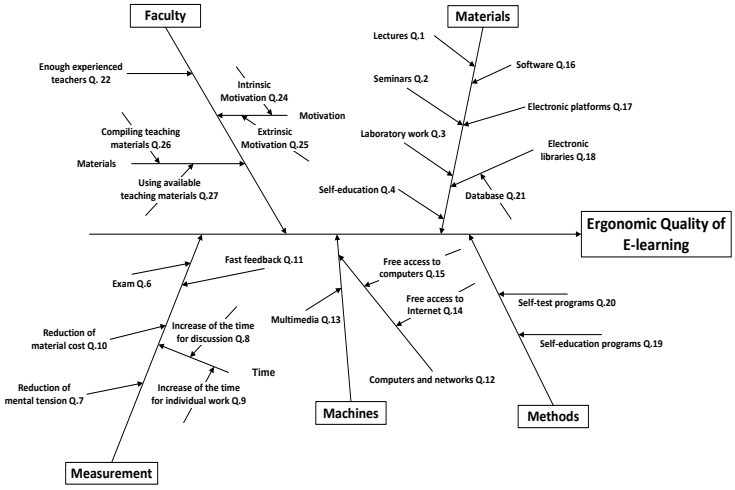


Fig.2. *Model for the assessment of ergonomic quality of E-learning at UCTM, Sofia by the faculty members (after Ishikawa)*

The methodology of the study includes the development of specialized ergonomic cards for the assessment of ergonomic quality by faculty and students [3, 4]. The survey was conducted among students and faculty at University of Chemical Technology

and Metallurgy (UCTM). The estimates are the basis for determining:

- the effectiveness of ICT in lectures, seminars, laboratory work, etc.)
- the efficiency (extent of reduction of costs and mental stress and increase of the time for individual work);
- the satisfaction with the state of the facilities and learning environment, motivation, etc. in the course of the use of electronic technology at the university.

The questions that are present in the ergonomic card were grouped into five categories, under the following headings - men , machines, materials, measurement and methods or the so-called rule "5M".

Two causal diagrams were constructed – using the "fish-bone" model proposed by Ishikawa that visually represent the relationships between "problem" - ergonomic quality of e-learning and its possible causes. Those "bones" are applied in quality management for presenting dependencies between quality parameters and the possible impact factors [5,6].

The main connections within the organization are outlined. Subsequently, the roots of a problem can be traced in order to improve a service through the introduction of innovations in the problem areas. The fish bones are two because the assessment of the university teaching staff and students is different.

Quality is not constant. To meet the expectations of the consumers or users and to maintain consistency in quality and sustainability depends on the good ratio and interaction between the various system components: human-machine-environment.

Table 1. *Results of the ergonomic survey among students (S) and faculty (F) in percentage*

Questions	**Yes**		**Rather Yes**		**Neither agree nor disagree**		**Rather not**		**No**	
	S	F	S	F	S	F	S	F	S	F
Are electronic technologies useful in delivering lectures?– y_1	65	94	25	3	7	3	-	-	3	-
Are electronic technologies useful in conducting seminars?– y_2	57	70	31	23	5	7	3	-	4	-
Are electronic technologies useful in conducting laboratory work? –y_3	35	70	30	14	15	3	9	10	11	3
Are electronic technologies useful for self-education? y_4	58	80	26	17	4	3	4	-	8	-
Are electronic technologies useful for self-tests?– y_5	44.5	57	32.5	26	8	14	7	3	8	-
Are electronic technologies useful in conducting exams? – y_6	34	30	28	33	11	13	13.5	17	13.5	7
The availability of good computer base- computers and software WOULD influence or not the work of students/ faculty in the following aspects: :										
-reduction of mental tension– y_7	39	43	34	27	11	10	8	13	8	7
-increase of time for questions and discussions – y_8	38	37	34	37	11	6	6	10	11	10
- increase of time for individual work– y_9	31	43	35	40	11	10	13.5	3	9.5	4
-reduction of material costs– y_{10}	62	33	12	30	7	10	12	13.5	7	13.5
-fast communication and feedback – y_{11}	63.5	47	16	37	11	10	5.5	3	4	10
Are there facilitations to implement E-learning in terms of:										
-facilities(computers and network) – y_{12}	39	30	26	47	7	7	13	13	3	3
-multimedia – y_{13}	38	23	42	30	9	23	9	21	2	3
-free access to Internet – y_{14}	39	53	22	27	22	17	11	3	6	-
-free access to computers– y_{15}	34	33	24	33	13.5	23	20	7	8.5	4
-software for engineering analyses and design – y_{16}	7	7	27	27	20	23	20	20	23	23
-electronic platforms – y_{17}	23	30	24	30	22	27	18.5	3	13.5	10
-electronic libraries – y_{18}	50	43	28	37	12	10	5.5	10	4.5	-
-self-education programs– y_{19}	30	3	19	14	28	33	11	27	12	23
-self-tests – y_{20}	24	11	18	23	24	23	18	30	16	13
-access to database - y_{21}	31	27	27	39	19	20	16.5	7	6.5	7
-enough experienced teachers– y_{22}	40.5	27	23	43	17	27	5	3	9.5	-
Do you think that electronic technology is sufficiently implemented in education /Intrinsic motifs to use electronic technology - y_{23}	53	60	20.5	20	12	10	9.5	3	5	-
Satisfaction with the implementation of the electronic technology at the university/ Extrinsic motifs to use electronic technology - y_{24}	38	10	17.5	23	21.5	27	8	13	15	27
Do you use electronic technologies outside the university? / Do you compile electronic materials? - y_{25}	50	30	28.5	47	9.5	20	8	3	4	-
Would you like electronic technology to be more widely used? / Do you use already compiled materials? - y_{26}	59	30	16.5	27	9.5	13	9.5	20	5	10

The ergonomic cards were then distributed and completed anonymously. The survey has 26 questions; the last four questions differ for university teaching staff / students, because they are two different categories of users. On Fig.1. and Fig.2. next to each subcategory, the number of the question in the survey is marked. For example, under the heading “Measurement” we have the subcategory “Exam” and next to it we have corresponding number of the question in the ergonomic card. Respondents were B.A. and M.A. students who attend both full-time and part-time programs, as well as faculty at UCTM. For completing the survey respondents used a five-point scale of evaluation: Yes; Rather yes; Neither agree nor disagree; Rather not; No. 74 valid cards were collected from students as well as 30 ergonomic cards from faculty members that were processed for the purposes of the report. The data are given in Table 1 as a percentage.

3. Results and discussion

After processing the ergonomic cards, the next stage was to determine the importance of the parameters, which was done by the help of Stoyanov method for determining the weightings in multi decision by ranking the target parameters [7].

For any criterion y_i, the sum of their assessment values was calculated. After processing the results, two graphs were constructed. It can be seen which of the evaluated criteria pass the line of satisfaction (over 60%) and which fail to do so.

Fig. 3 shows that teaching satisfaction (satisfaction with the set indicators over 60%) is valid for all parameters except y_{16} (software for engineering analysis and design), y_{19} (programs for self-education), y_{20} (self-tests) and y_{24} (extrinsic motives to use electronic technology). Software for engineering analysis and design is not sufficiently available; allegedly, one of the reasons is the high cost. Programs for self- education and self-control are also rated low, leading to the conclusion that there are few sufficiently developed or provided programs. The last criterion, which falls below the satisfaction line is y_{24}, which is intrinsic motifs for the use of electronic technology. But its low value is positive, because a small percentage of respondents tell that they use electronic technology incited mainly by better pay or fearing administrative sanctions. The fact that 94% of surveyed teachers are positive about the use of electronic technologies in lectures (y_{1}- the criterion with the highest positive value) is very indicative. The faculty realize that the teacher is no longer the only and main source of knowledge; he/she is a facilitator and manager of the learning process. It is possible to save time (instead of writing) or resources (it is no longer necessary to copy or buy teaching materials), which makes this process much more efficient, effective and satisfying [8].

From Fig. 4 it is seen that for the investigated students, the greater part of the parameters fall above the satisfaction line , i.e.they go beyond 60%. On the other hand, y_{24} – the criterion that directly assesses the satisfaction with the used electronic technology barely reaches the limit of 60%. There are just few clear trends – y_1, y_2, y_{11}, namely the use of electronic technology in lectures, seminars as well as fast communications and feedback with teachers.

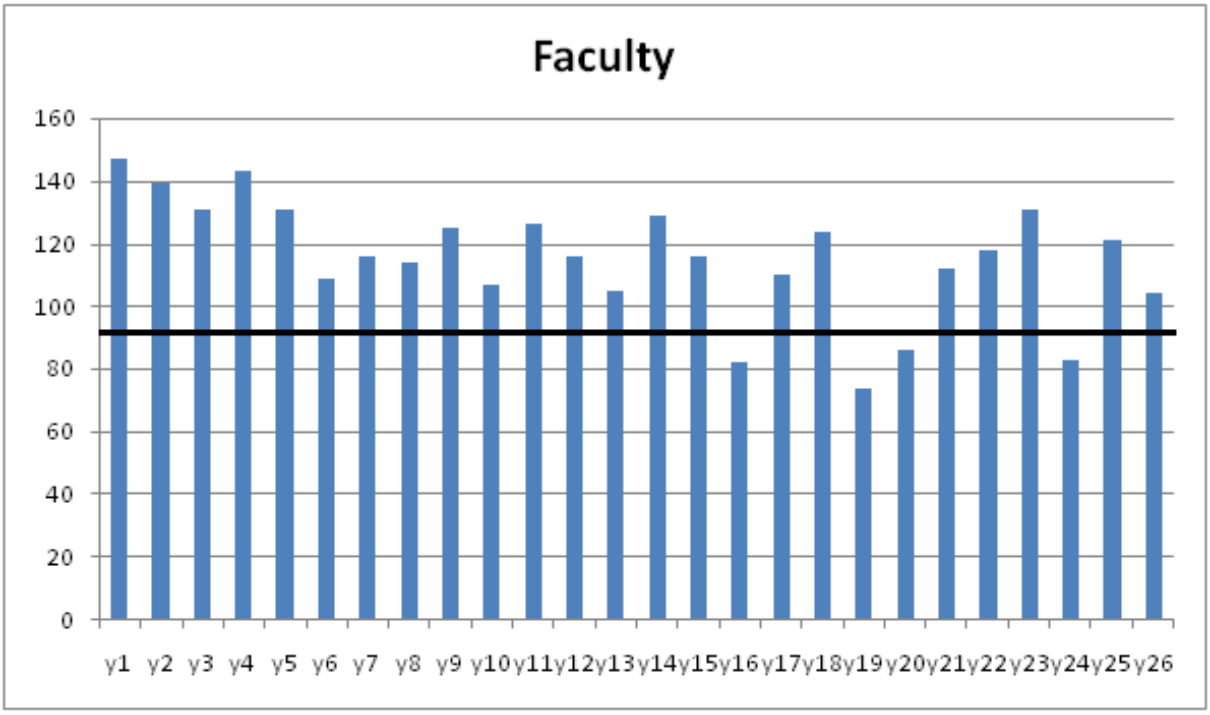


***Fig** 3.Graph showing the degree of satisfaction with the fulfillment of the set criteria by the teaching staff.*

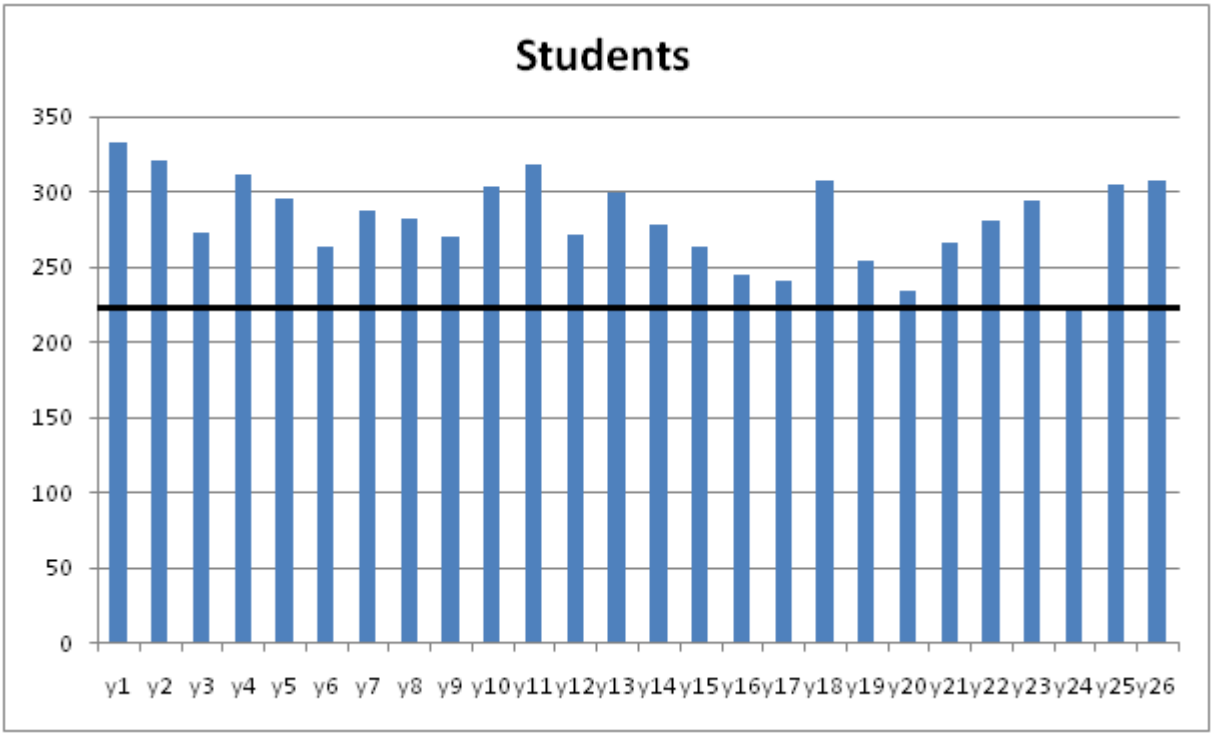


Fig.4 *Graph showing the degree of satisfaction with the fulfillment of the set criteria by the students*

4. Conclusion

Based on this study, it can be concluded that:

The criteria with the highest priority and satisfaction pertinent to both groups are:

1) Criterion y_1 (use of electronic technology in conducting lectures) and criterion y_2 (use of electronic technologies in conducting seminars). It can be concluded that the effectiveness is the highest.

2) The effectiveness of the existing software base was evaluated as the most unsatisfactory by both groups. Some additional work and efforts should be made to improve the indicators of criteria - y_4 (using electronic technology for self-study), y_{17} (using el.platforms to develop and compile materials) and y_{20} (self tests).

3) In terms of efficiency- For the following criteria: y_6 (using el.technology for examination), y_7 (reducing mental tension in classes), y_8 (increasing the time for questions and discussions), y_9 (increasing the time for individual work), y_{10} (reduction of material costs) and y_{11} (fast communication and feedback) , the values are very similar for both groups, except for y_{10}- reduction of material costs - an indicator that students assessed very positively, unlike the university teaching stuff.

4) When comparing the satisfaction with the use of electronic technology, the values clearly indicate that it is higher for the teaching staff (strong intrinsic motivation and a high percentage of those who indicated that they used electronic technologies in education). As far as the students are concerned, there is a tendency for a general satisfaction with few criteria with stronger satisfaction. Despite the fact that their assessment is not so clear, there is a positive trend not only to adopt and use the new technologies, but also an indication for ubiquitous presence of technology in education.

5. Bibliography

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