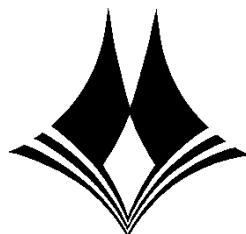


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CONTENTS

Anastasova, Y. Technologies for ensuring data quality and security in industrial information systems	5
Mitev, V. Management of the quantity and quality of the reserves and resources of ore deposits	9
Ivanova, D. Digitalisation of the industry as a key to risk reduction at a mining enterprise	15
Popovic, G., D. Mihajlovic. Prioritisation of criteria important for ore transport system selection	19
Preshelkova, A. Price formation of energy services in the sphere of natural gas in Bulgaria	23
Kovacheva-Ninova, V., V. Velevev, V. Vassileva, K. Vutova. Trends in the development of the tungsten production	28
Mitev, V. Analysis of the demand, supply, and prices of crude oil	37
Petrova, V. Research and analysis of the state of socially responsible policies of mining companies through the eyes of local communities	43
Trifonova, B., B. Galabova. Increasing the efficiency of human resource management in mining enterprises	49
Dimov, E., N. Stratiev. Transition to the euro and the expected impact on the Bulgarian economy	55
Atanasov, A., R. Marinova. Non-financial reporting in the mining industry – regulations and application	58
Ilieva-Stoycheva, K., G. Siderova, P. Yusein. The production function of a mining enterprise as an analytical tool for the production optimisation	64
Ivanov M. Socio-economic and regional differences in the labour market in Bulgaria and the European Union	67
Ivanov, M. Problematic aspects of the processes of decentralisation and deconcentration in local self-government in Bulgaria	72
Hristova, V., K. Ilieva-Stoycheva, M. Petkov. An economic and mathematical model for determining of optimal mining with pre-defined quality indicators in a mining enterprise	77
Naydenov, K. Tourism in green economy – some key issues	80
Yanev, N., L. Meshkov. Service oriented application for rendering reports on the training workload at the University of Mining and Geology “St. Ivan Rilski”	84
Trifonova, M. Expanding the functional abilities of mechanics ADD-IN for MS EXCEL with examples in the field of statistics	88
Simeonova, D., V. Christov. Designing of an information advisory system for assessment of measures against water pollution from mining activities	92
Yanev, N. Contemporary approaches in storage and data processing	96
Toncheva, S. Analysis of approaches to customisation of Autodesk-products	100
Mihaylov, D. Using simulation modelling in teaching the game theory elements	104
Toncheva-Pencheva, S., Y. Anastasova. Personalisation of distance and e-learning for learning content	108
Trifonova, M., R. Nesheva, M. Kiryakov. Application for tracking the workload of lecturers and students at universities	112
Izvorska, D., G. Velevev, M. Avdeeva. Good practices in language training at the Technical university of Gabrovo	117
Stoyanova, K. Technology of building testing questions and tasks in the vocational training education	121
Atanasov, V., K. Kalev. Some aspects in the design and development of learning applications for engineering specialties	126

Vukadinova, Ts. Similarities and differences in teaching English for specific purposes to engineering students at the University of Mining and Geology “St. Ivan Rilski”, Sofia, and at the Technical University Bergakademie, Freiberg	130
Izvorska, D. Computer mathematics systems in higher mathematics training of students from Technical Universities	133
Izvorska, D. Formation of professional competence in Technical University students during their higher mathematics studies	138
Purvanova, M., M. Hristova, V. Panichkova, Ts. Vukadinova, M. Papazova, E. Balacheva, E. Davcheva. Introducing academic and institutional terminology and analysis of students’ skills to recognize and translate specific terms in their work with scientific foreign language texts at the University of Mining and Geology “St. Ivan Rilski”	143
Tzolova, V., V. Dimitrov. On the problem of the aim and tasks of physical education in universities	149
Naydenov, K., M. Vasileva. Educational projects – an instrument for raising the potential of human resources	153

TECHNOLOGIES FOR ENSURING DATA QUALITY AND SECURITY IN INDUSTRIAL INFORMATION SYSTEMS

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ABSTRACT. There are different definitions regarding the quality of data in information systems, however, no absolute quality criteria could be set applicable to the different types of systems. From the point of view of information technology, data quality is defined as a set of qualitative or quantitative criteria. Key features of data quality are accuracy, completeness, consistency, uniqueness, relevance and timeliness. Using data in information systems based on client-server technology also emphasises accessibility and especially data security. In industrial information systems, the data is considered to be of high quality if it sufficiently reflects the described object and can be used to make effective management decisions. This article explores different technologies to provide the optimal set of required features that guarantee the quality of data in information systems applicable in the industry.

Keywords: data quality, security, technology, industrial information systems

ТЕХНОЛОГИИ ЗА ОСИГУРЯВАНЕ КАЧЕСТВОТО И СИГУРНОСТТА НА ДАННИТЕ ПРИ ИНДУСТРИАЛНИ ИНФОРМАЦИОННИ СИСТЕМИ

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РЕЗЮМЕ. Съществуват различни дефиниции относно качество на данните в информационните системи, като не може да бъдат определени абсолютни критерии за качеството им, валидни за различните видове системи.

От гледна точка на информационните технологии качеството на данните се дефинира като набор от качествени или количествени критерии. Основни характеристики на качеството на данните са точност, пълнота, последователност, уникалност, приложимост и своевременност. При използване на данните в информационните системи, базирани на технологията клиент-сървър се акцентира и на достъпността и особено на сигурността на данните.

В индустриалните информационни системи данните се считат за висококачествени, ако достатъчно реално отразяват описвания обект и служат за вземане на ефективни управленски решения.

Настоящата статия разглежда различни технологии за осигуряване на оптималния набор от необходими характеристики, гарантиращи качеството на данните при информационни системи, приложими в индустрията.

Ключови думи: качество на данните, сигурност, технологии, индустриални информационни системи

Introduction

Every individual and organisation needs the most current, accurate, and comprehensive information on the basis of which to take effective decisions.

This requirement is of particular importance for industrial information systems, where processes are in continuous dynamics and each of them can affect the performance of the entire system.

This is applicable to the greatest extent in the mining industry, since all processes are interrelated; they also depend on natural resources and require large investments in resources and tools (Eftimov, Anastasov, 2011). In this case, an inappropriate decision made on the basis of poor information may lead to huge losses for the particular enterprise.

In order to avoid such situations, it is highly important to obtain quality data, i.e. data conforming to the requirements of the specific information system. Data quality is directly related to the purposes for which they will be used (Tudjarov, 2012).

By definition, data quality is a characteristic that indicates the degree to which they can be analysed and to meet the needs of the business. From the point of view of information systems data quality is part of the whole process of data management.

Criteria defining data quality

The criteria according to which data quality is defined can be examined in two main aspects – from the point of view of their users and in terms of the possibilities for their usability in an information system (i.e., from the point of view of information technology).

Criteria for data quality, meeting the users' requirements

From the point of view of data users (i.e. people who take adequate decisions) the criteria for data quality can be considered in four large groups, namely availability, usability, intelligibility and security (Fig. 1).

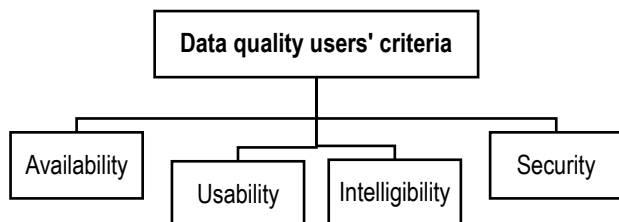


Fig. 1. Users' criteria for data quality

Availability of data

Availability of data means that in every moment, when appropriate, users need, to have access to them and they are always available.

In information systems, basic characteristics about the availability of data are accessibility, authentication, authorisation, and timeliness of equivalence.

In the client-server technology used by modern information systems the levels of access to a specific collection of data are defined at the design stage and an access level is assigned to every particular user, which determines what kind of data to be submitted. Various collections (databases) available for specific levels may exist. An example in this respect are the geographical information systems (Kazandjiev, Yanev, 2012), where there is different accuracy (data quality) depending on the type and level of access.

Depending on the specific level of access, it is verified if that user has permission (authentication) to use the information resource (i.e. to a lower or higher quality data). Authorisation is performed by the information system itself, as it gives the user rights to perform the permitted set of actions.

Since a large part of the information systems, including industrial ones, are used by many users, and different users can enter information, the equivalence of data is of particular importance. It measures the extent to which equality (equal values) of the same data is guaranteed.

The timeliness guarantees users that data are timely (as timely as possible), which is essential in making effective decisions.

Usability of data

The usability criterion means that data incoming in the information system from different sources can be processed and analysed. The data characteristics that determine their usability are documentation, validity, applicability, precision, flexibility and interactivity.

The most important feature of usability of incoming data is their ability to be converted into a digital format by the information system, i.e. they can be formalised by meeting their set conservation model (Kutzarov et al., 2012).

The validity of the data is determined by comparing the relevance to the requirements set for the specific information system.

Applicability is a characteristic that determines how much data can be processed and analysed in support of specific targets. In order to have adequate solutions taken on the basis of the data it is necessary to have precise data – i.e. they need to have values in the range specified in the information system. Thus, the level of detail of the data, which is required by different groups of users and management levels, is defined. The too high level of refinement and detail of data often leads to difficulties in the operation of information systems and it is therefore necessary to find a level of balance that satisfies both characteristics at one and the same time.

For the data to be used by different management levels (different user groups) and to be available on different devices (PC, Tablet, Smartphone), it is necessary to possess flexibility, which is particularly important in ERP systems. This means that they are subject to processes for different organisational changes or reengineering with minimal modification of the existing objects and relations in them. The use of information systems through the Internet or in a network mode requires the data to be interactive – that is, to have two-way communication between the data and users.

Data security

Data security assures the users that they are provided with the requested information in an accessible form and the data origin is guaranteed. The main features ensuring data security are standardisation, reliability, comprehensiveness, integrity, objectivity, comparability and stability.

Standardisation ensures that the data submitted and processed correspond to the rules set in each information system, which in some cases are valid for different information systems that share and exchange information. This data feature is set in the design process of the relevant information system and is monitored throughout its entire life cycle.

Nowadays, the reliability of data is a key feature not only for information systems but also for society as a whole. They give confidence about the source of the data and its reputation, which determines the degree of confidence in the data. Comprehensiveness is a complementary feature that determines to what extent the data is satisfactory and covers the user's request. Data integrity is one of the most important features of data, especially in an insecure environment such as the Internet, because it ensures that changes to data are made only by authorised users. The objectivity feature of the data ensures that the data are not modified under the influence of human emotions, i.e. only the specific facts about the data are reflected.

On-demand information systems should allow for comparability of data, i.e. to check that their values are the same in different systems (Arsova, Hristov, 2018).

Naturally, one of the most important features of data is the ability to be permanently stored and accessible over a long period of time to ensure its stability.

Criteria for the quality of data meeting the requirements of information technology

The requirement to use high-quality data in information systems, on the basis of which correct and effective solutions are available (nekdata.com), must meet at least five basic

criteria – completeness, accuracy, validity, consistency and timeliness (Fig. 2).

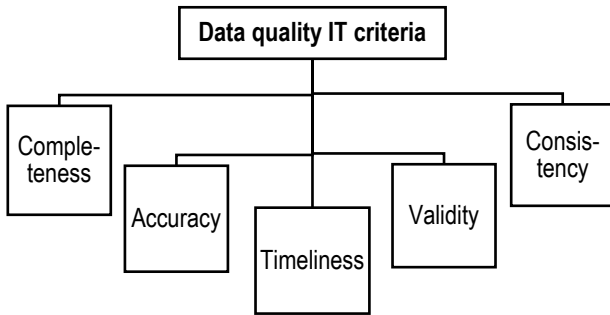


Fig. 2. Main criteria for data quality

Completeness of data

Unlike standard data collection (on paper), information technologies make it possible to ensure the completeness of data by using functions that allow the input and digital storage of information only where all attributes for the object, activity etc. have been introduced.

To ensure full quality data, additional features are introduced that check not only the correctness of the data provided but also the exact implementation of the data entry format defined by the particular information system.

Accuracy of data

Accuracy of data criterion suggests that incoming data in the information system are correct and fully reflect the depicted object, process, etc. To avoid the risk of inaccurate data submission, the interference of the human factor in this activity should be minimised already at the design stage of a specific information system. Unfortunately, this is almost impossible, and therefore, the implementation of this activity must be done by competent and well trained specialists.

To ensure the data accuracy, especially in cases of a high volume or a continuous stream of data, additional features are being set in the information systems which check for inaccuracies at every step and eliminate admission of such.

Data validation

The criterion validity of the data determines how data values are correctly measured according to the pre-set conditions. If we have received invalid data, this means that there is a problem in the process of collecting the data.

When you get values for specific data that are beyond the limits of the usual, it does not always mean that they are invalid. In such a case the values should be re-checked. In the flexible information systems this problem is easily solved by altering the defined limits for measured values and incorporating new values.

Consistency of the data

In information systems, especially in those with longer term of use, there are data about the same object, process, action, etc., that are introduced at certain periods and have different values. In other words, there are different versions of the data for an object or process.

The consistency criterion ensures that the data in the various versions are saved in the same format and most important, this data format is not changed during processing.

Timeliness of data

In order for an adequate and efficient decision to be made, it is important that the data we need to analyse should be timely – i.e. there is no time interruption of the incoming data stream for various reasons.

The timeliness criterion is especially important in industrial systems, which manage continuous production processes because the lack of data for a specific segment of time can lead to incorrect management decisions.

Data quality assurance technologies

Information technologies use a variety of techniques to ensure high-quality data needed to make effective management decisions. Out of this group, we can distinguish as particularly critical for the quality the technologies that provide standardisation, profiling, matching, control and clearing of data in real time (Fig. 3).

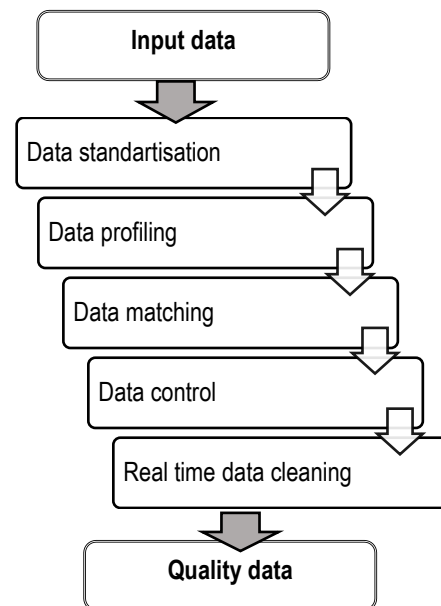


Fig. 3. Data quality assurance technologies

Data standardisation

The standardisation process is generally the affixing of various variables on the same scale. This process allows comparison of the results obtained from different types of variables.

In information systems, data standardisation is a tool that acts on the basis of set rules and ensures that the data comply with the specified quality criteria.

Data standardisation is the critical data input process in the so-called common format for large information systems used over the Internet. In order to ensure the quality of the data received, they undergo different transformation processes to meet the rules laid down in the specific information system (Yanev, 2013). Furthermore, in the business logic of these information systems, additional functions are provided to allow

automatic correction of minimal inaccuracies and rejection of data in case of significant discrepancies.

The standardisation is of particular importance in ERP systems – information systems that allow management of all business processes in a big company, where the information comes from different sources. This technology is essential also when we have exchange of data between different information systems.

Data profiling

Data profiling is a technique used to analyse the content, quality, and structure of output data, and is used in various criteria for data quality, such as determining their accuracy and completeness.

The data profile contains the definitions of the sources, functions, and functional parameters and the parameters of the profile session. This process examines the data sources by initially evaluating the data to identify potential and actual shortcomings. The goal is to find out the wrong areas in the data organisation that can be found in user input, interface errors, data corruption when transferring, and so on. The use of this technique significantly improves data quality.

Data matching

Data matching is a technique for finding records that relate to the same object, process, individual, etc. Typically, these records come from multiple datasets and do not have common object identifiers, but data matching techniques can also be used to detect duplicate records in a single database.

In information technology, data matching can be done in many different ways, but the process is often based on algorithms or programmed circuits, where processors perform sequential analyses of each set of data by comparing it with each separate part of another dataset or by comparing complex variables to find strings containing specific resemblances.

Data matching establishes links between similar, yet different, records using the set data matching rules.

Data control

Data control is a set of techniques that monitor for changes in data quality over time and notify about deviations in the pre-set quality indicators. Data control can be implemented through various technologies in modern information systems.

The completeness of the data as a quality criterion is realised through the so-called "mandatory fields" that do not allow incomplete data to be received.

The data accuracy and validity can be realised using the so-called "drop-down menus", where a value can be chosen only from the ones defined in the system.

The timeliness of data in information technology is most easily ensured through cloud structures where all data about a particular object, process, individual, are automatically transferred to the cloud once the process completes and become immediately available to all users authorised to work with them.

Real time data cleaning

Data cleaning is a process of identifying incomplete, incorrect and inaccurate data. The clean-up corrects or removes damaged or inaccurate records as well as

inappropriate sections of data, and then replaces, modifies or deletes the so-called contaminated data.

This is the process that ensures that the data is correct, consistent and applicable. Data clearing is important because it improves data quality by removing any obsolete or incorrect data and leaves the highest quality information.

Information technologies allow data cleaning and quality control processes to be embedded in the relevant applications in order to be implemented in real time. This in practice does not allow input of incomplete, inaccurate and invalid data.

Conclusion

The data quality is of particular importance for all modern information systems that operate in almost all areas. It is important both for the business as a whole and for a particular process, action, individual, etc.

The quality of data is of paramount importance in making informed, adequate and effective decisions, especially in the areas of national security, which include the mining and energy sector. Many big mining companies plan, control and manage their operations through specialised information systems tailored to their specific needs. Each mining company, depending on its specificity, determines which data is essential for management decisions, i.e. it defines its own set of high-quality data, the ultimate goal being to get quality product at optimal cost.

As can be seen from the above-mentioned, the criteria for data quality from the users' point of view do not fully match the techniques that guarantee the data quality via the information technology. The implementation of all of these criteria at the same time is not an easy task. It is therefore necessary to find the right balance between the consumers' requirements, the information technology and the most relevant criteria for high-quality data on a case-by-case basis.

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MANAGEMENT OF THE QUANTITY AND QUALITY OF THE RESERVES AND RESOURCES OF ORE DEPOSITS

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ABSTRACT. The paper presents methods for the effective management of the quantity and quality of the reserves and resources in the extraction and processing of deposits of ore minerals. Two approaches are proposed to optimise their management over the entire lifetime of the deposits. The first one is based on the methodology for carrying out feasibility study of the resources in ore deposits through the methods of the investment analysis of the annual net cash flows for the conditions of the Republic of Bulgaria.

The second one is based on operational methods for the efficient management of the extraction, processing and metallurgy processes using optimisation models of the indicators: extractable market value in extraction, processing and metallurgy processes; total profit from the extraction and processing of geological reserves for the entire period of extraction of the deposits; net present value of the profits from the mining extraction, mineral processing and metallurgical processes of the geological reserves of the deposits for the same period

Keywords: feasibility study, management of the quantity and quality of the reserves and resources, extracted market value

УПРАВЛЕНИЕ НА КОЛИЧЕСТВОТО И КАЧЕСТВОТО НА ЗАПАСИТЕ И РЕСУРСИТЕ НА НАХОДИЩАТА НА МЕТАЛНИ ПОДЗЕМНИ БОГАТСТВА

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РЕЗЮМЕ. В настоящия доклад са представени методи за ефективно управление на количеството и качеството на запасите и ресурсите при добива и преработката на рудни подземни богатства. Предложени са два подхода за извършване на оптимизация на управлението им за целия срок на експлоатация на находищата. Първият е основан на методиката за извършване на технико-икономическа оценка на запасите и ресурсите на находищата на метални подземни богатства чрез методите на инвестиционния анализ на годишните нетни парични потоци за условията на Р България.

Вторият подход е основан на оперативните методи за ефективно управление на добива, обогатяването и металургичната преработка с приложение на оптимизационни модели на показателите: извлекаема пазарна стойност при добива, обогатяването и металургичната преработка; общ финансов резултат от добива и преработката на геоложките запаси за целия срок на изземване на запасите; нетна осъвременена стойност на доходите от добива, обогатяването и металургичната преработка на геоложките запаси на находището за същия период.

Ключови думи: технико-икономическа оценка, управление на количеството и качеството на запасите и ресурсите, извлекаема пазарна стойност

Introduction

The effective management of the quantity and quality of the reserves and resources in the mining of ore deposits is based on economically substantiated conditions for contouring the reserves. These are based on the effective management of the quantitative and qualitative indicators of mining and processing processes along the entire technological chain beginning from the geological reserves, through the mined ore, to the produced concentrates, and to the final metals.

Under the conditions of strong dynamics of the supply, demand, and prices of metals on commodity exchanges, as well as of the strong dynamics of the development of mining and processing technologies, effective management of mining and processing has the following basic tools:

1. Change of the conditions and reassessment of the reserves and resources of the locality while keeping the mining extraction and mineral processing technologies and main technological indicators;

2. Modification of the technology or optimisation of the technological indicators of the mining and extraction of useful components from the conditional reserves, based on extraction events (decrease of quantitative and qualitative losses) in the mining, the mineral processing, and metallurgy.

3. Simultaneous change of the conditions, change of the technologies, and optimisation of the technological indicators.

The change in the prices of metals on the commodity markets leads to a change in the conditions regarding the quantitative and qualitative indicators of the reserves in the metal deposits. Some of the main condition indicators are the following:

- Cut-off grades and average grades of the content of useful components in geological blocks;
- The content of harmful components that reduce the quality of the extracted ores and of the produced concentrates and raise the price of the processing and metallurgical processes;
- Minimum spatial dimensions of the ore bodies, etc.

Based on these indicators, the geological reserves of the metal deposits are contoured.

The increase in the selling prices of extractable metals on the commodity exchanges increases the contour of reserves to include additional ore blocks with lower average content of useful components and units with smaller spatial dimensions. The lowering of prices of final metals on the commodity exchanges leads to the exclusion of contours of ore stocks with lower quantitative and qualitative indicators and spatial dimensions.

According to the Underground Resources Act, the assessment of the reserves and the resources of the exploited deposits is carried out annually. With a sustained trend of changes in metal stock prices, a reassessment of the reserves and resources of the deposits is required. The reassessment may be based on the existing mining and processing technologies, or on optimised or new technologies with increasing extraction in mining, processing, and metallurgy, and lowered single investment and operational costs. When the expected revenue grows faster than the total cost, the expected economic effect is positive, and in the opposite case it is negative.

According to Velev and Mitov (2013), in the economic assessment of the utilisation of technogenic deposits, it is advisable to take into account the technogenic waste accumulated as a result of the long-term exploitation of ore deposits.

The extremely favourable metals prices on international markets currently provide highly efficient mining of metallic ores and favour investment in: exploration, construction and exploitation of new or expanding old deposits and sections; extraction and processing of poorer-quality ores; replacement of the technologies and equipment for extraction and processing. In other words, invest now to get more, to reduce cost, or both at the same time. The goal is to accumulate

earnings to secure your future, even with unfavourable developments in metal price on the commodity markets in future periods.

Effective management of the mining and processing of metal ores can be provided in two ways. The first way is based on a thorough reassessment of reserves and resources of mineral deposits using the methods of investment analysis. This is the only feasible way in case of a substantial modification of the overall design work for mining and processing, in case of changes in the end price of the products, or of the prices of used resources. The second way is based on the use of operational methods of effective management of mining and processing based on the application of optimisation models.

Reassessment of the reserves and resources of deposits of metal ores

Reassessment of the reserves and resources at the stage of operation of the deposits or of separated sections of them is a method of effectively managing the mining works. It requires a feasibility study which includes economic assessment and risk analysis. An example flow chart of the stages of leading a feasibility study of the reserves and resources of the deposits of polymetallic ores, according to Mitev (2005), is presented in Fig. 1.

The method of analogy with existing similar sites (or deposits) is mainly used in developing the geological study of the deposits at the stages of reconnaissance and feasibility study. In this case, the development of partial design variants and the formation of complete design variants, i.e. steps (2) and (3) of the methodology, are skipped.

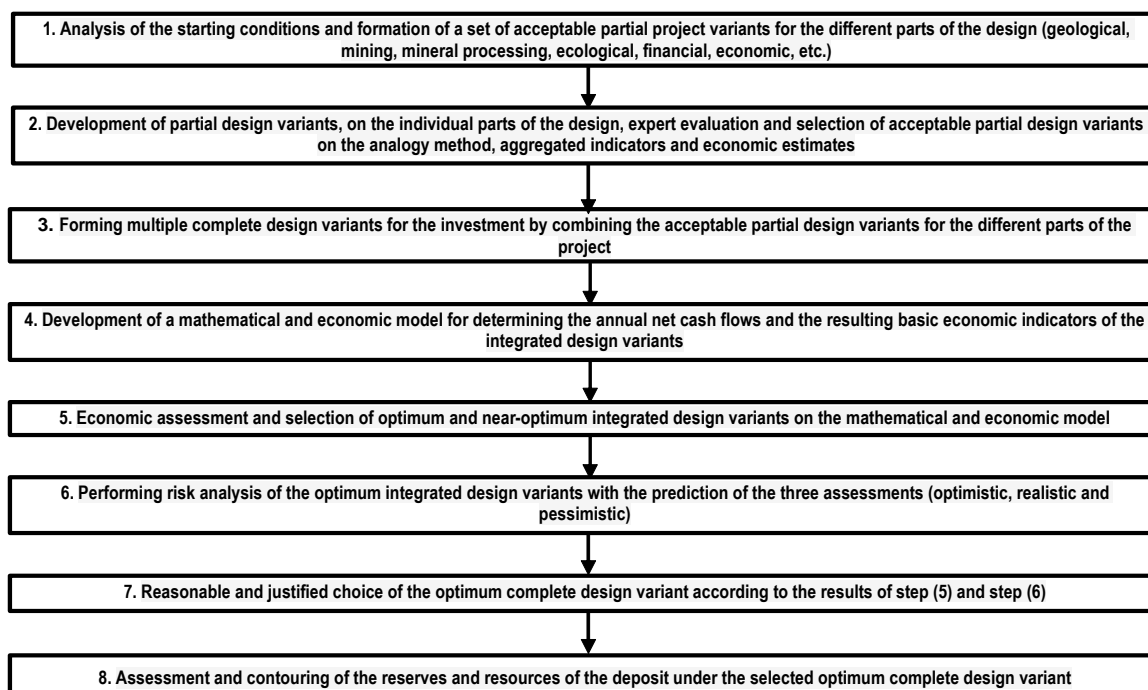


Fig. 1. Flow chart of the methodology for the assessment of the reserves and resources of deposits of metal ores

The feasibility study of the reserves and resource of deposits at the stage of design, construction, operation, liquidation or conservation of mining sites can be done alternatively, i.e. by completing all the steps of the above methodology (to design, assess, and select a leading design variant in conformity with which to perform reserve and resource assessment). Such assessments may also be made based on existing and functioning mining sites without developing and forming different partial and complete design variants. In this case, step (1) of the methodology is limited only to the analysis of the initial conditions, steps (2) and (3) are skipped, and it is passed directly to step (4) and the next steps.

The analysis of the starting conditions is based on a diagnostic analysis of the external and internal environment of the mining investment, i.e. the external and internal factors of mining and the subsequent processing of the reserves. The results of the investment analysis depend directly on the quality of this analysis.

Figure 2 presents the methodology, published by Mitev (2005), for the development of a mathematical and economic model for determining the annual net cash flows and the resulting basic economic indicators of the mining and processing of metallic underground minerals, with the inclusion of inflation (or the cost of the investor's capital) and the investment risk expressed by the discount rate of discounting annual net cash flows as a result of the investment. The figure is made for the conditions of the Republic of Bulgaria. Usually, the so-called minimum acceptable risk rate for the investor company is adopted as the value of the discount rate.

Methods for economic assessment of the reserves and resources of the metal ore deposits

The defined annual net cash flows of the complex project variants are assessed using the main methods of economic assessment of investment projects, namely Net Present Value (NPV) and Internal Rate of Return (IRR), and the additional methods used are Discounted Payback Period (DPBP) and Profitability Index (PI). When the results of these methods are similar, the conclusions regarding the profitability and the return on the project are confirmed. When the results are

conflicting, we should apply the practical methods that are most frequently used to find the cause of a conflict between the methods, the so-called "Fischer point".

An increase in the number of the observed economic and feasibility indicators based on the annual net cash flows brings about an insignificant raise in the timing of the assessment, but the amount and quality of the resulting information available to financial experts increase. This also leads to the possibility of evaluating long-term project variants from different aspects, which enhances the quality of such assessments and provides good reasons for the decisions taken.

When the investor is also the user of the mining and processing output, then the benefits to them, in addition to the expected income from the investment project, will also include the benefits of: gaining independence from suppliers and customers, increasing the assets they manage, vertical and horizontal activity diversification, and others. In other words, these kinds of investors consider the efficiency of the investment project, which is determined on the basis of the change in the efficiency of their total economic activity.

From the point of view of the mining of minerals, efficiency has different priorities for the owner of the mineral resources (the state - the grantor/concedent) and the investor (the concessioner/concessionaire). For the concedent, the efficiency of the exploitation of the deposits is measured in maximizing the extraction of the useful components from the deposit reserves, obtaining the maximum concession fee (royalties) from the concessionaire as a total sum or as a present value, increasing the revenues in the national and local budgets, limiting the import, accomplishing mineral and raw material independence, social impact of the investment for the population in the region, and many other non-monetary benefits. The measurement of the direct economic effect for the grantor is done using the Total Value of Royalties ($TV_{Royalties}$) and the Present Value of Royalties ($PV_{Royalties}$) as of the end of the concession period. According to Mitev (2006), non-monetary benefits to the state from the implementation of investment projects for the extraction and processing of minerals can be assessed through the Benefit - Costs Analysis, which is used for assessing public investment projects.

Sales Quantity x Net Selling Price	= Sales Revenues
- Cash Deductions	- Operating Costs - Transportation Costs - Commercial Cost - Royalties - Administrative and Managerial Costs - Local taxes, Fees - Loan Interests
- Non-Cash Deductions	- Depreciation
	= Profit before Tax (Taxable Income)
- Tax	- Corporation Tax
+ Tax Credits from Government	+ Tax Credits
	= Profit after Tax
- Capital Expenditures	- Investment
+ Non-Cash Deductions made for Tax Purposes	+ Depreciation
+ Cash Deductions made for Tax Purposes	+ Loan Interest
+ Cash proceeds from the residual value of fixed assets	+ Residual value of fixed assets at the end of the investment period
	= Annual Net Project Cash Flow

Fig. 2. Methodology for determining the annual net cash flows of the complex design variants for the contouring, mining, and mineral processing of polymetallic ores

Concession contracts recognise and measure the priorities and benefits for both parties. Concession contracts are agreements based on a mutual compromise on priorities and finding a balance in the distribution of project benefits between the grantor and the concessionaire.

The accounting of inflation in the evaluation of reserves and resources is based on its incorporation into the annual net cash flows. This is done through the detailed incorporation of inflation effects into the factors determining cash flows, namely: production prices; resources costs (labour, tangible, intangible) (Oresharski, 1997). Annual net cash flows are discounted at a discount rate, taking into account the investor's cost of capital and the risk for the project using the Risk Discount method.

Risk analysis of the mining investment projects

The high degree of variation in engineering decisions and the low degree of definition of incoming information involves high levels of risk for the mining investment projects. Risk analysis is performed based on a quantitative assessment by experts. This requires the risk to be quantified and included in the discount rate at the stage of the economic assessment and choice of optimum and near-optimum complex project variants based on the of the Risk Discount Factor method. Project variants should be assessed according to the risk-based prognosis of two or more scenarios for the development of the investment project. For this purpose, it is recommended to use the Sensitivity Analysis method or the Monte Carlo Simulation method employing the so-called risk-free discount rate at which the annual net cash flows of the investment project are discounted.

The high variability in the design and operation of mining and processing sites is due to the variety of engineering and management solutions at the stages of exploration, design, construction, operation and liquidation (or conservation) of mining sites. On the other hand, a large part of the input parameters for the assessment of the investment project are defined with varying degrees of definition of the input information; the latter is the result of the following factors:

- Limited geological information on the quantity and quality of the proven reserves on the accepted geological model of the deposit and variance in determining the cut-off grades and the average grades of the useful and harmful components, the minimum sizes of the orebodies subject to mining, and the subsequent contouring of geological reserves;
- Variation in the choice of the overall technology of the development of the deposit - mining methods, opening-out methods, system of reserve preparation, mining technology and equipment, mining transport, water drainage, ventilation, energy supply, etc., and their inherent degree of definition of incoming parameters in the mathematical and economic model for determining the annual net cash flows and the technical and economic assessment of the reserves;
- Variation in the order of mining of the separate sections of the deposit - in terms of minimising the payback period of the investments, maximising the net present value and reducing the risk for the investor;
- Variation for the production programme (annual produce volume), respectively the lifetime of the mine, investment and operating costs in order to maximise the profit and return for the lifetime of the investment;

- Variation regarding the choice of a complete mineral processing technology for the extracted ore - value of the investments; extraction of useful components; extraction of concentrates; content of useful and harmful components in the concentrates; variable and constant costs of the mineral processing process and waste disposal costs and reduction of the harmful effects of the mineral processing on the environmental components;
- Variation in terms of the adopted mining and processing stage - investment up to a certain stage of completion of the final product (ore, concentrate, final metal or products of the final metal);
- Risk in determining the estimated end-product prices over a long period of time (10 to 35 years);
- The risk of changing the prices of the resources used (labour, tangible, intangible, and financial);
- Risk in determining the discount rate - taking into consideration the time factor;
- Risk of changing the innovation, investment, industry, social, environmental, and fiscal policies of the government.

A sensitivity analysis of the assessment aims to quantify the risk with respect to input variables in the mathematical and economic model to determine the annual net cash flows of the investment. Through it, the so-called "Strategic" or "Sensitive" variables are identified that affect the economic indicators for the assessment of investment projects. Starting from the priority of the economic goals, the risk must be assessed primarily in terms of the main and additional economic indicators of a synthetic nature (NPV, IRR, DPBP, PI, $PV_{Royalties}$, etc.). They are set at a discount rate which takes into account the cost of capital of the investor or of the investment, not including the risk component.

All input parameters in the mathematical and economic model for determining the annual net cash flows of the overall design variants cannot be distinctively determined, they are random variables. This requires that they be expertly predicted on the basis of expert assessment, by determining their most probable (expected) values and by defining conditional intervals for their variation. It is advisable to determine their probability distribution within the range of their variation, but this leads to complications in the risk assessment of the projects for the mining and mineral processing of the deposits because of the impossibility to objectively prognosticate their probability distribution within the range of their variation.

Reasonable choice of project variant grounded on the results of the economic assessment and risk analysis

The choice of an overall project variant for mining and mineral processing that will help contour the reserves and resources of the deposit is based on the analysis and rating of the results of the economic assessment and the risk analysis. The values obtained for the monitored economic indicators (NPV, IRR, DPBP, PI, $PV_{Royalties}$, etc.) are ranked in the so-called Payment matrices and the decision-making criteria under the conditions of risk and uncertainty are applied (Velev, 1988). The following criteria are most commonly used and of sufficient information importance:

- Extreme Pessimism (the Wald Criteria) - of the utmost importance for the so-called "Mature industries", as is the

mining industry. The managers in the mining industry are people who are not willing to take high levels of risk;

- The Bayesian Criterion - optimum mathematical expectation for the main economic indicator;
- The Savage Criterion - under the conditions of risk and uncertainty, the option is chosen that is characterised by the lowest risk value (the variance of the economic indicators between the realistic and the pessimistic scenarios).

By decision of the investor, additional criteria may be used for decision-making under the conditions of risk and uncertainty. It is also possible to scale these criteria by placing great value on the individual criteria and obtaining a generalised summary, presented by summary criteria similar to the Belyaev Criterion.

Assessment of reserves and resources of the deposit based on the selected design variant

The assessment of the reserves and resources of the polymetallic ore deposits is based on the selected complete design variant. It will represent the expected most efficient opportunity for mining and processing of the reserves of the estimated deposit in view of the geological and technological information collected, the development of the mining and processing technologies, the expected mining, geological, technological, economic, and market conditions. On this basis, the final contouring of the reserves and resources of the particular deposit is made.

Operational method for the efficient management of the mining and mineral processing with the application of optimisation models

Many operational methods exist that optimise the quantity and quality of mining and mineral processing. This report discusses an operational method for optimising the average content, based on the theory of natural and market value. According to Mitev (2011), for this purpose, the indicator of the recoverable market value of the useful components in the geological reserves during the mining, mineral and metallurgical processing is used. This indicator has the following form:

$$EC_{GR} = \sum_t \sum_i Pr_{ti} \cdot Q_t^{GR} \cdot \frac{C_{ti}}{100} \cdot \frac{\varepsilon_{ti}^{mining} \cdot \varepsilon_{ti}^{proc.} \cdot \varepsilon_{ti}^{met.}}{10^6} = \sum_t \sum_i Pr_{ti} M_{ti}^{GR} \cdot \frac{\varepsilon_{ti}^{mining} \cdot \varepsilon_{ti}^{proc.} \cdot \varepsilon_{ti}^{met.}}{10^6}, USD, \quad (1)$$

where:

Pr_{ti} is the average selling price of the i -th metal in the year “ t ” of the operation of the reserves, USD/ t ;

C_{ti} is the average content of the i -th number of metal or non-metal component in the geological reserves, envisaged for mining during the year “ t ” of the operation, %;

M_{ti}^{GR} is the quantity of the i -th number of metal or non-metal component in the geological reserves, envisaged for mining during the year “ t ” of the operation, t ;

Q_t^{GR} is the quantity of geological reserves, envisaged for mining during the year “ t ” of the operation, t ;

$\varepsilon_{ti}^{mining}, \varepsilon_{ti}^{proc.}, \varepsilon_{ti}^{met.}$ are respectively the parameters of extraction of the i -th number of metal or non-metal component during mining, during processing, and during metallurgical or other activities during the year “ t ”, %.

When the sum of the estimated annual total costs is deducted from the above indicator, we will obtain the total gross financial result of the exploitation of the geological reserves from the deposit for the entire assessment period. The indicator is then transformed into the following:

$$TP_{GR} = \sum_t \sum_i Pr_{ti} \cdot Q_t^{GR} \cdot \frac{C_{ti}}{100} \cdot \frac{\varepsilon_{ti}^{mining} \cdot \varepsilon_{ti}^{proc.} \cdot \varepsilon_{ti}^{met.}}{10^6} - \sum_t TC_t - \sum_t In_t = \sum_t \sum_i Pr_{ti} M_{ti}^{GR} \cdot \frac{\varepsilon_{ti}^{mining} \cdot \varepsilon_{ti}^{proc.} \cdot \varepsilon_{ti}^{met.}}{10^6} - \sum_t TC_t, USD, \quad (2)$$

where:

TC_t are the estimated annual total costs of mining, mineral processing, and metallurgical or other activities during the year “ t ”; USD;

In_t are investments in the year “ t ”, USD.

To count the time value of money, we can convert the previous indicator by including the discount factor. In this case, the indicator will have the character of a net present value of the income from the exploitation of geological reserves (NPV_{GR}) and will have the following form:

$$NPV_{GR} = \sum_t \frac{\sum_i Pr_{ti} \cdot Q_t^{GR} \cdot \frac{C_{ti}}{100} \cdot \frac{\varepsilon_{ti}^{mining} \cdot \varepsilon_{ti}^{proc.} \cdot \varepsilon_{ti}^{met.}}{10^6} - TC_t - In_t}{(1+r)^t} = \sum_t \frac{\sum_i Pr_{ti} M_{ti}^{GR} \cdot \frac{\varepsilon_{ti}^{mining} \cdot \varepsilon_{ti}^{proc.} \cdot \varepsilon_{ti}^{met.}}{10^6} - TC_t - In_t}{(1+r)^t}, USD, \quad (3)$$

where: r is the discounted rate of annual cash flows, determined as part of a unit.

As can be seen from the above equations, the expected gross incomes from the mining and mineral processing of ore deposits are directly proportional to the following variables: the expected average annual net prices of the final metals; the expected average annual net prices of the final metals; the annual mining yield; the annual average content of the i -th number of the useful components in ores and the extraction of the individual useful components during the mining, the mineral processing, and the metallurgical activities or other processing in individual years. They also directly determine the total costs and investments necessary to carry out these processes.

If we consider several project variants characterised by variant combinations of the participating magnitudes in the above expressions, we will prefer the one that provides the highest income for the entire lifetime of the deposit. Taking into consideration the time value of the money, we will select the

project option that has the highest net present value of the income from the operation and processing of the geological reserves of the deposit, i.e. the optimisation function looks like this:

$$TP_{GR} \rightarrow \max. \text{ or } NPV_{GR} \rightarrow \max. \quad (4)$$

Conclusion

The efficiency of mining management is higher when methods of investment analysis are used than through the operational methods of management of the mining and mineral processing. Investment analyses make it possible to completely cover the economic activity of a company or a particular investment project, while operational methods are appropriate for partial optimisation and often cannot assess the aggregate effect on the profitability for the duration of the investment.

The essence of the assessment of reserves and resources in complex ore deposits is in the prediction of annual net cash flows, based on the specifics and uniqueness of the deposits, as well as on the basic engineering and management decisions adopted in the design, construction, exploitation, processing and realisation of the mineral resources.

The main economic indicators (NPV, IRR, DPBP, and PI) provide sufficient information to make a grounded choice of the preferred project options for the investment. This information will be used to assess the reserves and resources of the ore deposit.

Input variables in the mathematical and economic model for the assessment of reserves and resources in ore deposits are dynamic variables, and some of them are subject to optimisation. During partial or complete optimisation of engineering and management decisions, it is necessary to determine the variation in the economic indicators of the project. Thus, the optimisation of a parameter or of a project or management decision can be taken into account, as well as what impact it has on the change in efficiency and profitability of the investment project. It is, therefore, advisable to assess the efficiency of the partial optimisation (optimisation of the individual parts of the project) with the methods of investment analysis.

The economic indicators of the investment analysis performed are strictly specific. The formation of aggregate criteria for choosing an optimum design variant based on the scaling of economic criteria and on the decision-making criteria under the conditions of risk and uncertainty, integrated assessments or other approaches to mining investments is

only appropriate when an investor's opportunities and priorities, as well as their attitude to risk, are precisely defined.

Observing the dynamics of the identified "strategic" or "sensitive" variables of the mining investment projects during their economic life is particularly important for their future efficiency and return.

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DIGITALISATION OF THE INDUSTRY AS A KEY TO RISK REDUCTION AT A MINING ENTERPRISE

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ABSTRACT. Nowadays, mining enterprises are characterised by many risks. They concern not only financial and economic risks typical for any modern company but also many hazards related to safety. In modern conditions mining enterprises are forced to operate in complicated mining and geological conditions which result in many dangerous events, especially possible in case of underground mining. It leads to many negative consequences which damage not only the company and its image, but also pose a threat to company employees. The article describes the current situation at mining enterprises, highlights particular risks caused by modern working conditions and suggests a new problem solving method based on the use of a state-of-the-art technology of digitalisation.

Key words: mining company, risk, risk management, digitalisation, digital twin.

ДИГИТАЛИЗИРАНЕ НА ПРОМИШЛЕНОСТТА КАТО ОСНОВА НА НАМАЛЯВАНЕТО НА РИСКА НА МИННО ПРЕДПРИЯТИЕ

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РЕЗЮМЕ. Днес минните предприятия се характеризират с много рискове. Те се отнасят не само за финансовите и икономическите рискове, характерни за всяка съвременна компания, но и за редица опасности, свързани с безопасността. В съвременните условия рудодобивните предприятия са принудени да работят в сложни минни и геоложки условия, които водят до много опасни събития, особено в случай на подземен добив. Това води до много негативни последици, които увреждат не само компанията и нейния имидж, но и представляват заплаха за служителите на компанията. Статията описва настоящата ситуация в минните предприятия, подчертава специфични рискове, причинени от съвременните условия на работа, и предлага нов метод за решаване на проблеми, основан на използването на съвременна технология на цифровизация.

Ключови думи: минна компания, риск, управление на риска, дигитализиране, цифров близък.

Current state of the mining industry

The extraction of natural resources is a challenging process which includes many various operations from deposit evaluation to transportation of beneficiated ore to end customers. All these stages require experienced workforce, modern equipment and use of up-to-date technologies. Only in this case a mining company will remain competitive and efficient in current economic environment.

Today, compared with the period of a decade ago, mining operations are characterised by increased complexity. For example, one of the current trends is an increase in the depth of mining, characteristic of both open-pit and underground mines.

As an example, a list of the deepest careers in the world (Table 1) can be given (Melnikov, 2013). Underground mining has reached a much greater depth – the maximum depth of South African gold mines reaches 3800 m.

Increasing the depth of mining complicates the mining and geological conditions of extraction, for example:

1) the ore decreases and the thickness of the ore bodies also decreases, as can be clearly seen at the Khibiny apatite-nepheline deposits and the Kovdor baddeleyite-apatite-magnetite ore deposit, as well as most iron ore deposits;

2) an increase in the depth of the open pits leads to an increase in the waste-to-ore ratio and an increase in the distance of transportation of the rock mass for both open-pit and underground mining;

3) an increase in the depth of the open pits worsens their ventilation, and an increase in the depth and length of underground mine workings increases the cost of ventilation;

4) an increase in the depth of mining operations leads to the need to work in conditions of high rock pressure, which is fraught with its manifestations in the form of rock bursts and technogenic earthquakes.

Table 1. Deep open-pit mines

Name	Location	Depth, m	Dimensions, km×km	Extracted mineral
Kennecott Bingham Canyon Mine	the USA	1200	4×3.8	Copper, molybdenum, gold
Chuquibambilla	Chile	850	4.3×3.0	Copper, gold, silver, rhenium, selenium
Palabora	South Africa	700	1.9×1.7	Copper
Udachny	Russia	640	1.7×1.3	Diamonds
Escondida	Chile	620	3.8×2.7	Copper, gold, silver

Muruntau	Uzbekistan	600	3.5×2.5	Gold
Sibay	Russia	600	2.0×2.0	Copper, Zinc, Sulphur
Batu Hijau	Indonesia	550	2.5×2.2	Gold, copper
Escondida Notre	Chile	500	1.6×1.4	Copper, gold, silver
Kovdorskiy	Russia	500	2.3×1.6	Iron ore, apatite, baddeleyite

Increasing the depth of work leads to a variety of negative consequences, such as the complication of conditions for the maintenance and repair of equipment, reduced productivity of the enterprise, loss of life. As an example can be cited a partial collapse of the open-pit side at the Bingham Canyon open-pit (USA) in April 2013, where the volume of the collapsed rock amounted to 165 million tons. For comparison, the open-pit's mining productivity was 50 million tons/year. It should be noted that the monitoring system of the state of the open-pit sides, which was in operation at the open-pit, made it possible to avoid loss of human life and to minimise the loss of equipment.

Risks of mining companies

Today, it can be said with absolute precision that mining companies belong to high-risk enterprises, but this is caused not only by the deterioration of mining and geological conditions.

An important role is played by significant capital intensity of the mining production, due to the use of expensive equipment for the extraction, processing and transportation of raw materials, as well as the construction of above-ground and underground buildings and structures. In addition, environmental requirements for industrial enterprises, which have been growing in recent years, determine the growth of investments in modern equipment, reducing the company's load on the environment, and the need to increase the cost of developing new technologies for conducting works that have a sparing impact on the environment.

Another factor of increased risk of enterprises of the mineral-resource complex is the long term of construction of the enterprise, namely the length of the period from the beginning of construction to the moment of receiving the first cash flows from the sale of products. According to experts (Peshkova, 2002), such a period can be 5-8 years or more, which is a special risk, since during this period the demand for raw materials and prices for it can change significantly under the influence of various factors, such as the discovery of new deposits, the transition to a green economy and the use of alternative energy sources, the instability of the political situation in the world, and especially in mining production countries. All this can lead the company to significant losses and shortfalls in the originally projected profit.

Thus, the risk in the mining industry is an important factor for making management decisions and can determine the policy of an enterprise in the direction of its economic activity.

In addition to all types of risks, such as financial, marketing, transport, insurance, etc., special attention should be paid to the specific risk that is characteristic only for enterprises of the mineral-resource complex. This is the so-

called mining risk, which is a combination of all factors affecting the conduct of work on the extraction of raw materials.

The main one is geological, which reflects the likelihood of non-confirmation of explored mineral reserves. This includes such criteria as the accuracy of estimates of the boundaries of the ore bodies, the deviation of the amount of reserves from their projected volumes and the expected quality. The content of the concept of "geological risk", as well as its scope is variable and changes as work progresses. At the very first stage, the stage of prospecting, the risk is associated with the failure to detect a deposit due to the lack and low reliability of information. At the stage of geological and economic assessment of a deposit, geological risk is characterised by the possibility of not confirming the discovered and forecasted reserves. At the next stage – the stage of a feasibility study of a field – the geological risk means the possibility of not confirming the profitability of an estimated field. During operational exploration, the geological risk is manifested when comparing data obtained during exploration and development of a field. Thus, if we talk about the assessment of geological risk in monetary terms, in the case of a negative outcome of geological exploration, the risk is estimated by the sum of the costs of the work carried out.

The next important component is the geotechnical risk. It means the change in the properties of rocks in the process of conducting work underground. The influence of various factors, both natural and anthropogenic, leads to the loss of the original physical and mechanical properties of the enclosing rock taken into account during the development of project documentation. This leads to an increase in the possibility of rock collapse due to their volatility to loads and breakthroughs of the groundwater in the mine workings, therefore, in the case of assessing geotechnical risk, it is not only about material losses, but also about the occurrence of accidents harmful to human health and leading to their death.

Mining risks can also include the risk of growth in reserves, reflecting the availability of potential resources that can be assessed, transferred to reserves and mined in the future.

Mining risk not only predetermines the choice of equipment and technology of work, but also represents an important circumstance on the basis of which are made decisions to increase or decrease production volumes or stop it completely. Working conditions at mining enterprises are especially dangerous; therefore, the identification of the mining risk and its analysis are the key tasks of the management of a modern company in the mineral resource complex.

Identification of risks and their analysis allows the management of the company to make balanced and informed decisions both short term and of strategic importance. In particular, competent risk management allows the company to reduce financial losses, increase safety at an industrial facility and strengthen its attractiveness in the eyes of potential investors.

That is why, the risk management process is so relevant nowadays. However, despite the importance of this topic, today there is no clear and definite mechanism that would help not only to predict the occurrence of adverse situations, but also to calculate the possible damage and minimise it. Therefore, this paper proposes the use of digitalisation processes, which has been gaining popularity recently.

Digitalisation of the industry

The digitalisation process today covers not only the IT sphere. It strengthens its position in other industries, including the process of the extraction of mineral resources.

Taking into consideration the complexity of the whole production chain, it can be stated that during all the years of their history mining companies have been technology innovators and leaders in some aspects, and followers in others. As for adoption of new technologies, mining enterprises have always been slow due to different reasons. For example, mining companies are characterised by big scale of manufacturing; all the operations carried out during extraction are risk-related, and costs that accompany any process of change are high.

Today, when other production branches already face the digital revolution, the extractive sector has just begun to recognise the potential of innovations that could bring significant changes and invigorate the industry. However, in comparison with other branches, especially customer-facing ones, the mining production is considered to have lower levels of utilisation of digital technologies. This is being confirmed by numerous reports of international consulting companies like Earnst & Young or Deloitte.

Mining operations have always been divided into isolated steps, with insignificant interaction between such processes as extraction, processing and transportation of extracted resources. The chance to bring these components all together presents not only the good scope for change but also the strong chance to improve the efficiency of a mining company.

Implementation of digitisation allows a mining company to have an aggregate picture of the existing supply chain and prove a holistic view of the full process of extraction of mineral resources. Information received thanks to digitisation can be studied and used by managers afterwards. For instance, it can help in production problems identification, quality management, production tracking, and costs understanding.

Even if the realisation and the implementation of a fully automated supply chain are hardly probable in the short term, it seems to be the logical end point in a series of technology transformations that have already been launched by mining companies.

New technologies in general and digitisation in particular provide employees quick access to key statistical data and necessary technical knowledge. The presence of such information accelerates decision-making and performance efficiency.

Digitisation also improves collaboration between workers and attracts new staff by increasing job appeal. A growth of number of training, testing and process simulations with the use of life-like 3D environments contributes to the employees' skill improvement as these new methods are not only safer but also more engaging than existing traditional on-site ones. Remote operations, in conjunction with the above-stated opportunities result in fewer people in hands-on operational roles. It must improve productivity and safety, and also cut down total expenses. These advantages are impossible to resist for any company which is going to face future and remain competitive in new market conditions.

So, it cannot be doubted that digitisation is one of the main features of mining industry of tomorrow. Mining companies must become more agile and able to face the future. It means

they should be prepared for the adoption of new technologies that will continue to transform the industry in the next years.

Digital twins

One of the manifestations of the digitalisation process in the mining industry is the creation of the so-called digital twins.

The introduction of "digital twins" is the result of the development of the concept of "digital production" and the Industrial Internet of Things.

Currently, many industries are collecting equipment performance data. In recent years, digital transformation has been able not only to fully process the collected information using advanced analytics, but also to make informed decisions to optimise operations in various industries. Similarly, new modelling technologies provide manufacturers with the ability to use digital twins in their products and processes. A digital twin can be defined as a developing digital profile of the historical and current behaviour of a physical object or process. New projects can be tested in the virtual world, saving time, money and resources. The digital twin can enable companies to solve physical problems faster, discovering them with a much higher degree of accuracy, design and create better products, and ultimately optimise business performance. With this type of intelligent architectural design, companies can obtain value and benefits iteratively and faster than ever before (Michael, 2014).

The digital twin is based on big data that comes in real time through a variety of measurements. These measurements can create an evolving profile of an object or process in the digital world, which can provide important information about system performance, leading to decisions in the physical world, such as changes in product development, and in the production process.

The digital twin is different from the traditional computer-aided design (CAD) system and is not just another solution with support for the Internet of Things (IoT) sensors. The digital twin is much more than any CAD system that is completely encapsulated in a computer environment that has demonstrated success in modelling complex environments. It can also be a more complex system than IoT systems that measure such things as position and diagnostics for the entire component, but not the interactions between the components and processes of the full product life cycle [5].

Despite the fact that the mining industry uses the concept of digital twins, today it does not go beyond the limits of modelling the operation of any equipment or the processes taking place in a mine or an open-pit. In this case, the virtual production process creates different scenarios and shows what happens in different situations. This allows the company to develop the most effective methods of work, but does not solve the abovementioned problem of risk reduction, which is so relevant today.

Therefore, to manage risks in the process of the extraction of minerals the digital twin of the system can be used, which is a virtual model of the entire system (for example, a field). These digital twins collect huge amounts of operational data produced by devices and products in the system, get an idea and create new business opportunities to optimise all processes. In the mining industry, this consists in creating a

complete model of the field throughout the entire life cycle of an enterprise: from exploration to the final stages of production.

First of all, the benefit of such models lies in the fact that they accumulate not only information about individual processes occurring during production, but a full range of data about the field, which allows the company not only to have information about current processes, but also to predict the development of future ones.

Thus, the advantages of using digital twins of the system in the development of mineral deposits are as follows:

1) Reducing production costs;

As a rule, the procedure for the field mining undergoes various adjustments in the course of work, which is associated with the non-confirmation of mineral reserves, changes in water inflows, increased rock pressure and the danger of rock collapse, etc. These changes are very expensive because they require a significant investment of time and money. Digital twins allow engineers to perform all tests and simulations in a virtual environment, which reduces the likelihood of unforeseen situations during actual production. It is much easier, cheaper and faster to repair defects in the digital world than in the real one.

2) Predictable diagnostic maintenance.

Another important advantage of the technology "digital twin" is that it can solve many problems in advance. Virtual copies provide permanent remote control of their physical prototypes, collecting various information about them. Analysis of the collected data allows us to predict possible accidents and breakdowns (Rosen et. al. 2015).

3) The possibility of reuse and sale of the digital twin.

As the field is developed, the amount and reliability of information increases, reducing the cost of the digital model. However, the decline does not occur to zero, since the collected and processed information can be used in the development of other fields similar in certain parameters. Thus, it will allow mining companies to sell this intangible asset after its full use for its own purposes and to receive additional profits.

Thus, the introduction of the digital twin will allow companies to:

1) predict, with a significantly higher degree of reliability, the state of the field, possible emergency situations, respond promptly to them, reducing threats to safety, human health and the environment;

2) increase the depth of understanding of the processes occurring in production, by obtaining advanced statistics on the "virtual" operation of the facility;

3) more accurately calculate the economic performance of the project and manage them;

4) identify weak links and improve the engineering aspects of production;

5) reduce the time to implement the necessary changes.

Conclusion

The mining industry covers a wide range of operations from the exploration activities and deposit evaluation to the beneficiation and transportation of the product to the end user, therefore it is characterised by complexity and increased risk. The use of modern technology and the involvement of highly qualified personnel ensure the efficiency of the mining enterprise. However, today in modern market conditions, this may not be enough to ensure the competitiveness of the company. Given the increasing complexity of mining and geological conditions, increase of risk of production and the need to process information in large volumes, the so-called digitalisation of mining production comes to the fore.

Especially important is that in addition to such advantages as process automation and cost management improvement, digitalisation contributes to production safety increase. For instance, this concerns the use of robots in particularly dangerous areas in order to reduce the use of manual labour and the need for the physical presence of people underground. In addition, the use of modern technologies allows mining companies to process large amount of data needed to predict accidents and simulate risk events in order to minimise them.

In order words, today more and more enterprises around the world understand the feasibility of introducing information technologies at all stages of mining. Digitalisation allows companies to remain profitable, while maintaining a high level of safety for people and equipment.

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PRIORITISATION OF CRITERIA IMPORTANT FOR ORE TRANSPORT SYSTEM SELECTION

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ABSTRACT. The selection of an optimal ore transport system represents a delicate task for mining engineers. The decision-making process should involve every criterion that could affect the final choice. The main objective of this paper is to emphasise the criteria important for ore transportation system selection and demonstrate their prioritisation by using the Multiple-Criteria Decision-Making (MCDM) method. The paper proposes the Stepwise Weight Assessment Ratio Analysis - SWARA for determining the ranking order of considered criteria. The possibilities of the proposed method are demonstrated by using a numerical example and the obtained results are reliable and real.

Keywords: MCDM, SWARA method, criteria, ore transport system

ПРИОРИТИЗИРАНЕ НА КРИТЕРИИ, ВАЖНИ ПРИ ИЗБОРА НА РУДНИЧЕН ТРАНСПОРТ

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РЕЗЮМЕ. Изборът на оптимална руднична транспортна система е деликатна задача за минните инженери. Процесът на вземане на решение трябва да включва всеки критерий, който може да повлияе върху окончателния избор. Основната цел на настоящия доклад е да се наблегне на критериите, които са важни за избора на система за рудничен транспорт и да се демонстрира тяхното приоритизиране чрез използване на многокритериалния метод за вземане на решения (ММВР). Докладът предлага поетапен анализ на коефициента на оценка на теглото (ПАКОТ) за определяне на реда за класиране на разглежданите критерии. Възможностите на предложения метод са демонстрирани с помощта на числов пример и получените резултати са надеждни и реални.

Ключови думи: ММВР, метод ПАКОТ, критерии, рудничен транспорт

Introduction

The selection of the system for ore transport from the mine to the processing plant represents a very important issue because the selected system affects the total costs of a mine. As Karande and Chakraborty (2013) stated in their paper, the material handling costs participate in the total operating costs of a mine with 30%-75%. Bearing that fact in mind, in the transport system selection the decision-maker (hereinafter referred to as DM) should take into account all influential criteria that impact the final decision.

Numerous criteria should be involved in the process of the transport system selection which points out the fact that the decision process should be based on the multiple-criteria approach (Kluge et al., 2017). Although DMs involve every criterion significant for obtaining the proper decision, it is very difficult to determine which of the criteria have the greatest impact on the final choice in the present conditions. Helpful in the resolving of that unknown could be the Multiple-Criteria Decision-Making method (MCDM).

MCDM represents a field of operational research and management science that has achieved great popularity in recent years. Until now, many different methods were proposed and a good overview could be found in the papers of Velasquez and Hester (2013), Zavadskas et al. (2014) and

Mardani et al. (2015). Besides, a significant number of extensions of the proposed methods are introduced (e.g. Boran et al., 2009; Stanujkic et al., 2017; Stević et al., 2018). Various problems in many business fields could be resolved by using some of the MCDM techniques (e.g. Prasad et al., 2015; Luthra et al., 2017; Ghorabae et al., 2018).

The MCDM approach is also used in the area of the selection of the appropriate transport system in the mining exploitation. Elevation and Demirci (2004) applied the PROMETHEE method in the selection of the transport system for an underground mine. Grujić et al. (2007) investigated the possibility of applying MCDM in the selection of the transport system in lead and zinc mine. Owusu-Mensah and Musingwini (2011) considered options for transportation from Kwesi Mensah Shaft (KMS) to the mill at Obuasi mine. Kun et al. (2013) performed a selection of the wheel loaders in open pit mine by using a combination of the AHP (Analytic Hierarchy Process) and the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) methods.

In this paper, the importance of the question connected to the determination of the criteria that have the greatest influence on the final transport system choice is emphasised. The list of the criteria that are submitted to the evaluation by using the Stepwise Weight Assessment Ratio Analysis - SWARA method (Keršiliene et al., 2010) are adopted from the

paper of Owusu-Mensah (2010). Five DMs, experts in the field of mining exploitation were involved in the decision process. The rest of the paper is organised as follows: in the second part, the procedure of the SWARA method is presented; the third part of the paper includes the numerical example; the conclusion is given at the end.

The SWARA method

Various methods have proved to be very useful for determination of the criteria significance and some of them are: Analytic Hierarchy Process – AHP method (Saaty, 1980), the Kemeny Median Indicator Ranks Accordance – KEMIRA method (Krylovas et al., 2014) and the Pivot Pairwise Relative Criteria Importance Assessment - PIPRECIA method (Stanujkic et al., 2017). In this paper, for the prioritisation of the criteria important for the transportation system selection, the SWARA method (Keršulienė et al., 2010) is proposed and presented through the following series of steps.

Step 1. Select the evaluation criteria and sort them in descending order, in lieu of the expected significance.

Step 2. DM should express the relative significance of the criterion j relative to the previous criterion ($j-1$) for each criterion, starting from the second.

Step 3. Determine the coefficient k_j in the following manner:

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \quad (1)$$

where s_j denotes the ratio of the comparative importance of the average value.

Step 4. Determine the recalculated weight q_j is as follows:

$$q_j = \begin{cases} 1 & j = 1 \\ \frac{k_j - 1}{k_j} & j > 1 \end{cases} \quad (2)$$

Step 5. Calculate the relative weights of the criteria by using the following equation:

$$w_j = \frac{q_j}{\sum_{k=1}^n q_k} \quad (3)$$

where w_j is the relative weights of the criterion j .

A numerical example

In this section, a numerical example is presented which points to the prioritisation of the considered criteria. The criteria that impact the final decision relative to the transport system could roughly be divided into three categories and they are: technical, economic and environmental. Some authors, such as Kun et al. (2013) proposed introducing one more category –

commercial criteria. All of the mentioned criteria categories contain a greater number of sub-criteria.

For this paper, the list of the criteria proposed by Owusu-Mensah (2010) has been adopted. Each criterion from the given list belongs to one of the previously mentioned criteria categories. The proposed list of criteria, as well as appropriate explanations, are shown in Table 1.

Table 1. The criteria list (Owusu-Mensah, 2010)

	Criteria	Explanation
C ₁	System productivity	A working output of the system
C ₂	System flexibility	A system possibility to adapt to changes in tonnage
C ₃	Safety in operation	A possibility of the emergence of potentially dangerous and harmful situations
C ₄	Easiness of set up	The system requires minimal technical effort and time in preparing for use
C ₅	Topography	Easiness of manoeuvre in different terrains
C ₆	System availability	High work efficiency and rarely breaking down of the system
C ₇	Spare parts supply	Availability of spare parts
C ₈	Repair easiness	A difficulty of system repairing
C ₉	Durability	Long lasting of the system
C ₁₀	Capital cost	Capital for the purchase of the system
C ₁₁	Energy cost	Costs for fuel and electricity
C ₁₂	Maintenance cost	Cost for system repairing and maintenance
C ₁₃	Operating unit cost	Cost per tonne of ore moved
C ₁₄	Jobs/Labour	Cost of labour
C ₁₅	Emissions levels	Harmful emissions and gases that could damage the environment
C ₁₆	Noise levels	Loud and unpleasant sounds emitted into the surroundings
C ₁₇	Aesthetic/Visuals	Visual impact on the environment

Five DMs were involved in the evaluation process. By using the equations (1)-(3) the ranking according to the DM₁ is performed and the results are presented in Figure 1.

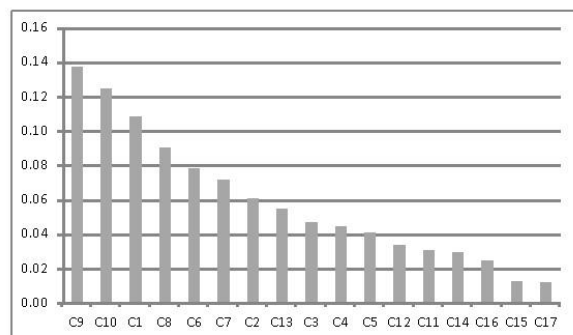


Fig. 1. The ranking order of the criteria according to the DM₁

As can be seen, the most important criterion for DM₁ is criterion C₉ – Durability. So, for this DM the lasting of the system represents one of the crucial aspects that impact on the final selection of the adequate transport system. Second-ranked is criterion C₁₀ – Capital cost and third is criterion C₁ – System productivity. According to the DM₁, the least significant is criterion C₁₇ – Aesthetic/Visuals.

In the previously explained way, the final rank of the criteria for the DM₂ is determined and the obtained results are presented in Figure 2.

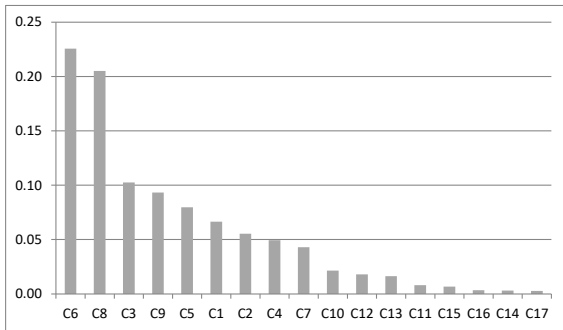


Fig. 2. The ranking order of the criteria according to the DM₂

Two extremely important criteria for DM₂ are C₆ – System availability and C₈ – Repair easiness. The criteria: C₁₆ – Noise levels, C₁₄ – Jobs/Labour and C₁₇ – Aesthetic/Visuals are not so important according to the DM₂.

The results for the DM₃ are presented in Figure 3.

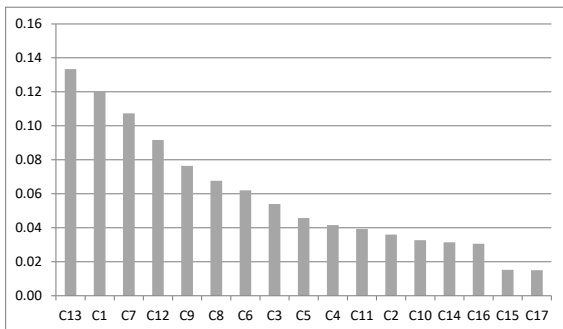


Fig. 3. The ranking order of the criteria according to the DM₃

Figure 3 shows that the criterion C₁₃ – Operating unit cost is the most influential. The mentioned criterion is followed by the criterion C₁ – System productivity, while the least significant are criteria C₁₅ – Emissions levels and C₁₇ – Aesthetic/Visuals.

Assessment results for the DM₄ are as Figure 4 shows.

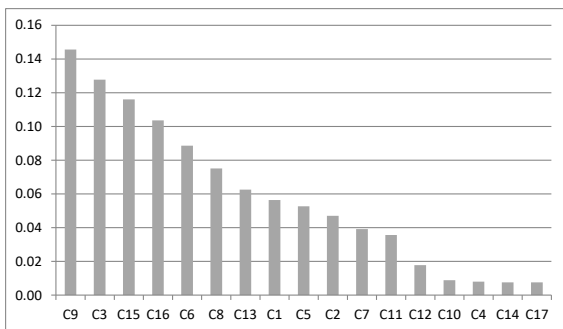


Fig. 4. The ranking order of the criteria according to the DM₄

DM₄ gives the priority to the criterion C₉ – Durability, which is the same case as with DM₁. In addition, the last three positions are occupied by the following three criteria: C₄ – Easiness of set up, C₁₄ – Jobs/Labour and C₁₇ – Aesthetic/Visuals. It seems that the way in which the transport system influences the visual conditions of the surroundings is not so important for the DM₄.

The results connected with the standpoint of the DM₅ are shown in Figure 5.

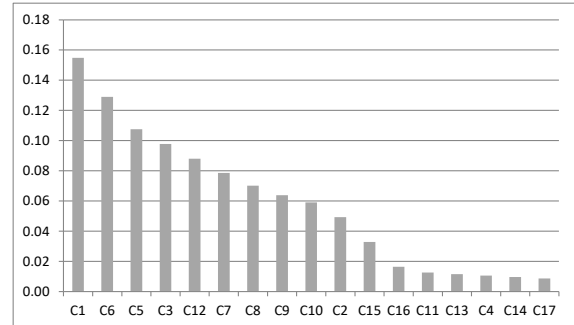


Fig. 5. The ranking order of the criteria according to the DM₅

DM₅ puts the criterion C₁ – System productivity in the first place. As well as in the previous cases, the last position occupies the criterion C₁₇ – Aesthetic/Visuals.

The overall result is obtained by applying the following equation:

$$w_j = \left(\prod_{r=1}^R w_j^{nr} \right)^{1/R}, \quad (4)$$

where w_j^{nr} denotes the weight of the criterion j obtained from the respondent r , R represents the number of the respondents, w_j is the group weight of the criterion j .

The obtained final results are as follows (Fig. 6).

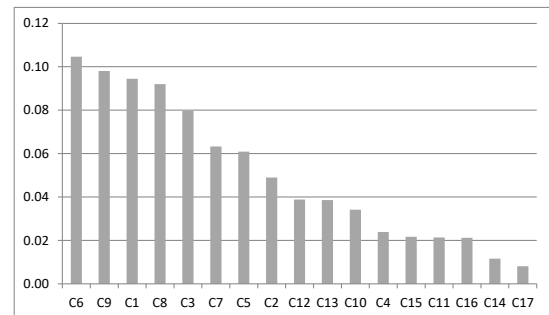


Fig. 6. The overall ranking order of the considered criteria

The overall results show that criterion C₆ – System availability has the greatest influence on the selection of the optimal transport system in the mining industry. As it was expected, the criterion C₁₇ – Aesthetic/Visuals is at the last position.

The obtained results show that a group of criteria connected to environmental issues is not so important for the selection of the optimal transport system. The crucial criteria are mainly of technical nature which is confirmed by the first ranked criterion. The proper functionality and reliability of the selected transport system are of the greatest importance for the DMs i.e. mining engineers.

Conclusion

The selection of the suitable transport system that enables the transportation of ore from the mine to a certain processing plant requires detailed and methodical analysis. Although the costs are the first issue when business planning is in question, the basing of a decision only on the economic type of criteria would not lead to justified and appropriate decisions. The decision, such as the selection and purchasing of the system for ore transportation should involve different types of influential criteria. In this case, it is very difficult to determine which criterion has the greatest influence on the final choice.

In this paper, for the prioritising the criteria for transport system selection the SWARA method is proposed. The evaluation process was performed in a group decision-making environment that involved 5 DMs which assessed 17 criteria (Owusu-Mensah, 2010). The final results, obtained by applying geometric mean, are completely reliable and justified.

The SWARA method proved to be useful and to successfully facilitate the decision process. Besides the prioritisation of the considered criteria, this method could be used in the process of the transport system selection, as well. Also, the SWARA method could be applied in other fields of mining exploitation as a tool that could increase the reliability and validity of decisions. The main shortage of the used method is that it is not quite suitable for group decision-making, because the process of obtaining the overall results is somewhat complicated. In that sense, the possibilities of the newly introduced PIPRECIA method (Stanujkic et al., 2017) should be used and it will be very interesting to perform the comparison of these two methods on the same example.

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PRICE FORMATION OF ENERGY SERVICES IN THE SPHERE OF NATURAL GAS IN BULGARIA

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ABSTRACT. At this stage (since the liberalisation of the gas sector in the European Union) a regulated gas market and a free natural gas market operate in Bulgaria simultaneously, and the country depends mainly on one source of supply. Local yield is negligible and there are no reverse connections to the neighbouring countries. Natural gas prices in Bulgaria are subject to regulation by the Energy and Water Regulatory Commission, in particular: natural gas price of natural gas sales from the Public Supplier to the End Suppliers and to the customers connected to a gas supply network; prices for distribution and supply of natural gas; prices for connecting customers to gas transmission or gas distribution networks; prices for balancing; prices for access and transmission of natural gas through gas transmission and/or gas distribution networks, except when the Commission at its own discretion approves a methodology for setting the price for access and transmission through a transmission network; price for access and storage of natural gas in storage facilities. The applied price-regulation methods are "rate of return on capital", "price cap" and "revenue cap".

Key words: natural gas, distribution, transmission, prices and tariffs

ЦЕНООБРАЗУВАНЕ НА ЕНЕРГИЙНИТЕ УСЛУГИ В ОБЛАСТТА НА ПРИРОДНИЯ ГАЗ В БЪЛГАРИЯ

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РЕЗЮМЕ. На този етап (от либерализацията в газовия сектор на Европейския съюз) в България функционират едновременно регулиран и свободен пазар на природен газ, като страната зависи основно от един източник на доставка. Местният добив е незначителен и липсват реверсивни връзки към съседните страни. Цените на природния газ в България подлежат на регулиране от Комисията за енергийно и водно регулиране, и по-конкретно: цена на природен газ при продажба на природен газ от Обществен доставчик на крайните снабдител на природен газ и на клиентите, присъединени към газопреносна мрежа; цени за разпределение и снабдяване с природен газ; цени за присъединяване на клиенти към газопреносните или газоразпределителните мрежи; цени за балансиране; цени за достъп и пренос на природен газ през газопреносни и/или газоразпределителни мрежи освен в случаите, когато Комисията по своя преценка одобрява методика за определяне на цена за достъп и пренос през преносна мрежа; цена за достъп и съхранение на природен газ в съоръжения за съхранение. Прилаганите методи на ценово регулиране са "норма на възвращаемост на капитала", "горна граница на цени" и "горна граница на приходи".

Ключови думи: природен газ, разпределение, пренос, цени и тарифи

Introduction

Natural gas market in Bulgaria

Currently, both a regulated and a free market for natural gas are functioning in our country. Local extraction is insignificant, there are no reversible connections to neighbouring countries, the first natural gas supply deals at a virtual point were made in 2019. These factors determine the uncertainty of supply and the still insufficient competition in the gas market.

Public delivery

Public supply is the supply of natural gas of a specified quality and regulated price, determined according to a methodology approved by the Energy and Water Regulatory Commission. The public supply of natural gas on the territory of the Republic of Bulgaria is carried out by Bulgargaz JSC – a public supplier of natural gas, ensuring its supply at prices regulated by the Energy and Water Regulatory Commission (SEWRC). The

public service provider Bulgargaz JSC sells natural gas at prices regulated by SEWRC, with its share in sales for 2018 being 98.90%. The remaining 1.10% is realised by traders at freely negotiated prices.

Transfer and storage

Bulgartransgaz JSC, a combined gas operator, carries out two main activities – "natural gas transmission" and "natural gas storage". Bulgartransgaz JSC is an operator of the National Gas Transmission Network (NGPM) for the transmission of natural gas on the territory of Bulgaria to gas distribution networks and non-household customers of natural gas; natural gas transit transmission network (GMTP) for the transmission of natural gas through the territory of Bulgaria to the neighbouring countries Romania, Turkey, Greece and Northern Macedonia and the Chiren underground storage facility (Chiren UGS) for storage of natural gas intended to cover seasonal imbalances in consumption and to guarantee security of gas supply.

Distribution and supply of natural gas from a final supplier

The gas distribution companies carry out the activities of "natural gas distribution" and "supply of natural gas from a final supplier", supplying natural gas to customers connected to the respective gas distribution networks in the licensed territories.

At the end of 2017, 24 companies in Bulgaria were licensed for 35 territories, covering 172 municipalities and representing 65% of all municipalities in the country. The necessary infrastructure for distribution of natural gas in the country is in the process of construction and the connected household customers to the gas distribution networks are few. Nine companies carry out the supply of compressed natural gas to some municipalities that have no connection to the gas transmission network.

According to gas distribution companies, the total number of customers in the natural gas sector in 2018 is 107669, of which 100439 (93%) are household customers and 7230 (7%) are non-household customers. The total amount of natural gas distributed by gas distribution companies for 2018 is over 5446597,263 MWh or 17% of the total natural gas consumption in the country.

Natural gas pricing methods in European Union countries.

Directive 2009/73/EC of the European Parliament and of the Council of Europe of 13 July 2009 on common rules for the internal market in natural gas establishes common rules for the transmission, distribution, supply and storage of natural gas. It lays down rules relating to the organisation and operation of the natural gas sector, market access, the criteria and procedures applicable to the granting of authorisations for the transmission, distribution, supply and storage of natural gas, and the operation of systems. Directive 2009/73/EC does not specify pricing methods. Only the need for prices to be marketable is stressed upon and only in some cases to be regulated for the so-called "Vulnerable" customers. However, the experience of the Member States is shared and as a result it can be confirmed that prices for energy services in the EU are mainly determined by the following three methods:

Rate-of-return method

The "rate of return on equity" pricing method is a method by which the prices and required annual revenues of the energy undertaking for a regulatory period of not less than one year are guaranteed with a guaranteed return; a subsequent regulatory review shall be carried out at the discretion of the committee or at the request of the energy company, with significant deviations between the approved and reported elements of the required revenue.

Price-cap method

The incentive pricing method is considered to be the most compliant with incentive regulation requirements and is becoming more widespread.

In the simplest form, the incentive pricing method (or in this case, the price cap method) is expressed by the following formula:

$$\text{Price for the current year} = \frac{\text{Price in the previous year} * (1 + \text{inflation index}) * (1 - \text{efficiency factor})}{1}$$

For a period of several years (usually between two and five), a starting price is determined, (price in the previous year), which is indexed for each subsequent year by the inflation index and the company performance factor. The efficiency factor is introduced by the regulator and is related to the achievement of certain performance indicators of the company, which are not directly related to revenue and are more related to the quality of the service provided - e.g. provision of gas with certain qualities, transport and supply of natural gas at a certain quality of the service.

By applying the incentive pricing method, the company is incentivised to generate additional revenue within the regulatory period by improving its operating efficiency (reduce costs or increase sales).

This method is designed to encourage utility companies to reduce costs. This is partly achieved by setting prices and revenues so that the company earns profits over the years, regardless of the costs it incurs during the year. This is also achieved by allowing the company to retain at least some of the benefits realised by improving efficiency.

Revenue-cap/revenue-based method

Pricing based on average cost plus return implies that all costs included in the company's financial statements are covered by the price at which the product/service is sold. The method is the most widely used pricing method for gas distribution companies. In doing so, the regulator approves energy company prices that cover the costs and return on capital that is sufficient to maintain, replace and expand the assets. In this method, the price can be obtained by dividing the required revenue by the forecast volumes. The required revenue or prices are usually fixed every year or every two years, but no more than five.

Regulated/unregulated natural gas prices in individual countries in the European Union

In the European Union, most regulated end-user countries have a dual market structure where both regulated and unregulated markets exist in parallel (Table 1).

Table 1. Summary of the year in which the market is fully liberalised and the percentage of household and non-household customers with regulated prices - December 2014

Year of final market opening	Households		Switching in and out allowed		% with social tariffs		Non-households	
	E	G	E	G	E	G	E	G
Bulgaria	-	-	100%	100%	Yes	No	100%	100%
Croatia	2008	2008	93%	100%	Yes	Yes	33%	
Cyprus	-	nap	100%		No		100%	
Denmark	2003	2004	80%	n/a	Yes	Yes	n/a	n/a
France	2007	2007	90%	67%	Yes	Yes	8%	8%
Greece	2007	-	100%		No	9%	86%	40%
Hungary	2007	2007	99%	98%	Yes	Yes	61%	86%
Latvia	2007	2014	100%	100%	Yes	No		100%
Lithuania	2007	2007	100%	100%	Yes	No		21%
Malta	-	nap	100%		No		10%	100%
Poland	2007	2007	98%	98%	Yes	Yes		100%
Portugal	2006	2010	53%	35%	Yes	Yes	1%	12%
Romania	2007	2007	100%	100%	Yes	No	12%	54%
Slovakia	2007	2007	100%	100%	Yes	Yes		30%
Spain	2003	2003	48%	25%	Yes	Yes	9%	

In the European Union, most regulated end-user countries have a dual market structure where both regulated and unregulated markets exist in parallel. In these countries, household consumers have the choice of being delivered at regulated prices or below market price. However, in most countries where switching to an unregulated price is possible, the majority of household consumers remain (i.e. choose to remain) at regulated prices (for example, 100% of electricity households in Bulgaria, Latvia, Lithuania, Romania and

Slovakia and gas households in Croatia and Slovakia). It is also noteworthy that after so many years of formal liberalisation of the EU market, the option to switch to market prices does not yet exist for electricity households in Malta and Cyprus and gas households in Bulgaria, Greece, Latvia, Lithuania and Romania (i.e. there are no alternatives to regulated prices).

By contrast, the unregulated electricity and gas markets in Spain and Portugal are expanding. This may be explained by the fact that markets in these countries were open to competition earlier and that consumers had more time to adapt, while in countries that open their markets later, consumers need a longer "transition period". In addition, in Portugal regulated prices are set higher than the market price in order to stimulate the transition to an unregulated market.

Specific regulated prices for vulnerable consumers (often called "social tariffs") aimed at protecting consumers who spend most of their energy income exist in several countries (seven in electricity and one in gas), but the available data in Table 1 shows that the percentage of users of prices for vulnerable consumers is relatively low.

In some countries there is also a link between the price and the so-called competitive market. For example, Denmark, the marginal cost is set at such levels that the cost is not lower than the cost of the service. A similar approach was introduced in Spain in 2004.

In most countries, it is the regulator that sets regulated prices, while in France, Greece, Hungary and Spain the government sets them, and the regulator only gives an opinion.

Natural gas pricing in Bulgaria

In exercising its powers of price regulation, SEWRC may apply different methods of regulation, determine the performance indicators of energy companies, indicators of comparability between them, fulfilment of basic criteria.

Pursuant to Ordinance No. 2 of March 19, 2013, on the regulation of the prices of natural gas (NRCSPG), issued by the Chairman of the State Commission for Energy and Water Regulation, SEWRC applies the following basic methods of price regulation:

1. "rate of return on capital" at which the commission, after carrying out the regulatory review, shall approve the prices and required annual revenues of the energy undertaking for a regulatory period of not less than one year; a subsequent regulatory review shall be carried out at the discretion of the committee or at the request of the energy company, with significant deviations between the approved and reported elements of the required revenue;

2. "price cap" and "revenue ceiling", in which the regulatory period lasts from 2 to 5 years; following a regulatory review, the commission shall approve the prices and required annual revenues of the energy company for the first year of the regulatory period and may amend them at the end of each price year or at the end of the regulatory period.

For the purposes of price regulation, SEWRC may apply comparability indicators between energy companies and require the fulfilment of basic benchmarks based on analyses using data from good practices at national and international level.

Prices of a public natural gas supplier

The prices at which the public provider sells natural gas to final suppliers and to customers connected to the gas transmission networks shall be formed on the basis of the last demanded estimated quantities of natural gas from the final suppliers and customers connected to the gas transmission networks, and the cost of their supply from imports into the internal market, from local extractive industries, from natural gas reserves and from the component of the "public supply" activity.

The price of natural gas at the inlet of the gas transmission networks is formed by the public provider as a weighted average, taking into account the most recently requested estimated quantities of natural gas from imports into the domestic market, from local extractive enterprises and from natural gas reserves for sale in the next period, contracts for the supply and transmission of natural gas to the Bulgarian border and the average exchange rate of the Bulgarian National Bank in BGN against the foreign currency in which natural gas imported into the country is paid for the period of forty-five days preceding the months of the submission of the price confirmation proposal.

The cost of supplying natural gas also calculates the component of the "public supply" activity up to 2.5 percent annually from the approved average purchase price of natural gas. The component of the "public supply" activity includes the costs of storage of natural gas, which are calculated on the basis of a plan submitted by the company for the quantities of natural gas for injection and extraction, valued at the current storage price approved by the commission. The periodic change in the price of natural gas takes into account the difference between the estimated and actual reported storage costs.

Prices for distribution and supply of natural gas

Prices for the activities of "natural gas distribution" and "supply of natural gas from a final supplier" are regulated by the SEWRC through the "price cap" method according to Art. 3 of the NRCSPG. SEWRC approves tariff structures by customer group, reflecting the allocated annual revenue required to provide the service for each group based on a service cost survey submitted. The current tariff structures and prices for the end customers of the gas distribution companies are differentiated depending on consumption (household and non-household), uniformity and non-uniformity of consumption and corresponding consumption.

Prices are formed on the basis of the required annual revenue and the estimated amount of natural gas distributed and supplied over a period of 2-5 years, approved by the Commission.

The required annual revenues include the economically justified costs associated with the transmission of natural gas and the return on capital. Annual costs include all costs directly related to the licensing activities of gas companies and approved by SEWRC. Return on equity is defined as the product of the regulatory base of assets and the rate of return on capital. The regulatory base of assets is the recognised value of the assets on which the energy undertaking receives a return on its invested capital. It includes realised investments and working capital less accumulated depreciation and financing (income from accession, grant schemes, donations, grants, etc.). The rate of return on capital is equal to the

weighted average cost of capital. The weighted average cost of capital is the rate of return on the attracted and the equity of the energy enterprise, weighted according to the share of each of these sources of financing in the total capital structure.

$$WACC = E * \frac{Re}{(1-T/100)} + D * Rd \quad (2)$$

WACC – Weighted average rate of return on capital before tax;

- E – share of equity in total capital;
- Re – rate of return on equity after taxation;
- T – corporate tax (10%);
- D – share of debt capital in total capital;
- Rd – rate of return on attracted capital.

The rate of return on equity is calculated using the capital asset valuation (CAPM) method, which is the most appropriate to calculate because it is based on measurable inputs and is the most commonly used by European regulators. According to CAPM, the cost of equity should be considered as the sum of the risk-free rate of return paid by each investor plus the risk premium multiplied by the beta (β). The risk-free premium as a component of CAPM is applied to offset (compensate) the long-term risk in the economy inherent in the least risky (or practically risk-free) economic actor – the state.

The formula for calculating the return on equity using the model for assessing capital assets is:

$$E(Ri) = Rf + \beta (E(Rm) - Rf) \quad (3)$$

- E(Ri) – the expected return on equity;
- Rf – the risk-free interest rate;
- β – beta is a relative risk measure showing the risk of a company relative to the risk of all companies in the market;
- E (Rm) – the average return on the market portfolio;
- E (Rm) – Rf – the equity premium or the required return over the equity risk premium.

In regulating prices in the energy sector in connection with the calculation of the rate of return on equity, SEWRC applies the CAPM using data published on the official website of Aswath Damodaran - Stern School of Business and the Bulgarian National Bank (BNB).

The prices for distribution and supply of natural gas are formed as the ratio between the discounted required annual revenues and the discounted quantities of natural gas for the respective period.

Prices are formed on the basis of planned data on natural gas sales, investments and costs for a period of 2-5 years. Planned sales have an impact on prices, with lower volumes leading to higher prices and conversely higher volumes reducing prices.

Each year, SEWRC conducts a regulatory review of the implementation of the approved business plan parameters by the gas distribution company (GDC). In case of significant deviations between planned and reporting indicators, the regulator may request the GDC to submit a proposal for updating the business plan/prices. For its part, the GRC may also request an update of the business plan/prices in the presence of objective circumstances.

According to the NRCSPG, prices can be updated annually with an inflation index for the previous year and a coefficient for improving efficiency, as well as performance indicators for

natural gas quality and quality of service. These updates are not applicable as methodologies for their implementation by SEWRC have not yet been established.

Prices for connection of customers to gas distribution networks

According to the Law on Energy and NRCSPG, SEWRC regulates the prices for connection of customers to gas distribution networks, which are formed by customer groups depending on the declared maximum capacity and pressure and the corresponding recognised costs for the group. Prices for connection to the gas and gas distribution networks of extractive gas pipelines, gas storage facilities, liquefied natural gas facilities, gas production facilities from renewable sources, gas distribution networks and non-household customers outside the above groups are individual and include actual costs for the above mentioned groups and the construction of facilities for connection to the network of the respective enterprise.

In accordance with the provisions of the NRCSPG, consumers are charged a price for joining the Gas Distribution Network (GDN). It includes part of the cost of joining without profit. These are mainly the costs associated with issuing documents from different institutions, as well as the costs of performing construction and installation work for joining the network. These costs are capitalised and included in the assets' regulatory base on which the distribution prices are formed. The revenue from the acquisition represents the financing of the gas distribution company by the customers. Therefore, the regulatory base of assets is reduced in the calculation of distribution prices in order not to duplicate these revenues. Revenue from accession is treated as a type of "asset" that is depreciated and its value decreases the regulatory base of the assets.

Balancing prices

SEWRC adopted Rules for Balancing the Natural Gas Market and Methodology for Determining the Daily Imbalance Charge. The rules for balancing the natural gas market (promulgated State Gazette 99/13 December 2016, amended and supplemented SG 57/07, July 19, 2019) are of key importance for creating conditions for opening the natural gas market and ensuring unimpeded market access for all market players, including new entrants, by establishing transparent and fair market-based mechanisms for the supply and transmission of natural gas. These rules ensure that network users will be able to be responsible for balancing their balance portfolios to minimise the need for an operator to take balancing actions. The methodology for determining the daily imbalance charge (issued by the Chairman of the Energy and Water Regulatory Commission, promulgated SG 57/19/2019, effective 19.07.2019) determines the method of calculating the amount of daily imbalances and of prices for positive and negative imbalances, ensuring the formation of non-discriminatory imbalance charges for users and creating incentives for transmission system users across the country to balance their balance portfolios efficiently.

Prices for access and transmission of natural gas through gas transmission and/or gas distribution networks

The Bulgarian gas transmission system operator (GTSO) Bulgartransgaz JSC has been applying the input-output tariff

model since the beginning of October 2017. The tariff system developed by it is two-component and includes tariffs on the basis of reserved capacity (prices for access) and on the basis of the transferred quantity of natural gas (transmission prices).

The price for capacity (tariff element per MWh/day) is paid against the user's right to use the gas transmission system for the period of the contract concluded with the operator. The right to use the system is determined by the maximum daily amount of gas reserved by the user for a specified period. In addition, the user may be charged excess capacity if he exceeds these reserved values. The transmission price is determined on the basis of the actual use of the system or the actual consumption expressed in MWh, i.e. the value per unit volume of natural gas transferred from an entry point to an exit point/zone.

The prices are determined on the basis of the necessary revenue, including the costs of performing the licensing activity plus the return on the investments made, mainly in gas infrastructure. Two approaches can be applied to allocate the necessary revenue to the access price and the transmission price.

The first one is based on the rule that variable costs relate to the cost of transmission and conditional costs and returns on a regulatory basis to access costs. The other approach is to determine the ratio of payment of the total required revenue administratively: to those paid from the access price and to those paid from the transmission price.

The second approach is more widely used, since the major part of the variable costs (technological costs, fuel gas costs and electricity for the operation of the compressor stations) for the regulatory period are related to the so-called technological component - the component of the total cost of transmission. This approach is widely used in international practice.

Some countries in Europe apply both access and transmission costs - Belgium, the Czech Republic, Greece, the United Kingdom, Ireland and Portugal, and in these countries the access/transmission ratio shows a clear tendency to recover more than revenue from the cost of access. For example, in Greece and Portugal, 90% of the revenue is recovered from the cost of access. The observed ratio of revenue from access and transmission costs reflects the higher proportion of fixed costs (capital and fixed operating and maintenance costs) compared to the variable costs (variable operating and maintenance costs) of the gas transmission networks. In recent years, the trend for gas transmission system owners in the United States has been toward higher revenue ratios collected from cost of access to revenue from transmission cost than 90%:10% and 95%:5%.

Access prices are charged at the entry and exit points/zones of the gas transmission system owned by Bulgartransgaz JSC based on the allocated capacity of the respective points. Access prices are divided according to points/zones (input and output), interruption (solid and interruptible) and period (annual, quarterly, monthly, daily and intraday) of the product. Depending on the period of the capacity products, the access prices are set in BGN/MWh/day/(year, quarter, month or day).

The transmission price consists of: the transmission component - it is charged to all the input and output zones/points of the gas transmission system depending on the

allocated volumes of natural gas at these points/zones; technological component - it is charged to all input and output zones/points of the gas transmission system depending on the allocated volumes of natural gas at those points / zones; component of obligations to society - is charged to all national gas transmission system exit points/zones without exit points to natural gas storage facilities, depending on the allocated volumes of natural gas at those points/zones.

Prices for access and storage of natural gas

SEWRC regulates the prices for access and storage of natural gas in storage facilities in accordance with the Energy Act, the NRCSPPG and the Guidelines for setting prices for access and storage of natural gas in storage facilities using the method of regulation capital adopted by the Commission. The prices for access and storage of natural gas at which the operators of natural gas storage facilities, respectively combined operators, offer the same service to different customers under equal contractual conditions guarantee compliance with the principle of non-discrimination against all network users and at the same time, the specific characteristics of the national market are taken into account.

Conclusion

Most current studies and analyses of the role of natural gas in the global energy and economy have a significant place on tariffs and terms of supply contracting as one of the main parameters of the newly emerging gas market. Economic logic determines that the more developed and competitive a market is, the greater the lack of regulation and the right to apply free competition and the direct negotiation of service prices.

In parallel with the development of free trade in natural gas as a commodity, the demand for services related to the storage, transmission and access, distribution and supply of natural gas will increase. Whatever direct trade practices may be applicable to the designation of some of these services, those related to infrastructure investments will continue to be regulated, at least for the reason that they are a natural monopoly for a particular territory.

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TRENDS IN THE DEVELOPMENT OF THE TUNGSTEN PRODUCTION

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ABSTRACT. Tungsten, as one of the "strategically important" metals, plays a key role in the contemporary development of the world industry and has specialised applications where it is currently impossible to replace it with other alternative materials. A study was carried out and data and information on the trends in the development of world resources, reserves and production of tungsten were analysed and summarised. Modern technologies and methods for obtaining concentrates, middlings or metal are presented. The trends concerning the changes in the production process have been identified and the forecast is for a steady low price trend over the next decade. New possibilities are presented for the production of metal of high purity by vacuum electrometallurgy methods - vacuum electric arc and electron beam melting. This enables both the production of metal of high purity and tungsten alloys and middlings with new or improved chemical composition, structure and properties.

Keywords: tungsten, primary production, processing, metal of high purity, electron beam melting, prices, markets

ТЕНДЕНЦИИ В РАЗВИТИЕТО НА ВОЛФРАМОВОТО ПРОИЗВОДСТВО

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РЕЗЮМЕ. Волфрамот, като един от „стратегически“ важните метали, заема ключова роля в съвременното развитие на световната индустрия и има специализирани приложения, в които понастоящем е невъзможна замяната му с други алтернативни материали. Направено е проучване и са анализирани и обобщени данни и информация относно тенденциите в развитието на световните ресурси, запаси и производство на волфрам. Представени са съвременните технологии и методи за получаване на концентрати, междинни продукти или метал. Установени са тенденции относно промените в производствената активност и е прогнозиран устойчив нисък тренд на цените през следващото десетилетие. Представени са нови възможности при получаване на метал с висока чистота чрез методи на вакуумната електрометалургия - вакуумно електродъгово и електроннолъчево толене. Това дава възможност за получаване на метал с висока чистота и волфрамови сплави и полуфабрикати с нови или подобрени химичен състав, структура и свойства.

Ключови думи: волфрам, първично производство, преработка, метал с високо качество, електронно-лъчево толене, цени, пазари

Introduction

Tungsten (W) is a transition metal with the highest melting temperature (3422°C) in the group of refractory and alloying rare elements (B, Ti, Zr, Hf, Mo, Ta, Nb and V) and among all metals. The metal has a number of specific physical and mechanical properties: high density (19.3 g/cm³), the lowest coefficient of thermal expansion (4.32-4.68.10⁻⁶.K⁻¹ at 25°C) and pressure of the vapour (8.15x10⁻⁸ Pa at 2000°C) among all metals, a high tensile strength (345-517 MPa at 1000°C), modulus of elasticity (390-410 GPa at 25°C), high heat (175 W/m.K at 25°C) and electrical conductivity (1.82x10⁷ S/m at 20°C) and high wear resistance. The tungsten is also characterised by high resistance to corrosion, water, inorganic (hydrochloric, sulfuric, nitric and hydrofluoric) and organic (formic, acetic, oxalic, tartaric) acids. Alkaline solutions do not act on tungsten but, when in contact with air, molten bases oxidise it to form tungstate. The tungsten is oxidised to tungsten trioxide at temperatures higher than 400-500°C. At temperatures ranging from 900 to 1200°C solid carbon and carbon-containing gases (CO, CH₄, etc.) together with the

tungsten form very hard tungsten carbides (WC and W₂C), which are wear resistant and with high-melting point (the melting temperature of WC is 2900°C, of W₂C – 2750°C).

The properties of tungsten make it widely applicable in various fields of modern industry and machinery: automotive, steel, instrumental, mining, oil, gas, aerospace, chemical, construction, lighting industries, etc. Tungsten is used as a pure metal and an alloying component in steels, wear- and fire-resistant alloys, solid alloys based on tungsten carbide, as tungsten compounds, etc. Pure tungsten is used in electronics (cathode-ray tubes), X-ray technology (X-ray tubes), in electrical engineering (electric lighting, spotlights, electric heating elements in electric furnaces, microwave ovens, batteries, etc.), as well as in applications related to surfacing and welding in gas and tungsten (arc TIG welding). In metallurgy, tungsten is widely used in the production of special steels and alloys. Its content reaches up to 18-20% in the tool and high-speed steels. Tungsten alloys with molybdenum, tantalum, niobium and rhenium are used as refractories in aircraft and missile technology. Refractory and wear resistant alloys also include alloys containing tungsten (3-15%), cobalt (45-65%) and chromium (25-35%), which are used to cover heavy wear parts

in machines (airplane engines, turbochargers jet engines, turbines, etc.). Nonferrous alloys based on Ni and Co with tungsten (Hastelloy® and Stellite®) are characterised by very high corrosion and wear resistance. Tungsten alloys of copper and silver and tungsten alloys of molybdenum are used in the preparation of high-temperature electrical sockets and thermocouples in electric arc furnaces and welding equipment. Tungsten alloys with copper and nickel (heavy alloys) are with high density (16.5-18 g/cm³), which is used in the military industry to produce counterweights in aviation instruments, artillery parts, armour piercing bullets, super-fast gyro rotors for stabilising ballistic missiles, etc. They are also used in radiotherapy to protect against γ -rays and to produce containers for the storage of radioactive isotopes. An important area in the application of tungsten in the metallurgical industry is the production of solid alloys based on tungsten carbide (85-97% WC and 3-15% Co or Ni). Solid alloys are the highest quality tool alloys that retain their high hardness and wear resistance when heated to 1100°C. They have a wide range of industrial

applications in the heavy machinery, mining and petroleum industries, etc., with some brands of these alloys containing titanium, tantalum and niobium carbide. Chemical compounds of tungsten are used in the production of catalysts, inorganic pigments and high temperature (up to 500°C) lubricants (based on tungsten disulphide). Tungsten oxides are used for the production of ceramic glazes, and "tungsten bronze" (named after the colour of the tungsten oxides) is used in the manufacture of paints. Tungstate (calcium and magnesium) is used in the production of luminescent luminaires. Crystalline tungstate is used as a scintillation detector in nuclear physics and medicine. Tungsten salts are applied in the chemical and tanning industries. A number of tungsten compounds are used in the textile industry for the aging of fabrics and the production of fire and waterproof fabrics.

The structure of the world primary application (www.itia.info/tungsten) and the end use of tungsten in the industrial sectors (base 98 thousand t W; *ITIA*, 2017) is shown in Table 1 and 2.

Table 1. World primary application of tungsten (*Roskill – ITIA, 2010*)

Application	World, %		Countries, %					
			China	Europe	Japan	Russia	USA	
Solid alloys (based on tungsten carbide and cemented carbides)	54	65*	54	72	66**	67	70	66
Steels/Alloys (high-speed, drilling, tool, refractor, heavy alloys, super alloys, etc.)	27	17*	28	9	11**	11	26	9
Middlings (wire, laminas, sheets, plates, etc.)	13	10*	11	8	10**	11	4	20
Other applications	6	8*	7	11	13**	11		5

Source: * *ITIA*, 2018; ** European Hard Materials Group (*EuroHM*), 2017

Table 2. End use of tungsten worldwide

Industrial sector	Usage, %
Energy	10
Transport	34
Industrial equipment	11
Mining and construction	21
Defence	8
Medicine, etc.	10
Consumer (household durable goods)	6

According to the British Geological Survey (2015) of chemical elements or groups of economic value, tungsten is defined with a high supply risk index with a value of 8.1 at a scale of one to ten.

Resources, reserves and mining production of tungsten

Identified tungsten resources worldwide have been estimated at around 13 million t W (16.34 million t WO₃) (*Lapteva*, 2018) and are available in 27 countries. Their distribution is characterised by a high degree of concentration in six countries (China, Kazakhstan, Russia, Canada, Australia and Vietnam), where over 80% of global resources are concentrated, Table 3.

Table 3. Distribution of resources worldwide (base 2015)

Countries	Resources, thousands t		
	W	WO ₃	%
China	5713.6	7205.0	44.1
Kazakhstan	1590.0	2005.0	12.3
Russia	1576.5	1988.0	12.2
Canada	996.0	1256.0	7.7
Australia	644.8	813.1	5.0
Vietnam	225.8	284.7	1.7
Others	2210.8	2787.9	17.0
Overall	12957.5	16339.7	100.0

The proven tungsten reserves are estimated at about 3.345 million t W (base 2017). The development of the proven reserves and the mining production for the period 2002-2017 are presented in Figure 1 (*USGS*, 2002-2018). The increase of the mining reserves for the indicated period is 1.1 times and that of the production - 1.4 times. The reserves are characterised by a high degree of concentration in 13 countries, with around 90% in the world's top four (China, Russia, Canada and Australia). There is no published data about the US reserves. According to the used classification about the depletion rates of mineral reserves (*Slastunov et al.*, 2001), the tungsten reserves for the period are characterised by a high rate of depletion, with a reserve life index of a resource (RLI, %) within the range of 2.0-3.0%. If global production is maintained at the level of 2016-2017, the reserves will ensure tungsten supply for no more than 35-40 years worldwide. The identified global tungsten resources may extend this period with about 80-85 years.

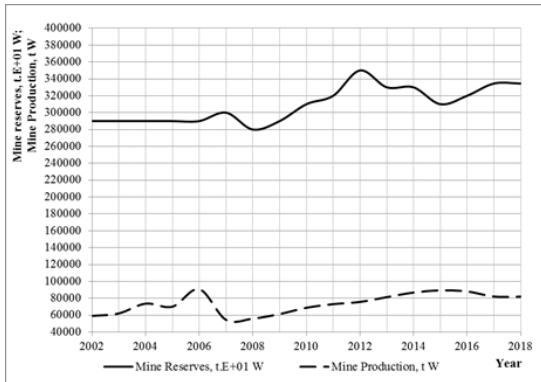


Fig. 1. World reserves and mining production of tungsten, 2002-2017

The main geological, genetic and industrial types of tungsten deposits (Vangelova, 2013) are presented in Table 4. Out of the 50 known minerals and mineral varieties of tungsten, only the minerals wolframite (Mn,Fe)WO₄ (with 74% W ± Nb, Sc, Ta, Y, In, Mo), ferberite FeWO₄, huebnerite MnWO₄ (with about 60.5% W) and scheelite CaWO₄ (~64% W) are of industrial importance. Wolframite and huebnerite cover about 75% of the world's yield, while the scheelite - about 25%.

Table 4. Industrial types of tungsten deposits

Type of deposit	Ore minerals		Known deposits
	Primary	Secondary	
Skarn	scheelite, sometimes molybdenite	cassiterite, bismuthinite, magnetite, pirrhotite, pyrite, arsenopyrite, wolframite, etc.	Vostok II, Turnaus (Russia); Chorukh-Dayron (Tajikistan); Ingichka (Uzbekistan); Sangdong (South Korea); Shizhuyuan, Huanpodi, Iliu (China); Emerald Fini, Mactung Cantung (Canada); Pine Creek, Osgood Range (USA); Salau (France); King Island, Moana (Australia) and others.
Greisen	wolframite, molybdenite, cassiterite	magnetite, bismuthinite, pirrhotite, pyrite, chalopyrite, galena and sphalerite	Akchatau, Kara-Oba (Kazakhstan); Yugodzyr, Bayamod (Mongolia); Piaotian, Xinhuangshin (China); Wolfram Camp, Torrington (Australia); Cornwall (United Kingdom); Altenberg (Germany); Cínovec, Krupka (Czech Republic); Zabaykalie (Russia) and others.
Veined (plutonogenic-hydrothermal)	wolframite, huebnerite, more rarely scheelite	cassiterite, molybdenite, bismuthinite, arsenopyrite, pyrite, pirrhotite, chalopyrite, galena, sphalerite, etc.	Panasqueira (Portugal); Iultin, Bom-Gorhon, Holtoson, Bukuka, Antonovogorskoe (Russia); Boguty, Verkneye Kairakty (Kazakhstan); Tumen-Tsogto (Mongolia); Red Rose (Canada); Herberton (Australia); Liandushan, Shanping (China); Belfort (France); Grancharitsa (Bulgaria) and others.
Epithermal (volcanogenic-hydrothermal) complex composition (Sn-Ag-W, Hg-Sb-W, Au-W, Mn-W)	Ore associations: (cinnabar) – antimonite-scheelite-ferberite; Ag-Au-scheelite; psilomelan-wolframite		Ascensión, Tazna (Bolivia); Tungsten Queen (Canada); Yellow, Boulder, Atolia, Golconda (USA); Gumusler (Turkey); Morococha (Peru); Akenobe, Ashio (Japan); Usin, Xian (China); Taskor (Kazakhstan), Ikar (Tajikistan) and others.
Orogenic	ferberite, antimonite, cinabar	pyrite, chalcopyrite, sphalerite, arsenopyrite, siderite	Felbertal, Kleinertal (Austria); Barun Shiveya, Olympiadinskoe (Russia); Hillgrove (Australia)
Placer (cassiterite-wolframite, wolframite, huebnerite, scheelite)	cassiterite, wolframite, huebnerite, scheelite		Iultin, Omchikandin, Sherlova Gora (Russia); Kara-Oba, Boguty (Kazakhstan); Bvabin, Heida (Myanmar), Atolia (USA), China, Indonesia, Thailand, Congo, Bolivia and others.

More than 98% of the world's tungsten reserves are concentrated in endogenous deposits, which according to their structural and morphological type are mainly stockwerk, layer- and lens-shaped and veined. The distribution of the world reserves and the production of tungsten in the main industrial deposits are shown in Table 5 (Vangelova, 2013; Starostin, 2016). The stockwerk deposits have a low WO₃ content (0.15-0.8%), but are of great importance because of their very large sizes and reserves. The skarn deposits are mainly represented by scheelite and molybdenite and are very important for the reserves and the tungsten yield. The veined deposits are small and medium in reserves, but have a high WO₃ content (0.5-2.0%) and are therefore also very important for tungsten yield.

Table 5. Major industrial types of deposits and tungsten production

Geological and industrial types of deposits	World reserves, %	World output, % WO ₃
Stockwerk:		
Wolframite (hydrothermal and greisen)	31	28
Scheelite	29	
Skarn scheelite	23	25
Veined wolframite	12	43
Stratiform scheelite	4	-
Placer	>1	-

Global tungsten mining is about 82.1 thousands t W (base 2017) (USGS, 2002-2018) and it has grown 1.4 times over the period. There is no published output data about the United States. There is significant tungsten production in 10 countries, accounting for over 98% of the world output. China is an undisputed leader with a share of about 82%, followed by Vietnam (8%), Russia (2.5%), England (1.3%), Bolivia (1.2%), Austria (1.2%), Portugal (0.9%), Rwanda (0.9%), Spain (0.7%) and Mongolia (0.2%).

The modern development of the tungsten mineral resource base is related to the price of the metal. In 2006-2007 there was an increase in the reserves and the production of tungsten under the pressure of two major political and economic factors – the formation of a tungsten sector in China, leading to strict control and change in the structure of metal exports, and the growing demand for tungsten in China and globally. The rapid rise in the

price of tungsten resumed the assessment and prospecting work and the introduction of new or recovery of existing productions in China and a number of countries (Australia, Vietnam, Canada, United Kingdom, Spain, South Korea, etc.) with a peak in the activity in 2011-2012 and at maximum prices of the metal. Over the next few years, due to the overproduction of tungsten, the price of the metal dropped down and a number of projects for the utilisation of economically viable deposits were discontinued or closed down. The rest of the projects could provide for a significant increase in the output of tungsten concentrate. The significant tungsten deposits ready for exploitation and processing are shown in Table 6.

Currently, mining production in Europe is carried out in several mining enterprises, accounting for about 3.6% of the world output. The main parameters and characteristics of the significant mines and mining projects are shown in Table 7.

Table 6. Basic parameters of the deposits ready for exploitation and processing (Lapteva, 2018)

Deposit	Type	Mining method	Basic quantity		% WO ₃ in the ore	Capacity according to	
			Ore, million t	WO ₃ , thou. t		Ore output, million t	WO ₃ output in the product, thou. t
Sisson (Canada)	porphyry	opencast	334.4	220.7	0.07	11.05	5.9 (C); 5.5 (APT)
Sandong (South Korea)	skarn	underground	8.0	35.5	0.45	0.45–0.64	1.2–2.5 (C)
Mt Pleasant, (Canada)	porphyry	underground	13.5	44.5	0.33	0.84	1.6 (APT)
La Parrilla, (Spain)	veined	opencast	46.9	42.2	0.09	3.5	3.4 (C)
Watershed, (Australia)	veined	opencast	21.3	31.4	0.15	2.5	2.7 (C)
Big Hill, (Australia)	veined	opencast	25.2	28.1	0.11	2.4	2 (C)
Barruecopardo, (Spain)	veined	opencast	8.7	26.1	0.30	1.1	2.3(C)
Mt Carbine, (Australia)	veined	opencast	18.0	25.2	0.14	1.5–3	1.6–3.2 (C)
Dolphin, (Australia)	skarn	opencast	3.1	22.9	0.73	0.45	3.5 (C)
Molyhil, (Australia)	skarn	opencast	3.0	9.2	0.31	0.5	1.3 (C)
Valtreixal, (Spain)	veined	opencast	2.5	6.4	0.25	0.5	0.7 (C)

Note: C – concentrate, APT – ammonium paratungstate

Table 7. Parameters and characteristics of tungsten mines in Europe (Cuesta-López, 2016)

Mine	Parameters							
	Company/Operator and stock exchange	Resources (assessed and identified), million t	Content WO ₃ , %	Operational costs, US\$/mtu	Capital costs, US\$	Annual output, mtu WO ₃	Exploitation, years	Mining method
Panasqueira (Portugal)	Almonty Ind. Inc (TSX-V) 100%	9.54	0.22	160-170	-	85000–95000	10	underground
Los Santos (Spain)	Almonty Ind. Inc (TSX-V) 100%	2.21	0.29	88	80	65000-75000	4	opencast and underground
Drakelands–Hemerdon (UK)	Wolf Minerals Ltd (ASX) 100%	56.6	0.17	155	150	110000-120000 (in future up to 500000)	20	opencast
La Parilla (Spain)	W – Resources plc London AIM: WRES (100%)	51	0.096	95	52	250000 (2017) 500000 (2020)	15	opencast
Mittersill (Austria)	Sandvik AB (100%) (Wolfram Bergbau und Hutten AG)	6.1	0.2	-	-	85000	10	underground
Valtreixal (Spain)	Almonty Industries Corp. TSX-V: ATT (25%) и SIEMCALSA (75%)	2.83	0.34 (eqv. Sn)	80-90	45	90000	10	opencast
Barruecopardo (Spain)	Ormonde Mining plc LON: ORM (30%)	17.8	0.30	117	57.2	260000	7-10	opencast and underground
Regua (Portugal)	W – Resources plc London AIM: WRES (100%)	5.46	0.28-0.30	-	-	130000	5	underground

Note: mtu – 10 kg (100mtu – 1 t)

Data shows that Europe has sufficient tungsten resources, but due to the delicate balance between supply and demand and price fluctuations, some projects and mining might turn out to be economically not viable.

Tungsten production and tungsten intermediate compounds

The principle scheme for the tungsten production and intermediate tungsten compounds is shown on Figure 2 (BGS, 2011).

Due to the low content of tungsten in the mined ores (0.1-0.8% WO_3) and the high requirements for the quality of the commercial concentrates (65-75% WO_3), the beneficiation schemes usually include two cycles – the main cycle which produces a coarse tungsten concentrate and an additional beneficiation cycle to obtain a marketable concentrate. Tungsten ores are enriched by purely gravity, gravity-flotation and purely flotation schemes, depending on the dispersion of the tungsten minerals in the ore. The resulting concentrates are poor (5-20% WO_3) and besides tungsten they also contain other minerals - cassiterite, sulfides, tantalum, columbite, etc. The additional ore dressing cycle, depending on the mineral composition of the coarse concentrates, includes one or more of the following processes - magnetic and electrical separation, flotation, flotogravitation, roasting and hydrometallurgy. In some processing schemes a preliminary beneficiation cycle, which includes mechanical sorting of the ore prior to conventional beneficiation methods, is applied. Photometric sorting is applied for wolframite, and also for scheelite if it is contained in white quartzite veins. The preliminary beneficiation of the scheelite ore is performed by fluorescence sorting.

The wolframite concentrates are melted directly into electric arc furnaces to produce ferrotungsten (FeW), a widely used alloying component in the steel industry. The scheelite concentrates are also melted directly for the production of steel. Recycling of tungsten scrap (60 to 70% scrap) in the production of high-speed steel is widely used. In modern factories, the tungsten concentrates are subjected to hydrometallurgical processing to produce middlings – mainly ammonium paratungstate (APT). Important secondary raw materials for the production of tungsten intermediate compounds are the oxidised scrap and wastes (sludge, dust, precipitates, chips, etc.) containing from 40 to 95(99)% W. Innovative technologies for industrial hydrometallurgical recycling of scrap generating less toxic emissions (Takehiko, 2016) are currently being financed. The principal scheme of hydrometallurgical processing of tungsten concentrates, scrap and wastes is shown in Figure 3 (Lassner, Schubert, 1999).

The tungsten concentrates are decomposed under pressure – the scheelite with Na_2CO_3 and the wolframite with $NaOH$. Mechanical activation is required in parallel with the leaching for both types of concentrates to avoid formation of insoluble particles on the minerals' surface. Tungsten scrap is easier to process than ore concentrates due to the absence of impurities such as P, As and Si. Prior to the alkali leaching process, the scrap is subjected to oxidation in oxygen-containing environments in furnaces. The decomposition is achieved by one of the processes – leaching under pressure with $NaOH$, oxidative alkaline melting (Na_2CO_3 with the addition

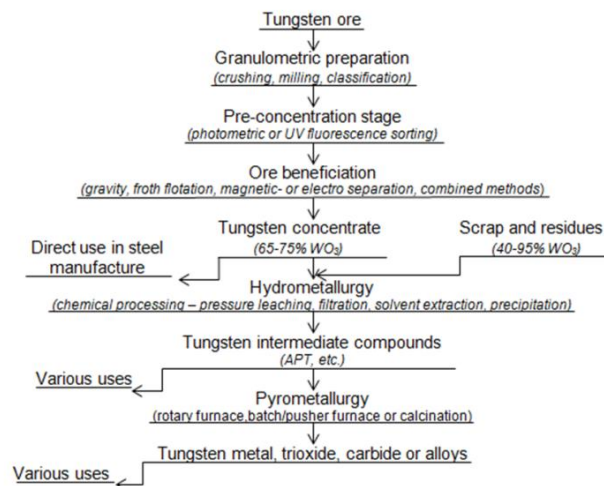


Fig. 2. Simplified flow sheet showing generic steps in processing tungsten

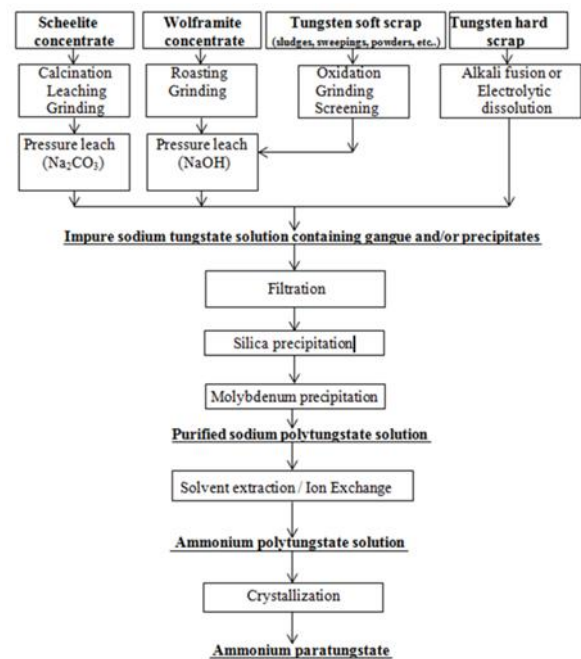


Fig. 3. Simplified flow sheet of hydrometallurgical processing of tungsten concentrates and wastes

of $NaNO_3$ and $NaNO_2$) or electrolysis. The residues undissolved after the decomposition are removed by filtration. The impurities (silicates, molybdenum, etc.) in the sodium tungstate solution are removed using precipitation under strictly controlled conditions of the environment. By applying liquid extraction or ion exchange, the solution of sodium tungstate is converted to ammonium isopolytungstate. The solution obtained by the two processes is subjected to heating to evaporate water and ammonia, where the ammonia concentration decreases compared to that of WO_3 and the paratungstate, whose ammonium salts have low solubility and crystallise. Depending on the conditions of the environment, the APT reaches a purity of 90-99%. The ammonium paratungstate $(NH_4)_{10}(W_{12}O_{41}) \cdot 5H_2O$ is the major precursor used to produce various tungsten middlings (tungsten "yellow" trioxide (WO_3), tungsten "blue" oxide ($WO_{2.97}$), tungstic acid (H_2WO_4) and ammonium metatungstate $(NH_4)_6H_2W_{12}O_{40} \cdot xH_2O$) by partial or total thermal or chemical decomposition.

The pyrometallurgical processing of APT involves calcination under oxidative conditions until its conversion into WO_3 . By maintaining low reduction conditions, calcination results in the formation of tungsten "blue" oxide. The treatment of both oxides in furnaces turns them into a tungsten metal powder that is used in the production of WC and a number of tungsten alloys. Globally, 70-80% of tungsten is produced by powder metallurgy.

Methods for obtaining tungsten of high purity and tungsten super alloys

On the basis the analysis of the world and Bulgarian experience to obtain tungsten of high purity and properties, which meet the high requirements for many of its applications, the following modern methods have been accepted as sufficiently effective: powder metallurgy (PM), electrolysis of salts, metallothermic refining, and some of the special electrometallurgical methods such as chemical vapour deposition (CVD), plasma arc melting (PAM), spark plasma sintering (SPS), vacuum induction melting (VIM), electron beam melting (EBM), hot isostatic processing (HIP) and thermoplastic routes that are successfully applied in metallurgical and metalworking practices around the world.

It has been found that an established method for the preparation of a technically pure metallic tungsten and for the production of solid alloys on its basis is the powder metallurgical method – the metallic powders are initially obtained by reduction of their compound, usually an oxide, in an atmosphere of hydrogen or carbon. The reduction occurs at relatively low temperatures (800-1200°C). The reduction processes, occurring in the reactions presented in Table 8, are the most widely used in the practice.

Table 8. Reduction metallurgical methods for the preparation of pure tungsten from its oxides

Reducer	Metal	Reaction	Technological conditions
C	W	$2WO_3 + 3C = 2W + 3CO_2$	800 – 1200°C
H ₂	W	$WO_3 + 3H_2 = W + 3H_2O$	800 – 1200°C

The behaviour and properties of the compact metal in the subsequent processing steps are highly dependent on the chemical composition and structure (including particle size and shape, size distribution) of the resulting metal powders. The structure of the metal powders depends on the structure of the parent compounds and the reduction regime. The powder metallurgical method, used to process the resulting metal powder to a compact metal, comprises of the following steps:

- Compacting metal powders as briquettes, washers or moulds close to the type and dimensions of the metal products after the sintering process;
- Sintering the blanks by heating to a specific temperature;
- Additional processing (forging, drawing, rolling) of the sintered blank to a final product.

This tungsten processing technology does not provide the metal with sufficient plasticity and weldability. The physical and mechanical properties of tungsten produced by sintering are too anisotropic and depend on the initial state, purity and structure of the powders prior to sintering (Mushegyan, 2009). The metal

produced after the reduction has a high percentage of metallic and gas impurities. It needs to be further refined as the requirements to the chemical composition, structure and quality of the final product are constantly increasing.

Tungsten displays brittle behaviour at ambient temperatures limiting the use of some conventional processing methods. Additive manufacturing (AM) also has unique features to produce components of high melting point refractory alloys that are difficult to process using conventional methods (DebRoy, 2018). By utilising AM techniques such as selective laser melting (SLM), complex geometries of even refractory metals like tungsten can be realised. SLM of tungsten remains a challenging task due to the high melting point, high viscosity, high thermal conductivity, its affinity for oxygen at high temperatures and brittle nature at room temperature, resulting in parts with cracked and porous microstructure (Iveković et al., 2018; Tan et al., 2018).

So far the world production of tungsten has been achieved mainly by conventional metallurgical processes and, as a final phase of refining, the top refineries mainly use hydrometallurgical and electrolytic processes. Another possibility to improve the quality of the obtained refined metal can be the application of vacuum metallurgy as part of the special electrometallurgy. The development of effective methods for the production of metals and alloys with a low content of metallic, non-metallic and gas impurities and the preservation of the achieved chemical composition during further processing are important problems that modern metallurgy has successfully solved. Vacuum metallurgy occupies a leading position among the industrial methods for the production of metals and high purity alloys.

As part of the vacuum metallurgy, the electron beam (EB) refining method achieved significant success in scientific research in the last decades of the last century, and the development of electron beam technologies as high-performance aggregates has also established it in the industry as a promising method for obtaining high-purity metals and alloys in vacuum (Vassileva et al., 2005; Vutova et al., 2010; Mladenov et al., 2011; Oh et al., 2013; Tan, Shi, 2013; You et al., 2018; Vutova et al., 2019).

Methods such as vacuum arc melting (VAM) and electron beam melting (EBM) are required for further refining in the industrial production of pure tungsten and its alloys in countries such as the United States, Ukraine, Russia, etc. In VAM, the starting materials are melted in electric arc furnaces with consumable electrode in vacuum or in argon medium, in copper water-cooled crucible or in melting furnaces with a copper or graphite melting-pots.

Electron beam melting (EBM) technology has been considered as one of the key steps for preparing high purity tungsten and its alloys, and reasonable setting of process parameters is the premise. The EBM yields the metal with the lowest impurity content, there is a possibility to obtain large ingots and the melted tungsten ingot consists of well-collimated long columnar crystal grains (Takaai, 1966; Tan, Shi, 2013; Long et al., 2015;).

The electron beam method is suitable both as a final step in the production of tungsten with improved chemical composition and structure using metallic concentrate obtained after thermal reduction, and for the recycling of waste materials from tungsten or its alloys and compounds (Mladenov et al., 2011; Vutova et al., 2018). The method combines two main advantages –

achieving a very high temperature and vacuum environment in which the hot molten metal cannot be oxidised. The EBM method does not have special requirements for the type of initial material, there is economical feedstock preparation, and yet it provides for good refining from gases, non-metallic and metallic impurities that are more volatile than the refined metal.

With the electron beam melting, the possibility of uncontrollable side reactions is excluded as there is no direct contact between the molten metal and the fire-proof lining or the atmospheric gases. In the refining process, favourable conditions are created for the reactions and processes, in which the gas phase is involved, to continue till the end, as it is possible to displace their thermodynamic equilibrium in the desired direction. Under the conditions of electron beam refining certain reactions can take place - degassing, reduction of oxides, reduction and evaporation of volatile impurities that cannot be used in case of atmospheric pressure. Refining takes place at the boundary surface between superheated liquid metal and vacuum in several reaction zones. In each of them, processes such as mass transfer (from the volume to the boundary surface and vice versa), chemical interactions between components present in the surface area (elements and chemical compounds) and evaporation from the boundary surface of impurities in the form of atoms or connected as compounds, take place simultaneously.

To summarise, based on the characteristics and advantages of the EB method, the following options can be realised:

(a) in the established metallurgical scheme for the production of tungsten, the EB method can be applied as:

- final stage – to use tungsten powder prepared by reduction of tungsten oxide as an initial material for the EB refining.

(b) in secondary recycling processes for:

- tungsten scrap
- waste tungsten carbide products.

Market price characteristics of the tungsten production

The market-price parameters for tungsten ore extraction and subsequent processing are determined by the behaviour of two main factors and their interdependence.

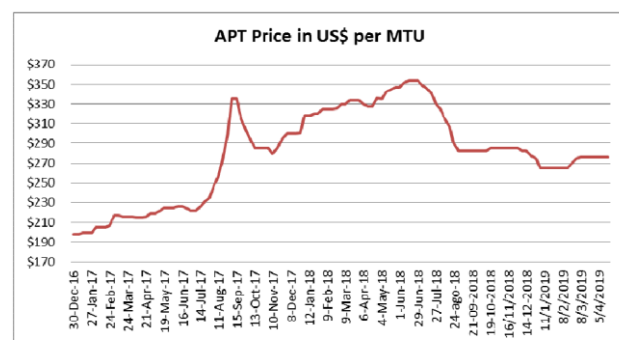
First, this is the state and behaviour of the world economy, its cyclicity and the associated fluctuations in the quantities of the extracted primary tungsten, the products produced and consumed and, of course, the prices at which these processes take place. For the sake of clarity, we will point out that, unlike the predominant part of the mineral resources where market-pricing procedures are specific and very often standardised products (e.g. the base metals at the London Metal Stock Exchange, noble metals, etc.), the tungsten range is very wide, and the variety in the product nomenclature depends on the vertical development of the production and includes *tungsten ores*, *tungsten concentrates (scheelite and wolframite)*, *paratungstate*, *tungsten anhydride*, *ferro-tungsten*, *metallic tungsten*. This makes the economic feasibility assessment of the development of a particular tungsten deposit quite specific, the most important being the type of final output to be produced, i.e. concentrates or subsequent industrial products.

The genesis of the second factor emerged in the 1990s and is based on the tungsten production in China. According to

information from (INFOMINE Research Group, 2017), China owns the largest tungsten ore reserves and produces the largest quantities of tungsten concentrates and end products, which contain tungsten in various forms. These estimates do not account for the US reserves about which no official information is available. In fact, the world market is monopolised by China, which is both the largest consumer and exporter of tungsten concentrates and products. There is a hybrid political-economic approach in this process in which the Chinese government plays an important role and has a strong influence on the world market by imposing export duties and quotas.

As a result of the interaction between these key factors, the prices of tungsten concentrates and products are subject to sensitive fluctuations, which have been particularly high during the last decade. Since 2011, there has been a tendency for a dramatic decrease in the price of tungsten concentrates. For example, for a period of five and a half years, the price has fallen about 3.5 times (from 415 USD/MTU WO_3 to 140 USD/MTU WO_3). The main reason for this price collapse is the presence of oversupply as a result of unsold final production and the accumulation of huge quantities of waste products containing tungsten. In order to get a clear idea of the parameters of this collapse, we will point out that at the beginning of 2015 the price fell below the average world production cost of 195 USD/MTU WO_3 and in the second half it became even lower than the average production costs in the Chinese enterprises - 165 USD/MTU WO_3 . These processes resulted either in the closure of a number of tungsten mining enterprises or in sharp reduction of the production.

The price bottom was reached in the beginning of 2016 when the price fell to 120 USD/MTU WO_3 , which caused a lot of losses to a number of companies. Naturally, analysts' forecasts for a recent price backlash came true and at the end of 2016 they reached 150 USD/MTU WO_3 , which is seen as a threshold for the profitability of a large number of enterprises. Since then, there has been a tendency for relative retention, even reduction of the price. According to the latest data of April 2019 (price.metal.com), the price of 65% tungstate concentrate on the Chinese market was around 135 USD/MTU, which indicates stability of the price at a low level. The trends with respect to the ammonium paratungstate are similar, the values and price trends are presented in Figure 4.



Source: Almonty Industries

Fig.4. Price dynamics of ammonium paratungstate, 2016-2019

As a general conclusion it can be stated that the market environment is dynamic and unpredictable for the products from primary tungsten. It is obvious that there are a number of factors which influence it and they have maintained relatively low price levels over the last ten years. As it is quite safe to state that the

Chinese producers will have a major influence on the market, it can be concluded that the launch of new tungsten production is justified only in the case of presence of mining and geological characteristics similar to those of the major world producer.

Conclusion

Based on the above, the following main conclusions can be made for the future development of tungsten mining and processing, which can be useful for elaborating the company policies in our country:

- Firstly, the tendency for retention and slight increase of the world consumption of tungsten will remain stable in the next one to two decades as a response to the technological development and new areas of application;
- Secondly, the presence of significant quantities of tungsten scrap suppresses the growth of prices, which poses serious problems to the investments in new deposits and to the ongoing development of those with low quality indicators and difficult mining and geological conditions;
- Thirdly, the above estimates suggest that tungsten prices in the next decade will have a sustained but low upward trend, offsetting inflation pressure;
- Fourthly, the new applications of tungsten and its alloys in modern technologies and directions imply higher requirements for its composition, structure and technological properties, which can only be achieved by the application of modern metallurgical methods. One good option is the electron beam melting method that combines the advantages of vacuum metallurgy and high energy special electrometallurgy.
- Fifthly, the integration of these conclusions makes it possible to conclude that investing in new and developing existing mining capacities for extraction and processing of tungsten ores with low quality indicators has an increased component of market risk.

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ANALYSIS OF THE DEMAND, SUPPLY, AND PRICES OF CRUDE OIL

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ABSTRACT. The report presents world demand and supply of crude oil for the period 1997-2018 and the forecast of the US Energy Information Administration for 2019 and 2020. World crude oil reserves at the end of 2017 are presented according to data provided by OPEC. The change in average crude oil prices for the period 2004-2018 and in the average monthly prices for the period January 2007 – May 2019, according to OPEC, are also analysed. The US Energy Agency's long-term forecast for the world consumption and for the change in crude oil prices by 2045 is presented. Key factors influencing crude oil demand, supply, and prices are outlined.

Keywords: world demand and supply of crude oil; crude oil prices; key factors influencing crude oil prices

АНАЛИЗ НА ТЪРСЕНЕТО, ПРЕДЛАГАНЕТО И ЦЕНИТЕ НА СУРОВИЯ ПЕТРОЛ

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РЕЗЮМЕ. В доклада е представено световно търсене и предлагане на суров петрол за периода 1997-2018 г. и прогноза на Американската информационна администрация по енергетика за 2019 и 2020 година. Представени са доказаните геоложки запаси от суров петрол към края на 2017 г. по данни на ОПЕК. Анализирани са изменението на средногодишните цени на суровия петрол за периода 2004-2018 г. и на средномесечните цени по данни на ОПЕК за периода януари 2007 – май 2019 година. Представена е дългосрочната прогноза на американската информационна агенция по енергетика за световното потребление и изменението на цените на суровия петрол до 2045 година. Изведени са основните фактори, оказващи влияние върху търсенето, предлагането и цените на суровия петрол.

Ключови думи: световно търсене и предлагане на суров петрол; цени на суровия петрол; ключови фактори, влияещи върху цените на суровия петрол

Introduction

Forecasting the demand, consumption, and prices of crude oil has been carried out since the middle of the 20th century. Dozens of world, national, and branch agencies, banks and organisations all over the world prepare and periodically update their own medium-term, long-term, and super long-term forecasts for the demand, supply, and prices of this important energy raw material under the conditions of a highly dynamic marketplace and of a volatile economic and political situation.

Along with the demand and supply of crude oil, prices are also affected by the change in volume of the commodity stocks and by the change in the proven geological reserves of this raw material.

World demand and supply of oil

The two most prestigious institutions that make and update their forecasts for the demand, supply, and prices of energy sources, and of crude oil in particular, are: the US Energy Information Administration (US EIA) and the International

Energy Agency (IEA). The latter currently has members from 30 countries and 8 associate members.

S&P Global Platts is another popular source in terms of the latest news concerning the market information on oil, natural gas, electrical energy, shipping transport, oil products, metals, and agro-cultures. The agency's website releases analyses and forecasts that support sales and facilitate investment decisions. Oil and natural gas quotations published by the agency generally serve as benchmarks in determining the current and futures prices of crude oil.

Fig. 1 introduces the change in world crude oil demand and supply for the period between 1997 and 2018 along with the US Information Administration forecast for 2019 and 2020. The figure is made according to data provided by the US EIA, 2019.

The data presented in Figure 1 shows that demand and supply of crude oil over the past twenty-two years has increased by about 33.1%, or by an annual average of 1.5%. At some points, demand has exceeded supply, and at others, it has been the opposite. Over the years, these temporary surpluses and market deficits have been offset by the change in commodity stocks of this raw material.

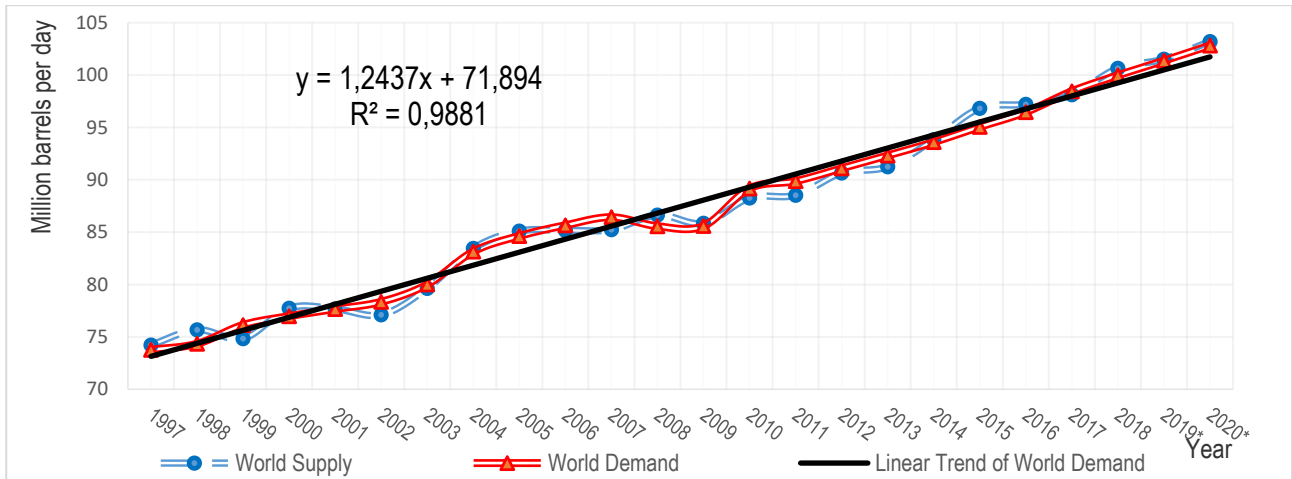


Fig. 1. World production and world consumption of crude oil and other liquids per day for the period 1997-2018 and projection for 2019 and 2020

Kovacheva-Ninova and Velev (2018) conclude that: “in general, after the 1970s, oil consumption has doubled, and the consumption of natural gas has risen almost 9 times.”

According to data provided by OPEC, in 2018, oil supply by the organisation amounted to 38.29 million barrels per day. According to data by the US IEA, world oil supply within the same year was 100.66 million barrels per day. This shows that the OPEC member states account for about 38.04% of the world oil production.

The US IEA forecast for 2019 and 2020 points to an increase in oil demand and supply of up to 101.52 million barrels per day in 2019 and of up to 103.21 million barrels per day in 2020, which is an approximate average annual production growth of about 1.3%.

As shown in Fig. 1, the linear trend of world demand during the period analysed has been one of growth and is

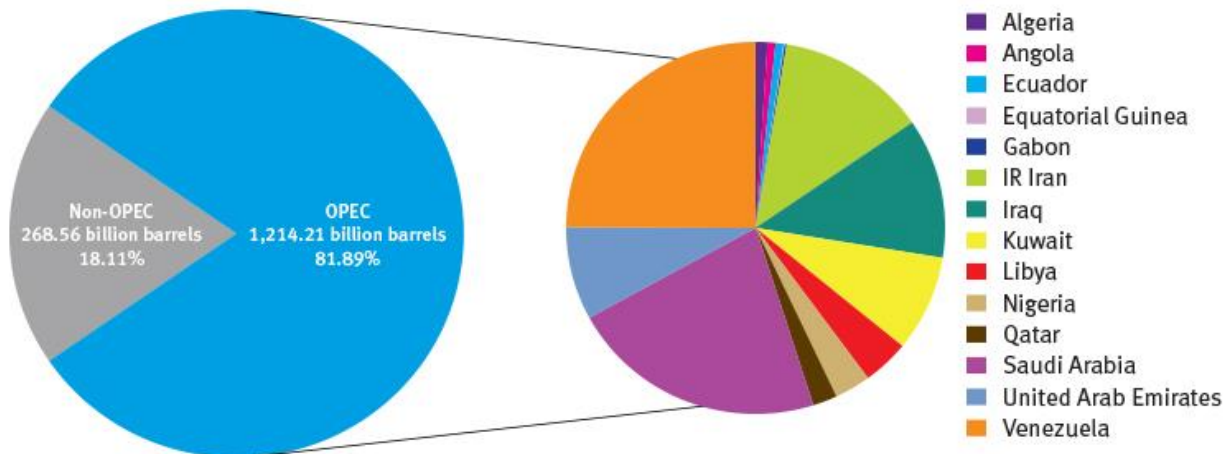
characterised by a very high determinant coefficient of 0.9881 and a correlation coefficient of 0.9940, respectively.

According to Kovacheva-Ninova and Velev (2018), at the beginning of the third millennium, humanity has not only continued but has even strengthened its energy dependence on primary hydrocarbon raw materials and this raises issues of current and long-term effect.

Proven geological reserves of crude oil

According to data provided by OPEC, about 81.89% of the proven geological reserves of crude oil throughout the world are in the oil fields located on the territory of the OPEC member countries. The data as of the end of 2017 are presented in Figure 2.

OPEC share of world crude oil reserves, 2017



OPEC proven crude oil reserves , at end 2017 (billion barrels, OPEC share)

Venezuela	302,81	24,9%	Kuwait	101,50	8,4%	Qatar	25,24	2,1%	Gabon	2,00	0,2%
Saudi Arabia	266,26	21,9%	UAE	97,80	8,1%	Algeria	12,20	1,0%	Equat. Guinea	1,10	0,1%
IR Iran	155,60	12,8%	Libya	48,36	4,0%	Angola	8,38	0,7%			
Iraq	147,22	12,1%	Nigeria	37,45	3,1%	Ecuador	8,27	0,7%			

Source: OPEC Annual Statistical Bulletin 2018.

Fig. 2. OPEC share of world crude oil reserves, at the end of 2017

The OPEC countries account for about 81.89% of the proven global geological reserves, with approximately 67.03% of the global reserves in the Gulf region.

At the end of 2017, the proven crude oil reserves were estimated to be 1482.77 billion barrels. With the current world demand, those will be sufficient for a period of about 40.6 years. The most significant stocks are in the following countries: Venezuela – 302.81 billion barrels (24.9%), Saudi Arabia – 266.26 billion barrels (21.9%), Iran – 155.60 billion barrels (12.8%), Iraq – 147.22 billion barrels (12.1%), Kuwait – 101.50 billion barrels (8.4%), UAE – 97.8 billion barrels (8.1%), etc. (see Fig. 2).

Analysis of the change in crude oil prices

The price of crude oil depends on its quality, as well as on its location, and, likewise, on a whole set of geopolitical, economic and market factors. It should be pointed out that oil price has been significantly dynamic both in the past and in the present century.

As a result of the global financial and economic crisis of 2008-2009, oil prices plummeted sharply to reach record levels of US\$ 131.22 per barrel in July 2008. This was followed by periods of downs and ups. February 2016 saw a 30-year bottom level of US\$ 29.61 per barrel. Since then, oil prices have been marked by fluctuations and in June 2017, it was US\$ 44.58 per barrel.

World oil prices in the period from January to May 2017 climbed against the background of the new US sanctions against Iran.

Brent oil has risen by 0.35% reaching US\$ 57.01 per barrel in March 2017. The Iranian national oil company increased oil output to 4 million barrels per day. At the same time, however, in compliance with the OPEC agreement, Tehran was not to exceed the level of 3.79 million barrels per day. Iranian oil company leader Ali Kardor voiced his confidence that the export of raw materials was going to reach 3 million barrels a day by the end of 2017. He also pointed out that in December 2016 Iran reached a record rate of petroleum product export

for Europe amounting to 900 thousand barrels a day. In late November 2016, at its meeting in Vienna, OPEC decided to reduce oil production to 32.5 million barrels a day. It was then claimed that in the first half of 2017, the members of the cartel would reduce the average daily yield by nearly 1.2 million barrels. An exception was made for Iran since international sanctions against this country had only recently been lifted.

OPEC allowed the Islamic Republic to increase oil production by 90,000 barrels per day to a level of 3,797 million barrels per day. Nigeria and Libya were also allowed not to reduce yields, Russia's Information Agency (TASS) recalls. Iran has summarized the results from an auction held on 15 February 2017, wherewith the Russian Gazprom and Lukoil companies participated, that concerns the development of oil fields, Reuters reported. The Iranian National Petroleum Company has prepared a second list of foreign companies that would be eligible to tender for oil extraction from localities in Iran.

Figure 3 shows the change in the average annual crude oil prices for the period 2004-2017. The graph in Figure 3 is based on OPEC Backed Price.

As can be seen from the data in Figure 3, the average annual crude oil prices for the period between 2004 and 2019 are characterised by extremely high dynamics.

From April 2009 to December 2014, there was a steady rise in crude oil prices. By the beginning of September 2010, they rose by about 2.5 times, bringing about an increase in production costs in all sectors of world economy.

No estimate can be given as to the direction of the price of crude oil in the next few months of 2019.

Crude oil rose by about 40% between January and April 2019, boosted by the contraction in yield among OPEC members and their partners, as well as due to US sanctions against Iran and Venezuela. The performance of China's industrial activity in April 2019 was weaker than expected and this also lowered the prices of "black gold". The surge in US production has exerted additional influence on oil prices, and OPEC will offset most of the shortfall following the US sanctions against Iran. However, analysts say that the market remains tight.

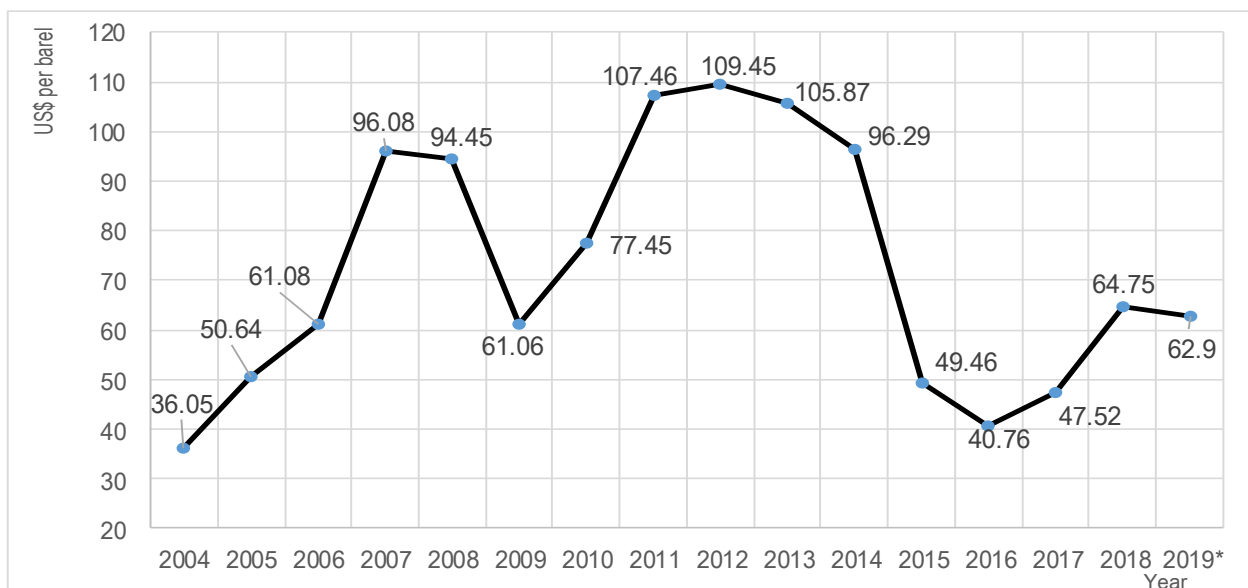


Fig. 3. Annual crude oil prices for the period 2004 - 2019

The performance of China's industrial activity in April 2019 was lower than-expected and this, too, has lowered crude oil prices. Many factors affect the crude oil trade. One of them is related to the concern about global economic growth due to the intensification of the trade dispute between the US and China.

Pressure for a drop in crude oil prices is also exerted the call by US President Donald Trump to OPEC and its leader Saudi Arabia for an increased produce. US sanctions have already halved exports of Iranian crude oil over the past year to less than 1 million barrels per day. In addition, due to the tightening of sanctions, deliveries to customers are expected to drop to half a million barrels per day in May 2019.

According to SPI Asset Management, OPEC will want to curb the rise of prices below levels that might distort demand.

Bank of America Merrill Lynch estimates that Iranian oil production will shrink from 3.6 million barrels per day in the third quarter of 2018 to 1.9 million barrels per day in the second half of 2019. However, the bank is expecting a "nearly balanced market" this year, as the OPEC and US produce will grow.

BNP Paribas predicts market growth by the third quarter of 2019, after which prices will become sensitive to the sharp rise in US exports as a result of the increase in pipeline and terminal capacities.

The Venezuelan crisis also violates the supply of crude oil. Crude oil extraction there has dropped to the 2003 level.

Oil prices have an impact on the price of natural gas in Bulgaria, albeit with a several-month delay. The reason is the formula used which takes into account the price of alternative fuels. The fact is that the gas market has changed in recent years. Extra sources are now available, not just the so-called "tubular" gas, and this forces the manufacturers to gradually become more considerate to their customers.

The World Trade Organization (WTO) contributes on a global scale to lowering trade barriers by means of: reducing duties, fees and other constraints; securing the uniformity of trade regulations by the introduction of international standards; overcoming conflicts of interest through the creation of

mutually beneficial trading conditions. Its core business is founded on open trade that is based on commercial interests. WTO's policy is aimed at expanding market opportunities and promoting free competition.

Crude oil, natural gas and coal, whose prospecting and exploitation require significant investment and operating costs, are of strategic importance for the global energy balance. The total oil consumption over the past 20 years has increased by more than 33%. It has been the largest in industrialised countries, such as the USA, China, Japan, Germany, France, Italy and others. Research has shown that with an increase in economic activity in the world by 1%, global energy consumption increases by an average of 0.5%. It is expected that, in 2030, the quality of life of about 80% of the planet's population will depend heavily on the energy resources used.

Global demand and supply of energy carriers depends mainly on the development of world economy, on the growth rates of the individual sectors of the economy, on the growth of the population of the planet, on the amount of explored and proven deposits of underground natural resources, and on the mining and extraction facilities constructed in various countries. The main indicator for ensuring the world economy with energy raw materials is the ratio between the volume of proven geological reserves and the yield level.

Global oil trade covers their exports and imports both worldwide and in individual regions and countries. World market conjuncture is primarily determined by the impact of a number of economic and political factors. In 2019, the largest exporters in terms of value have been the Gulf countries and Russia.

The International Energy Agency (IEA) predicts for the global consumption of oil and other liquid fuels to range from 100 million barrels a day in 2019 to 105 million barrels a day in 2020 and to around 125 million barrels a day in 2040.

In its annual report for 2018 (US EIA, 2019), the US Energy Information Administration predicts that the change in crude oil prices for the 27 years to come will vary within the limits shown in Figure 4.

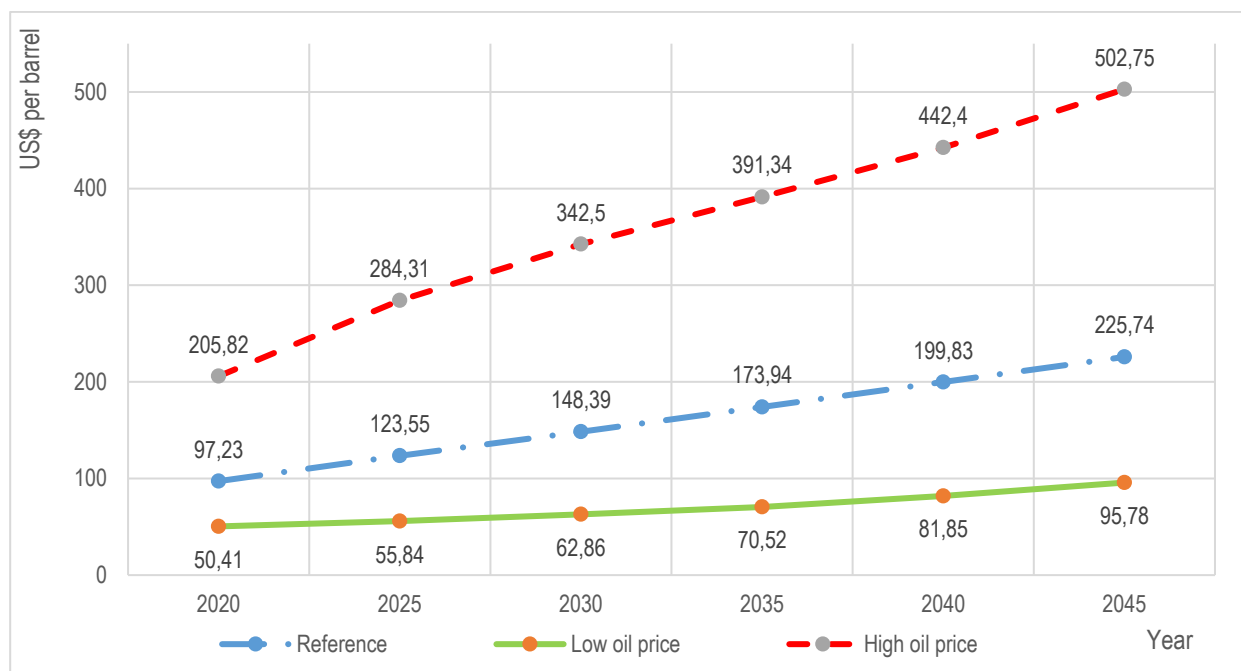


Fig. 4. Projection for crude oil prices according to US IEA, 2019

According to the IEA, the strategic development will be oriented towards solving the following priority tasks:

- exploitation of new oil and gas fields needed to meet the growing demand for energy raw materials;
- construction of new pipelines and gas pipelines to supply energy raw materials to consumers;
- expanding international cooperation to attract the necessary investments;
- improvement of extraction and processing technologies with a view to improving economic and environmental efficiency;
- developing long-lasting and mutually beneficial connections between countries producing energy resources and those consuming energy resources;
- stabilising the international markets for energy raw materials in order to ensure global consumption;
- intensifying the interaction while ensuring the required safety of the energy equipment and power facilities;
- coordination of efforts and actions to overcome possible energy crises in the world economy, etc.

In the present century, the global commerce in energy raw materials will continue to have clear geo-economic and geopolitical dimensions. Those are determined by the strategic interests of individual countries and, above all, of the industrially developed countries and are due to the great geographic diversity in the location of the world centres of production and of those of energy consumption in the world.

Should oil prices rise, this could boost US shale production and gain market shares at the expense of OPEC, Citigroup Bank experts say. According to analysts at Morgan Stanley Bank, the American shale industry is the "obvious winner" after OPEC's decision.

Although the lowering of yields to 36.5 million barrels per day does not immediately solve the supply problem, it can potentially lead the world oil market to rebalancing, which will be felt in the first half of 2019, Morgan Stanley Bank points out. With a yield of 38 million barrels a day, rebalancing will only have effect in the second half of 2019, though "supply outside OPEC may put this moment at risk," the bank states in its report. It also says the following: "The truth is that when production outside OPEC grows, the cartel will not be able to manage prices in the medium term."

The aim of all of these agreements is to raise crude oil prices in the short term, but this could hardly be achieved in the medium and long term.

Figure 5 shows the variation in the average monthly crude oil prices for the period between January 2007 and May 2019. The figure is based on OPEC Backed Price.

From January 2014 to January 2016, there was a significant drop to a level of US\$ 27.25 per barrel. From early 2016 to October 2018, the price of crude oil rose almost threefold to a level of US\$ 79.39 per barrel. Since then, until May 2019, there has been a slight fall to US\$ 69.97 per barrel.

The reason for the rise in oil prices has been the statement by the Saudi Arabian Energy Minister that all OPEC and non-OPEC participants have effected a settlement to extend their agreement on the production cutback. It is interesting who is going to benefit from such low prices. Cheap oil is beneficial to both consumers and OPEC countries. High oil prices would lead to an increase in shale production and petroleum production from petroleum sands, whereby the cost of extraction and processing is higher.

According to Radev (2016), what is characteristic of the current drop in global oil market prices is that it is caused by changes in both demand and supply. On the one hand, there is a boom in shale oil production in the United States, and on the other hand is the weak demand on the global market.

The major factors affecting demand, supply, and prices of crude oil are extremely diverse (Mitev, 2017). In the long term, oil prices are influenced by the following factors:

- the economic growth of the global economy;
- population growth;
- the change of proven geological reserves;
- international and regional military and political conflicts;
- OPEC production regulations and the cartel agreements to limit mining and to impose extraction quotas for member states over certain periods of time;
- the security of crude oil supplies for oil refineries;
- the imposing of an embargo and of import and export restrictions;
- climatic cataclysms;
- the effect of seasonality;
- the imposing of import duties and the like;
- world production and consumption of oil;
- market speculations;
- exchange rate fluctuations;
- intense competition, etc.

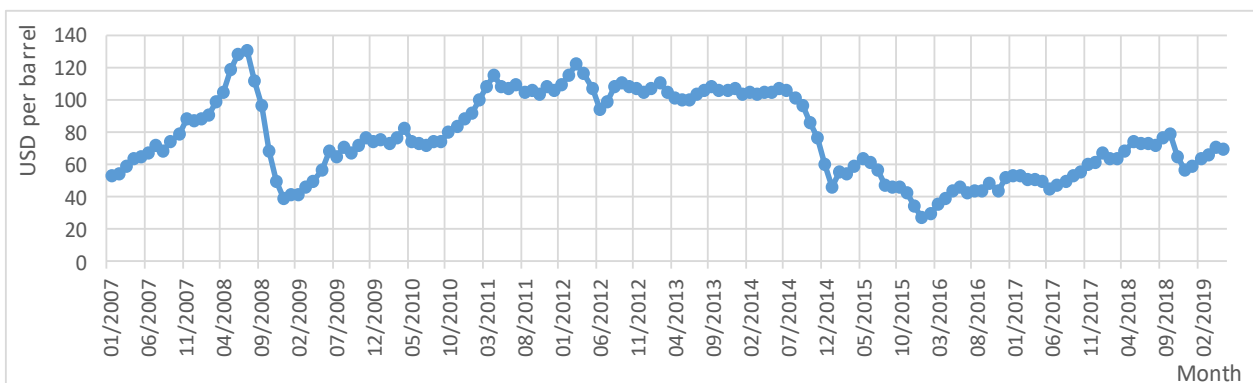


Fig. 5. Average monthly crude oil prices according to OPEC data for January 2007 ÷ May 2019

Conclusion

Crude oil production and consumption in the period between 1997 and 2018 has grown by about 33.1%, from 75 million barrels per day in 1997 to 100.66 million barrels per day in 2018.

The US IEA forecast for 2019 and 2019 is for oil production and consumption to increase to the level of 101.52 million barrels per day in 2019, which is about 1.5% average annual output growth.

Average annual crude oil prices during the period 2004-2018 are characterised by extremely high dynamics, which is mainly affected by temporary surpluses or deficits in the stock volume, but also by political and economic conflicts.

If oil prices are on the rise in the short term, shale production and other producers may be boosted to gain market share at the expense of OPEC. This would again push prices down.

In the long term, global demand, supply and prices of energy carriers depend on:

- the development of the world economy;
- the growth rates of the individual sectors of the economy;
- the growth of the population on the planet;
- the geo-economic and geopolitical situation;
- the amount of explored and proven geological reserves, and the constructed mining facilities in various countries.

Cartel agreements, on the other hand, have a rather short-term effect.

In general, after the 1970s, oil consumption has doubled, and the consumption of natural gas has risen almost nine times.

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RESEARCH AND ANALYSIS OF THE STATE OF SOCIALLY RESPONSIBLE POLICIES OF MINING COMPANIES THROUGH THE EYES OF LOCAL COMMUNITIES

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ABSTRACT. In recent years, socially responsible initiatives in the mining industry have been a fact that companies report both in their financial statements and in their non-financial ones, affirming their reputation. The article presents a study aimed at demonstrating to what extent these policies reach to local communities and how they affect them. The survey was conducted in 10 municipalities in Bulgaria with significant mining enterprises. The results, albeit divergent, prove both the negative impact on the environment and the dialogue and support of businesses to local communities.

Key words: socially responsible policies; local communities; mining companies

ИЗСЛЕДВАНЕ И АНАЛИЗ НА СЪСТОЯНИЕТО НА СОЦИАЛНООТГОВОРНИТЕ ПОЛИТИКИ НА МИННИТЕ КОМПАНИИ ПРЕЗ ПОГЛЕДА НА МЕСТНИТЕ ОБЩНОСТИ

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РЕЗЮМЕ. През последните години социалноотговорните инициативи в минната индустрия са факт, който компаниите отчитат както във финансовите си отчети, така и в нефинансовите си такива, утвърждавайки своята репутация. Статията представя проучване, имащо за цел да покаже до каква степен тези политики достигат до местните общности и какво е отражението им върху тях. Анкетното проучване е проведено в 10 общини на България със знакови минни предприятия. Резултатите, макар и разнопосочни, доказват както негативното влияние върху околната среда, така и диалога и подкрепата на предприятията към местните общности.

Ключови думи: социалноотговорни политики; местни общности; минни компании

Introduction

The past few decades have shown that pursuing a socially responsible policy is the foundation upon which modern companies build their business strategies. This approach helps companies not only to increase their influence on the market, but also to build a positive public image. People today are tolerant of businesses that participate in charitable initiatives and support financial, cultural and social events. Their efforts related to protection of the environment through recycling of consumables (toners, paper, glass, plastic packaging, etc.), introduction of energy efficiency measures and treatment or destruction of hazardous industrial waste are also respected. On the other hand, employees are looking for employers who offer them not just a good remuneration, but also an appropriate social package with care for them and their family members. Thus, with slow steps and regardless of its different forms and manifestations, corporate social responsibility gradually captures companies around the world. CSR means companies to work voluntarily, without being forced by law, to achieve social and eco-goals during their day-to-day business activities (Velev, Radev, 2012).

Despite its fundamental role, the mining industry encounters a very wide range of challenges - such as administrative procedures, large number of permits and the time they require to be obtained and those related to the so-

called "license to operate", or the credibility of the community to develop mining activities. Globally, there is a growing demand for mining companies to be increasingly accountable to society in terms of safety, environment, human rights, and Bulgaria is not isolated from this process. Local communities, as part of the stakeholders, also expect the world's highest standards of work safety and environmental friendliness.

Corporate social responsibility is an important tool for conducting these good business practices through which good partnerships can be achieved. In recent years, its dimensions have been inextricably linked to non-financial reporting, social audit and corporate culture.

Care for the well-being of people and communities where mining is done should be a top priority for companies. The misunderstanding, the misinterpretation of the mining industry and the opposition of green practices industry are a serious problem.

The publication aims to reveal the logical link between socially responsible initiatives and local communities. The most important stakeholders for a company are the human capital (Chobanov, Velev, 2018).

Hand in hand with the employees are also the local communities that often overlap with the first group. They are a major factor when studying socially responsible initiatives by mining companies. The purpose of the publication also predetermines its main tasks:

1. To investigate and analyse the attitudes of part of the mining communities in the field of environmental protection, conduction of regular dialogue and engagement of local communities.

2. To explain the most important issues and perceptions amongst the surveyed communities regarding the following components: environmental protection, regular dialogue with local communities and voluntary participation, investment or support to local community initiatives.

The subject of analysis is the assessment of socially responsible initiatives by the local communities surveyed.

The residents of the municipalities belonging to the Srednogorie cluster – Mirkovo, Chelopech, Zlatitsa, Pirdop and Panagurishte are subject of this survey. The surveys outside this cluster are completed by the local communities in Stara Zagora, Krumovgrad, Kardzhali and Senovo / Vetovo.

The companies that carry out mining activities in these regions are Ellatzite-Med, Assarel-Medet, Dundee Precious Metals Chelopech, Dundee Precious Metals Kardzhali, Aurubis Bulgaria, Kaolin, Gorubso, Maritza East – all with long-lasting socially responsible policies and practices that are formally reported both in their financial and non-financial reports.

The theoretical significance of the publication is justified by the systematisation of current theories as well as the presentation of national significant results of empirical research on the issue. Expectations for increased interest from the mineral-raw business are set.

The hypothesis of the study is as follows: local communities have an active attitude and understand the policies of mining companies in the surveyed regions.

Elaboration and approbation of the questionnaire

For the purposes of this publication, an online and on site questionnaire is used as a source of information, and the respondent is expected to read, render and fill it out. The poll is anonymous in order to ensure the free will of opinions and attitudes of the local communities.

The purpose of the developed survey card is to conduct a CSR study and, in particular, to study the views of the local communities on the company's commitment to socially responsible policies. The survey was conducted in regions with a well-developed mining industry since studies are showing that large enterprises have the potential and resources to implement meaningful socially responsible policies.

The questionnaire contains 9 questions, 3 of which are in the environmental category and 5 in the local community category. The last question seeks to determine to which region the respondent belongs. Respondents were randomly selected.

The questionnaire (Table 1) was completed by 217 people. 82 polls were filled in on site by region. 135 questionnaires were filled in online.

Table 1. *The Questionnaire*

Questionnaire					
1. Do you think mining companies in your region have a negative impact on the environment?	Yes	Rather yes	Rather not	No	I do not know
2. On which part of the environment do the mining enterprises in your region have the greatest and most negative influence?	Soils	Air	Water	Infrastructure	Everything listed
3. To what extent is environmental protection important for mining enterprises in your region?	Very important	Important	Not so important	They do not matter	I do not know
4. To what extent do mining companies consider important the problems that arise from their activities and the local communities?	Very important	Important	Not so important	They do not matter	I do not know
5. Do the mining enterprises in your region have a local community engagement plan?	Yes	Rather yes	Rather not	No	I do not know
6. Do mining companies in your region offer training opportunities for young people from the local community?	Yes	Rather yes	Rather not	No	I do not know
7. Do mining companies in your region regularly conduct a dialogue with the local community?	Yes	Rather yes	Rather not	No	I do not know
8. Do mining companies in your region offer voluntary participation, investment or support to local community initiatives?	Very important	Important	Not so important	They do not matter	I do not know
9. Which local community do you belong to?	Mirkovo	Chelopech	Zlatitsa	Pirdop	Panagurishte
	Stara Zagora	Krumovgrad	Kardzhali		Senovo/Vetovo Other

Analysis of results and discussion

Interaction of companies with the local community is very important for their effective functioning. Globally, leading national and international companies recognise that long-term successful business is not possible without complex reporting of different factors from the external business environment. Company's responsible behaviour towards the local community is a guarantor of their maintenance and the obtaining of the public "license to operate" in the respective region. (Bakardhieva, 2018)

Empirical information clearly indicates that respondents understand the negative impact of mining activities but at the same time also see and understand the commitments of mining enterprises to the environment and local communities. Some weaknesses indicate the answers to the questions "Do mine businesses in your region hold a regular dialogue with the local community?" and "To what extent do mining companies consider important the problems that arise from their activities and the local communities?" The answers to these two questions are diverse and do not give a clear direction. Nonetheless, respondents report a high percentage of voluntary participation, investment, and support for local community initiatives.

Environmental impact means the extent to which business activities have a negative impact on the environment. Obviously, this strand is of utmost importance and relates to some of the most current global issues - air, water, soil and infrastructure pollution. When the business is working in a socially and environmentally responsible way, it gets the approval of local communities and the ability to develop its production.

Over the past two decades, mining companies have clearly started to realise that economic activity, environmental protection and social engagement are closely linked. More and more environmental commitments are being made, implementing the best technologies and practices. 45.5% of the respondents believe that mining companies have a significant and negative impact on the environment. 25.7% think "Rather yes" – that they have such an impact. The percentage of respondents who consider that the enterprises do not have or rather do not have any harmful influence – 11.20% and 12.30%, respectively, should also be noted. 5.30% of the respondents do not know whether the mining business in the region damages the environment.

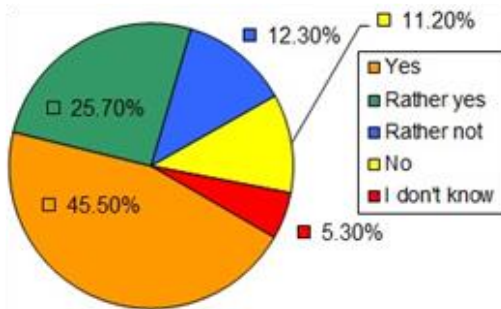


Fig. 1. Do you think mining companies in your region have a negative impact on the environment?

Numerous technical and organisational actions have been undertaken in recent years to maintain a high level of emission control and to minimise all releases of harmful substances into air, water and soil. These are the components on which the mining companies have the greatest and most negative influence, and the respondents confirm it. 39.30% of them consider that the enterprises affect negatively and equally all components, where the largest share falls on air and soil components – 22.00% and 17.20%, respectively.

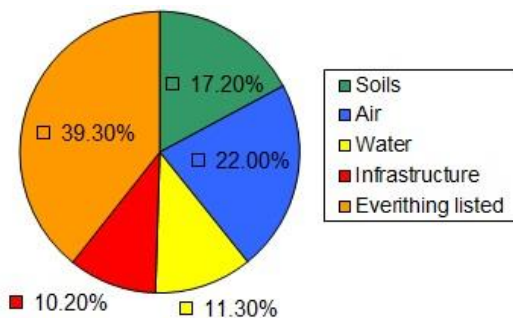


Fig. 2. On which part of the environment do the mining enterprises in your region have the greatest and most negative influence?

Over the last two decades, there has been a continuous reduction in specific emissions of heavy metals in mining regions. For example, Aurubis Bulgaria declares that over the same period it has reduced the specific emissions of SO₂, dust and heavy metals by more than 95%. Total water consumption in 2017 was decreased by about 30% compared to 2003. The company has been building a stand-alone air quality monitoring system that has been in operation since 1999.

Dundee Precious Metals Chelopech has implemented a number of large-scale projects for modernisation of the infrastructure and the facilities, with projects focusing mainly on production efficiency with care for the environment and human health. The most significant projects are:

- Modernisation of the ventilation system by installing a new, highly efficient fan;
- Modernisation of the Chelopech tailing pond and of the fermentation plant;
- Construction of a modular waste water treatment plant for domestic and faecal water.

With a triple increase in yield compared to 2004, in its Sustainability report (2018) Dundee Precious Metals Chelopech declared:

- 43% reduction in the quantity of disposed mine waste per tonne of extracted ore;
 - 41% reduction in the amount of used fuel;
 - 90% decrease in discharge of tailings water into the environment;
 - 60% reduction in the amount of cement per tonne of extracted ore used to fill the seized areas in the mine;
 - 74% reduction in fresh water consumption;
 - 28% reduction in consumed electricity per tonne of ore;
- Towards the end of 2018, a total of 22.5 hectares of land damaged by mining activity in the past were reclaimed, with over 160 000 trees and shrubs being planted and grown. (Sustainability Report, 2018)

The leading companies in the Srednogorie (Assarel Medet, Dundee Precious Metals, Elatzite Med, Aurubis Bulgaria, etc.) are also implementing a number of environmental projects to modernise production and protect the environment. All these efforts are unequivocally appreciated by respondents, with 40.90% believing that environmental issues are "Very Important" for companies and 23.10% identifying them as "Important". 11.30% think that companies are not concerned with the environment, and 15.60% – that it is not that important.

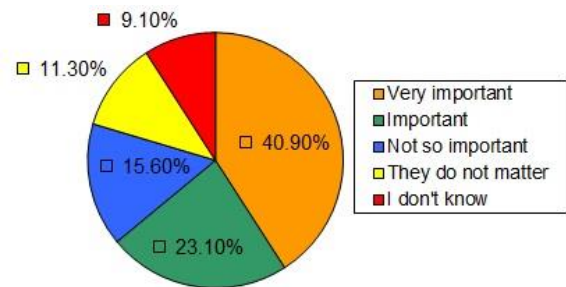


Fig. 3. To what extent is environmental protection important for mining enterprises in your region?

Mining companies around the world are actively involved in the communities in which they carry out their activities. Their participation is perceived as a strategy for encouraging the local population on the one hand, and on the other – integrating the members of the company and the community. The mining industry is among the sectors with high social expectations. Moreover, the condition to start working is to obtain the so-called "social license to operate". For example, Assarel-Medet supports annually the implementation of sustainable local initiatives by signing a donation agreement

with Panagyurishte Municipality. Separately, it is carrying out significant investment projects on the model of the public-private partnership during the implementation of the company's programme "Support for homeland". Thereby, the company contributes to the higher standard of living of the population in the region by financing infrastructure projects, supporting social activities, education, health, culture, sports, youth initiatives, tourism, etc.

The 27.80% and 25.10% consider that local communities are "very important" and "important" to mining enterprises, respectively. However, the percentage of respondents who think that local communities do not matter (19.30%) or are not so important (19.30%) is serious. Possible cause is a missing dialogue with all stakeholders.

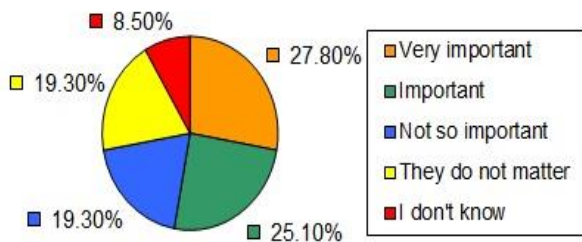


Fig. 4. To what extent do mining companies consider important the problems that arise from their activities and the local communities?

The objective assessment of the effectiveness of the financial resources invested in addressing the needs of the local community implies the use of a wealth of tools from the companies - consulting the local population, assessing the compliance with the expectations of the main local stakeholders. As a result, enterprises should develop short-term and long-term strategies and concrete development plans for the region and the local community in which they operate (Bakardhieva, 2018).

There are different forms of social investment. In general, Stefanova (2018) described them as:

- Investments in capacity building – these investments bring benefits to both the company and the local stakeholders by generating inclusive processes, strengthening the confidence in them and building engagement and good relationships.
- Investments through direct funding – this is the most common form of investment in local communities which can be done through the following tools: donation, sponsorship, subsidy, community investment, scholarship, etc.
- Investing through employee engagement – this is one of the company's core tasks as its employees are a key stakeholder and the first test for its social projects. The forms of investment in this case are through volunteering and payroll donation.

The significant percentage of respondents (39.30%) who are not familiar with the plans of the mining enterprises to engage the local community is quite impressive. In comparison with this percentage, the share of those who claim that companies have a plan or rather have a plan is relatively small, 17.20% and 22.00%, respectively.

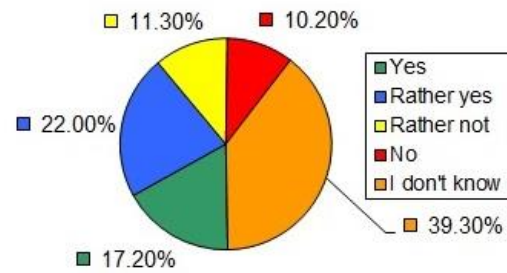


Fig. 5. Do the mining enterprises in your region have a local community engagement plan?

Community involvement and its development are essential for the enterprise and for improving the local community in which it operates. It goes beyond the definition and the engagement of the stakeholders with regard to the impact from the organisation's activities. Supporting and building relationships with the community increases the value of the company. This often solves or prevents problems, encourages partnerships with local organisations. Creating jobs and developing skills can encourage economic and social development.

Trends with regard to employment in the sector show a relatively permanent and steady decrease. Nevertheless, the Bulgarian mining industry remains one of the largest employers on national level, with employees' wages higher than the average ones (Galabova, Nestorov, 2019).

The recruitment of young people from the local community is an essential element for promoting employment and helping people to live with more dignity. 47.10% of the respondents categorically believe that mining companies offer training opportunities for young people from the local communities. 26.70% answer "Rather yes" to the question.

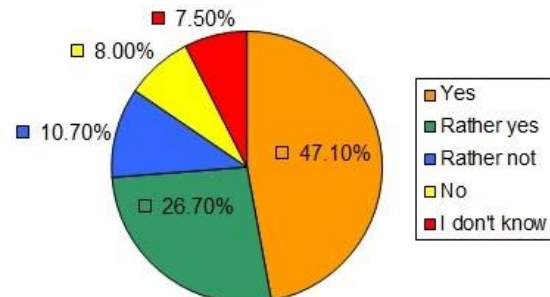


Fig. 6. Do mining companies in your region offer training opportunities for young people from the local community?

Commitment and community development through dialogue is a continuous business process. The Association of Global Communities gives guidance in this direction to ensure establishment of relationships based on trust and mutual respect. They are described by Stefanova (2018):

1. Getting to know the community – every active member of the community knows its peculiarities, resources, needs, structure of power and decision-making processes. Companies have the ability to monitor the local press, send their representatives to local events or research, make use of local services as well as of current projects in the different directions.

2. Active listening to community representatives – making active conversations with various organisations or informal groups with or without a reason is extremely important. It is not only good to have official relations established, but also informal channels for receiving information – talks with occasional people, unplanned visits to public places.

3. Organising discussions to create a common vision – the pre-identified common interests and the people who share them are a logical first active group “to draw” a common picture of community development. This can only happen at joint meetings where individuals and organisations share their vision of the ideal community and if it is shared by everyone.

4. Preliminary assessment of the resources, needs and problems of the local community – such meetings as well as individual conversations make it possible to identify the “weak” places of a community – lacks, limitations and deficits. They can also be used to discuss the priority of the individual areas of possible intervention by the company.

5. Choosing Priority Directions for Work – the most successful strategy is to help community members recognise and identify their deficits and problems themselves. This means active search and acceptance of help to overcome them. They are leaders in their own development and in most cases they have the knowledge, the capacity and the readiness to take the right actions. When the company participates by providing tools, resources, moderation, and household, it facilitates the process but does not recognise it as its own commitment and responsibility.

6. Creating a small working group – a relatively small, committed and ambitious team is needed to successfully carry out an activity which can create a pilot “tool for change”. In the beginning it can take up some of the functions and then transfer them to the existing community organisation.

7. Develop an action plan – together with a small but active part of the society, a comprehensive strategic plan can be developed that includes long, medium- and short-term goals as well as actions to achieve and share with the others. Plans must be understandable and acceptable to members of the community, indicating a direct link between goals, activities, responsibilities, timelines and resources.

8. Implementation of the Action Plan.

In the context of the question related to a regular dialogue with the local community by the mining companies, there is no dominant answer. 21.90% think that ‘Yes’, companies run a regular dialogue and 24.10% – ‘Rather yes’. 19.80% responded with ‘Rather not’, 21.90% with ‘No’ and 12.30% with ‘Do not know’. The hesitation in the answers indicates uncertainty and problem in this component.

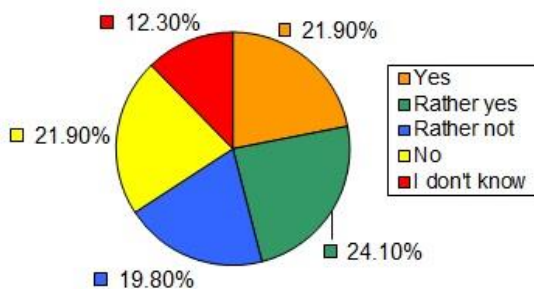


Fig. 7. Do mining companies in your region regularly conduct a dialogue with the local community?

Although local communities are generally unaware of the existence of a plan to engage them, 31.20% of the respondents strongly claim that mining companies offer voluntary participation, investment or support to local community initiatives, while 28.50% say “Rather yes” as an answer.

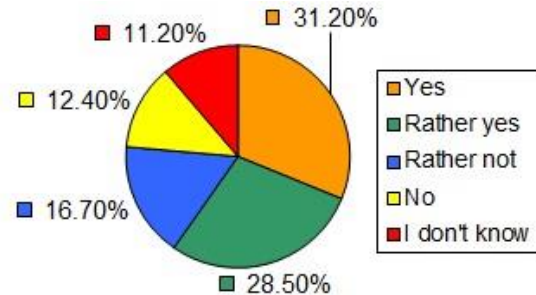


Fig. 8. Do mining companies in your region offer voluntary participation, investment or support to local community initiatives?

The last question concerns the local community to which the respondents belong. The largest share is the population of Zlatitsa, followed by those from Pirdop, Senovo/Vetovo, Panagyurishte, Chelopech and Stara Zagora. The lowest is the share of Mirkovo, Krumovgrad and Kardzhali. 3.80% indicate “Other” as an answer.

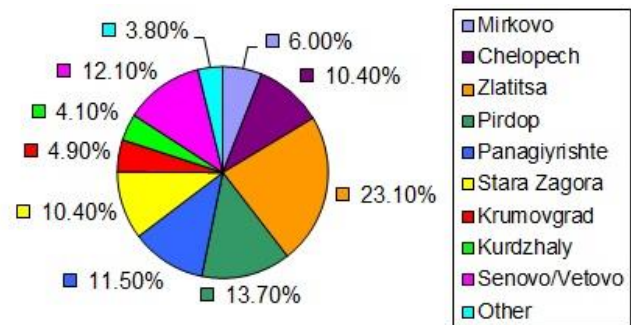


Fig. 9. Which local community do you belong to?

Conclusion

Corporate Social Responsibility approaches are a flexible tool in the company’s dialogue with local communities. In this sense, interactions with local communities should be seen not as a company expense, but as a sustainable investment in the future. Effective interaction of companies with local communities contributes to the sustainable socio-economic development of regions, ensures good management of non-financial risks (corporate, ecological) and corporate reputation, accumulation of resources (financial resources, technologies) achieves sustainable goals and builds trustful relationships between businesses and local communities.

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INCREASING THE EFFICIENCY OF HUMAN RESOURCE MANAGEMENT IN MINING ENTERPRISES

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ABSTRACT. This study is dedicated to analysis of the effectiveness of human resource management in some leading mining enterprises in Bulgaria for the period from 2014 to 2017. The object of the study is the efficiency of human resource management achieved in four big companies in the mining sector, along with the company practices and policies as a basis for improvement. The objective is to evaluate the efficiency achieved by applying different indicators for using human resources and to research the causes and preconditions for its increase. As a result of the analysis, good practices are summarised and guidelines are outlined for improving the results of the human resources management process.

Keywords: efficiency, human resources management, mining enterprises

ПОВИШАВАНЕ НА ЕФЕКТИВНОСТТА НА УПРАВЛЕНИЕТО НА ЧОВЕШКИТЕ РЕСУРСИ В ДОБИВНИТЕ ПРЕДПРИЯТИЯ

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РЕЗЮМЕ. Настоящото проучване е посветено на анализ на ефективността на управлението на човешките ресурси във водещи добивни предприятия в България за периода 2014-2017 г. Обект на изследване е постигнатата ефективност на управлението на човешките ресурси в четири големи компании от добивния сектор, заедно с фирмените практики и политики като основание за повишаването ѝ. Целта е ефективността да се оцени чрез прилагане на различни показатели за използване на човешките ресурси и да се потърсят причините и предпоставките за нейното нарастване. В резултат на анализа е направено обобщение на добрите практики и са изведени насоки за подобряване на резултатите от процеса на управление на човешките ресурси.

Ключови думи: ефективност, управление на човешките ресурси, добивни предприятия

Evaluation of the use of human resources in enterprises

The use of human resources characterises the state of their operation in an enterprise as well as the effectiveness of this operation. It can be considered as extensive and intensive. The extensive use determines the use of employees as numbers and over time. The intensive use assesses human capacity, actual mental and physical capabilities and potential within the legitimate working day. The quantity and quality of human resources invested in an enterprise is in direct relation to the results achieved. There is the following dependence: the more completely and effectively human resources in an enterprise are used, the lower the labour costs for output and marketed production are and the higher the economic results of the organisation's activities and the income of the employers and employees are. Conversely, the inefficient use of human resources, under equal conditions, cannot ensure an efficient and stable functioning of an enterprise.

In practice, a great number of indicators are applied to characterise the use of human resources, such as:

- Coefficient for the use of human resources at a time;
- Internal labour losses of working time per employee;
- Quantity of the production and/or service output per employed person;

- Growth of the volume of production and/or services per employed person;
- Sales per one employed person;
- Profit per one employed person;
- Percentage of implementation of labour standards;
- Workforce costs per unit of production;
- Wage costs in the cost of the output and marketed production.

All indicators provide information about the state of human resources and their use within the enterprise, outlining different aspects of the management process. On the basis of their application, it is possible to ascertain what has been achieved in this key area. It will become a basis for evaluation and identification of the reserves for improving the process.

Indicators for the use of human resources in enterprises applied as part of the survey

The process of evaluation of the extent to which the human resources in the enterprise are used starts with determining the objectives. The objects assessed can also be different: the employees in an enterprise; employees in individual production or functional units; employees in a particular position or post;

groups of employees who get poor results in the work process; specific posts or positions.

Selection of the most appropriate indicators for determining the use of human resources in an enterprise depends on the objectives of the assessment, the specifics of the work process and the nature of the tasks and functions performed. In the current survey, the availability of statistical information about the results of the companies was a major factor for determination of the objects and targets of the survey and for selection of the indicators for evaluation.

The Indicator "Sales per one employee in an enterprise at comparable prices" is uniform with the indicator "Quantity of production per one employee". Both indicators characterise the quantity and value of the output, or of the marketed production, respectively, as divided by the total number of employed persons in an enterprise. In this way, the extensive and intensive use (productivity) of human resources can be assessed simultaneously. The formula for determining this indicator is as follows:

$$Q_{1pers} = \frac{Rs}{Ans}$$

where

Q_{1pers} - volume of sales of goods and services of a person at constant prices;

Rs – sales revenue;

Ans – average number of staff without women on maternity leave.

"Growth of sales revenue per one employee" is an indicator that is also often used to describe the extensive and intensive use of human resources. It can be determined by the following two basic formulas:

$$\Delta Rs = Rs_1 - Rs_0$$

$$IRs = \frac{Rs_1}{Rs_0}$$

where:

ΔRs - growth in sales revenue

Rs_1 - level of sales revenue during the reporting period;

Rs_0 - level of sales revenue during the basic period;

IRs - Index reflecting the increase in sales revenue in the reporting period compared with the basic period.

The larger the growth in the volume of marketed products and the bigger the sales revenue per one employed person in an enterprise are, the more effective the use of human resources is. If the index characterising the increase in sales revenue is higher than a unit, then the growth is positive and if it is lower than a unit, the growth is negative.

When using these indicators, three essential points should be taken into account. First, not every increase in the volume of output or marketed production per one employee is a result of the better use of human resources. It could be a result of improvement in the technique and technology, replacement of obsolete machinery, apparatus and equipment with new, more productive ones, or of organisational changes.

Second, structural changes of production also have their influence: for example, increase or decrease in the production of labour-intensive products. In practice, the smaller the relative share of labour-intensive products is, the higher the degree of use of human resources will be, and vice versa.

Third, another dominant factor should also be taken into account. When the cost of production increases due to a specific market situation, the use of human resources seems to be improving without any changes in production, and vice versa. The impact of price changes on the dynamics of the output per employed person in an enterprise should also be reflected. To that end, the volume of the output and marketed production or the sales per one employed person should be recalculated at comparable prices.

The indicator "Profit per one employed person" characterises the intensive use of the workforce in an enterprise. It is calculated as the annual profit received by the enterprise is divided by the total number of employees for the year concerned. Unlike the two preceding indicators, as part of the assessment it also includes the achievements of the aggregate workforce in an enterprise in terms of the structure of the production with regard to its profitability, the market positions of the enterprise and its competitiveness. However, the impact of the market situation must also be taken into account here - which, at the same level of intensive use of the workforce, may lead to a different profit per one employed person in the enterprise.

Evaluation and practical application of the indicators for evaluation of the use of human resources in mining enterprises

The four enterprises included in the further analysis are among the leading companies in the mining industry sector. According to the European Commission's classification of the enterprise's size, they fall under the category of "large enterprises" with over 250 employees. During the four-year period considered, each of them has a targeted human resource management policy and implements planned activities in the field of human resources. The selected companies work transparently and regularly inform the public about their activities by officially publishing part of the results achieved. These circumstances are a good prerequisite for inclusion of these enterprises in this study. Within its framework, the object of study is the efficiency achieved in the process of human resource management, along with the company policies and practices as a basis for potential efficiency increase. The aim is to assess whether higher efficiency is achieved by applying different indicators for human resource use and to look for the causes and prerequisites for its growth.

The application of the indicator "Sales per one employee in an enterprise at comparable prices" characterises the marketed production per employee. The rating on this indicator for the four analysed mining enterprises allows for the intensive and extensive use (productivity) of human resources to be characterised.

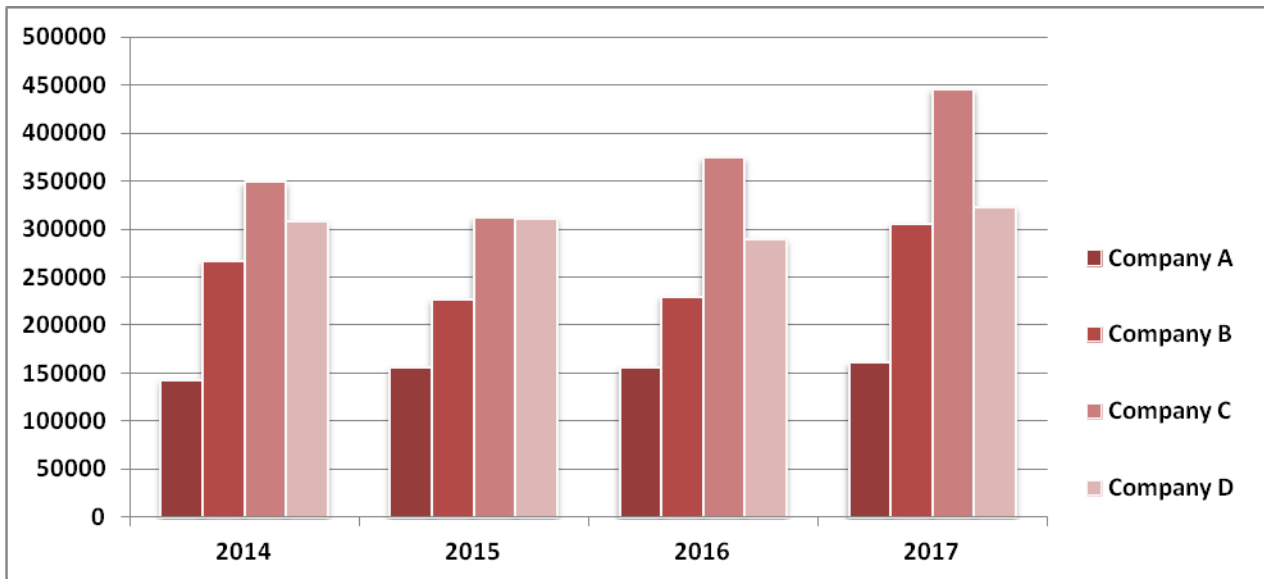


Fig. 1. Values of the indicator “Sales per one employee in an enterprise at comparable prices” (BGN)

Note: The figure is created according to the authors' calculations based on official data for the annual sales revenue and total number of workers and employees of the enterprises included in the study. Source: ICAP Bulgaria, 300 Business Leaders in Bulgaria 2014-2017, ICAP Bulgaria, Sofia

The results presented graphically in Figure 1 show that the values of enterprise A have been slowly and gradually increasing – from 142 505 BGN to 160 695 BGN annually. Enterprises B, C and D in 2017 achieved the highest scores – 305 659 BGN, 444 961 levs and 322 490 BGN, respectively, although there are conflicting general trends. It may be noted that if this indicator is applied to companies from other sectors, the result will be less than 100 thousand BGN per one

employee. The high values of the mining enterprises are directly linked to the large investments made in tangible and intangible resources during the period under consideration. The following good practices of the respective enterprises for human resource input are repeatedly recovered, as evidenced by the results of the analysis.

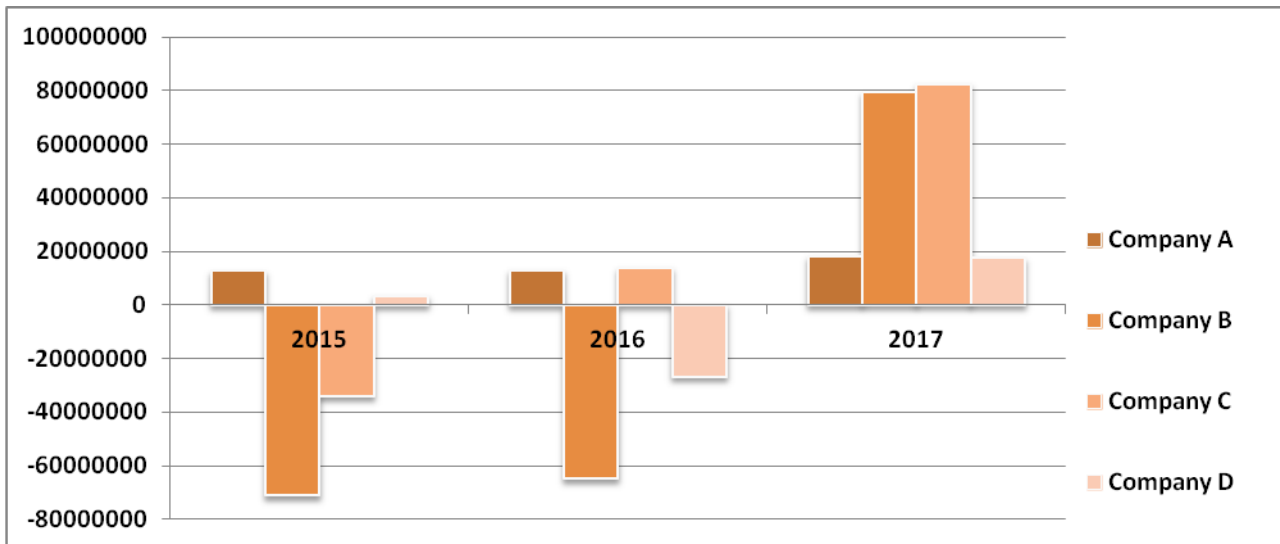


Fig. 2. Values of the indicator “Growth of sales revenues per one employee” (BGN)

Note: The figure is created according to the authors' calculations based on official sales revenue data for the enterprises included in the study. The year 2014 is taken as a basis. Source: ICAP Bulgaria, 300 Business Leaders in Bulgaria 2014-2017, ICAP Bulgaria, Sofia

The application of the indicator "Growth of sales revenue per one employee" makes it possible to identify any current change recorded against a prior reference period on a comparative basis.

As apparent from Figure 2, the obtained absolute values of the growth in sales revenue per one employee vary widely both from year to year and when comparing the values of individual

enterprises. While in 2015 two of the enterprises (B and C) had a significant negative growth in sales revenue compared to the previous year – 2014, and the other two had a very modest positive growth, in 2017 all enterprises effected positive growth.

Regarding the Index which characterises the increase in sales revenue during the reporting period compared to the

basic period (IRs), the results are also not unambiguous. For company A only, the Index varies from 1.09 (2015) to 1.13 (2017) and there is a positive growth. For company B and C, the values changed from negative in 2015 to positive in 2017. In the case of company D, the Index was positive with the exception of 2016.

If we apply the indicator for evaluation of the use of human resources "Profit per one employee" for the four analysed mining enterprises, we will get the following results presented graphically in Fig. 3. The profit as a final result of the enterprise's activity is an absolute indicator that characterises this activity quantitatively and measures the financial and economic performance. In terms of human resource management in the mining enterprise, it is important to analyse with how many workers and employees it was achieved and what costs were incurred in order to secure these resources. The results presented in Fig. 3 show that in 2014, the value of

the indicator for enterprise A was negative. In the next three years, it was already positive and increasing – from 17 922 BGN (2015) to 23 552 BGN (2017). Company A has achieved the registered profit over the years with roughly the same total number of employees. For company B, the results were contradictory: the highest value was obtained in 2017 (81 981 BGN) and the lowest value was in 2015 (only 31 996 BGN). These values are obtained with small changes in the total number of employees over the past two years. For enterprise C, the highest score of the indicator was reported in 2014 (135 785 BGN) and the lowest was in 2016 (75 951 BGN), with very small changes in the total number of employees over the years. The data for enterprise D describes a similar situation. The highest value of the index was in 2014 (98 030 BGN) and the lowest was in 2016 (52 583 BGN).

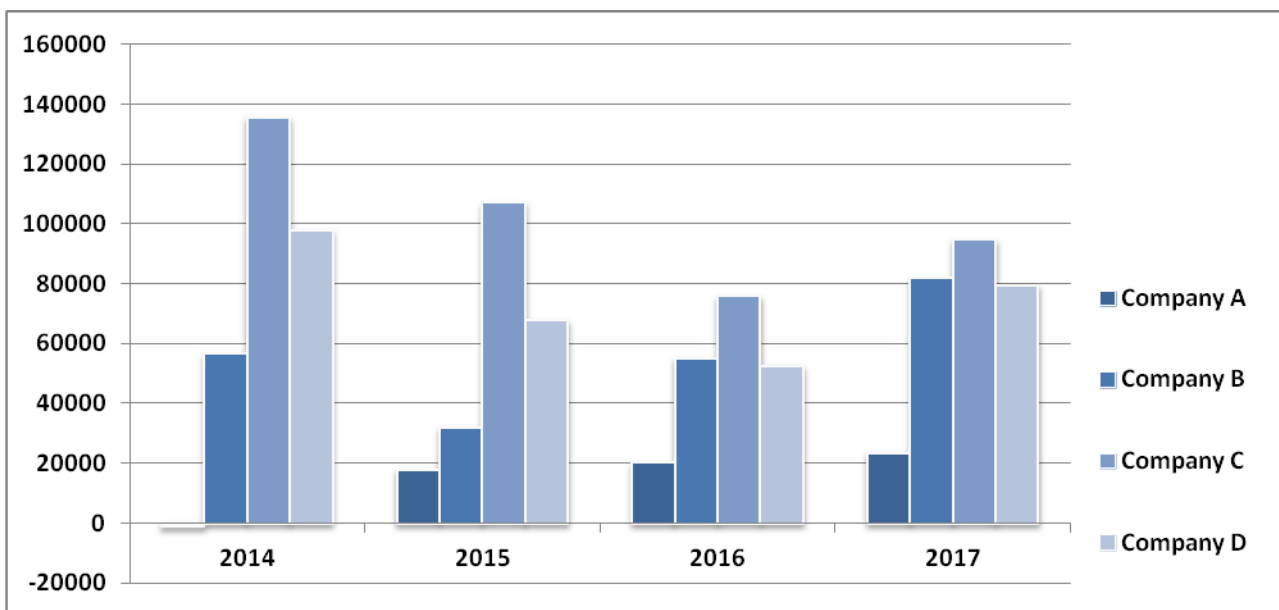


Fig. 3. Value of the indicator "Profit per one employee" (BGN)

Note: The figure is created according to the authors' calculations based on official data for the annual profit before tax and total number of employees of the enterprises included in the study. Source ICAP Bulgaria, 300 Business Leaders in Bulgaria 2014 - 2017, ICAP Bulgaria, Sofia

According to the estimates for the four companies of the indicator "Profit per one employee", only in one of them (enterprise A) there is a sustained increase in efficiency in the use of human resources. For enterprise B, there has been a positive trend and a relatively steady increase in efficiency since 2015, while the other two (enterprise C and D) have rather contradictory results. Two conclusions can be drawn as a result of the calculations made. First, during the period from 2014 to 2017, the four companies didn't make significant changes in the total number of employees. At the same time, as a second point, it can be noted that there are significant changes in the profit obtained as a consequence of investments made in the field of human resource management and due to the influence of other factors like market situation, innovations and investments in new equipment and technology and human capital development, reorganisation of the business activity, etc. It must also be mentioned that in 2017, the price of metals on the world exchanges rose by 20.7%. The reasons for this development may be sought in the increased demand caused by the growth of the industrial production and

the lower supply from China as a result of the measures taken for reducing air pollution. The increased demand is precisely what requires changes in the behaviour of the four enterprises which rely on investments and innovations as an adequate response. It can be concluded that all companies have achieved positive financial-economic results which increase over time (with the exception of company A in 2014). Investments in material and human resources have contributed to these results.

Investments in human resources in the mining enterprises surveyed

In the extractive industry, the company's investments in human resources are focused mainly on their more rational use in the work process. This means applying measures to reduce all-day work time losses and absences from work in general. In this way, the increase in individual labour productivity is stimulated, which in turn leads to a reduction in

the cost of labour as part of the cost of production of one unit. In an industry where safety risks and workload are enormous, the transformation of the care for human resources into value is not only a must, but it also supports the competitiveness of these companies. Not surprisingly, the leading mining companies develop special policies, procedures and rules and invest in safe workplaces and staff training aimed at forming responsible behaviour for each worker.

In company A, a complex software has been introduced in recent years in order to improve labour productivity when extracting resources. It creates a geological 3D model of the components of the resources and finds optimal solutions for exploitation of the deposits. It is also useful in the field of safety at work through the ability to signal for dangers, regulate traffic and speed of movement and improve traffic in case of limited visibility.

In company B, as of 2015, a mining management system has been introduced to increase labour productivity. It allows the production process to be managed completely automatically according to parameters specified by mining engineers, mine surveyors and controllers. All data is recorded and stored to be used when making future decisions. This system contributes to maximum productivity of the machines, which reduces downtime as well as labour costs. Since 2016, its scope has been increasing and the data collected is available 24 hours a day for the engineering and technical staff, not only on their PCs, but also on their mobile phones, which is a leading factor in making quick and reasoned decisions. A procedure for "Health and Safety" is implemented and currently operates as a duty and responsibility of all employees. Its goal is the continuous improvement of working conditions. The procedure includes application of good practices, control of the working environment factors and the production process, risk assessment, proper use of personal protective equipment, prevention of occupational accidents, incidents and occupational diseases. At the end of 2018, a professional training programme was also launched in the company, led by lecturers from the University of Mining and Geology "St. Ivan Rilski". The trainings were organised and conducted according to the corporate policy and aimed at acquiring the knowledge and skills needed to perform the modified working process. Thus, increasing capacity of employees in different activities is pursued.

Since 2011, an Annual Sustainability Report has been published in Enterprise C, which takes into account the company's relationship with its stakeholders - employees, investors, state and local communities, environment. One of the main goals that the mining company has set itself is the provision of a variety of possibilities for the staff to acquire new knowledge, develop leadership skills, professional and technical qualities. Attention is drawn to the relationship between human resources and trade unions, and on this basis a constant dialogue has been achieved through the developed corporate policy for decent work. Procedures are in place to submit complaints about irregularities within the scope of the labour law or about violated human rights. Since 2013, the company has launched a project to integrate the safety processes into the production processes with the task of providing a risk assessment for 100% of the performed work activities. In this regard, a programme to improve the health of employees and a programme to promote a healthy lifestyle, endurance and positive self-control have been developed.

Since 2016, an innovative approach in the company to improve safety practices has been the introduction of golden rules to ensure more secure and safer working environment. These rules must be followed by every person that performs any kind of activity on the territory of the enterprise.

In 2018, the results from a survey of employees' opinions revealed that the company successfully manages to take care of the development of its staff, which is recognised as a fact by most of its members. The answers received are: 59% have commitment to work and willingness to make additional efforts; 70% are willing to remain at work in the company; 62% approve of their performance; 57% approve of the work of senior management. The company continues to implement the project "Working Together", which includes training all employees to make decisions, work in a team and respond quickly in various situations.

In company D, as of the end of 2014, an integrated safety system has been developed, including video surveillance, access control and fire alarm. The effect of the balance between technology and human factor is the achieved prevention of workplace accidents. As a result of the systematic and purposeful policy that the company has followed since 2012, zero levels of workplace traumas are reported and professional diseases are limited to a great extent. Among the permanent measures to improve the health and safety at work are the supply of new machinery and equipment, taking into account the highest world safety norms, as well as the strict control of the implementation of the rules in this direction. In summary, it is correct to conclude that the improvement of the system for human capital management has been successful, has been accepted by company employees and should be considered as a stage of permanent operational staff management system (Chobanov, Velev, 2018).

Main factors and prerequisites for improving the use of human resources in the mining enterprises

Management is a dynamic and open process, as the key phases are re- and follow-up research as well as continuous monitoring (Chobanov, Velev, 2017). Based on the summaries of theory and good practices in the extractive industry, several basic conditions leading to an improvement in the use of human resources in an enterprise can be inferred. Improving the process of using human resources in the mining enterprise depends on several key factors:

- improvement of the strategic planning in human resource management;
- improvement of the quality of labour and production standards;
- introduction of new equipment and technology;
- extent to which workers, employees and managers meet the requirements for the jobs occupied;
- ensuring favourable working conditions;
- employee motivation;
- focus on the constant development of human resources and their career advancement;
- improvement of the work organisation.

The direction of business development is dictated by the values of society, which gradually become commensurate with the profit of the enterprise (Petrova, 2018). In this sense,

essential for a better use of human resources is the company's approach towards a targeted identification of the additional needs of new employees and their timely satisfaction. In practice, selection of new employees should be undertaken only after identification of the general needs and assessment of all reserves for the use of available personnel. The extent to which the workforce in an enterprise can be used depends on its rhythmic interaction with the suppliers of raw materials, materials, fuels, energy, spare parts, tools and accessories and on the buyers of the products. The effective use of human resources also depends on the existence and justification of labour standards in the enterprise, and in particular, on the availability and quality of job descriptions, labour norms, scheduled tasks, work schedule, internal order rules, wage rules, etc. Once developed, however, the labour standards should not be permanent. It is recommended that they are to be changed with any change in the technical, technological, organisational and production conditions and thus, a new, generally higher standard level of human resources use to be defined.

The use of human resources in the enterprise is very much dependent on the extent to which workers, employees and managers meet the requirements of their posts or jobs. This question should be resolved by recruiting and carefully selecting human resources. Under certain economic, technological, organisational and production conditions, the more complete and efficient use of the workforce in a mining enterprise depends to a large extent on employees' motivation, their attitude and willingness to make full use of their working hours, working in accordance with the requirements of the labour standards and respecting the industrial and technological discipline.

The concept of ensuring health and safety at work is essential for the development of the mining enterprise. It includes two guidelines of work. The first one is the development of a mining management system that gives a signal in case of danger to the workers. This includes the development of programmes to improve the health of employees. The second guideline is to conduct targeted training of staff on compliance with health and safety at work. It is necessary to understand that the talent, personal qualities and skills of the employees have a strong influence on the better performance of the mining enterprise on the market. The investment in human resources development and opportunities for career advancement is a priority in its activity. Main indicators for achieving the business objectives are the increase of the employees' competencies and the continuous trainings for acquiring new knowledge, developing leadership skills, professional and technical qualities.

Significant potential for increasing the motivation of the personnel in the mining enterprise, for more complete and

efficient use of the workforce as well as of all other resources, is found in two directions. First, ensuring favourable working conditions, including measures to ensure safe and health-conscious jobs. Second, providing real opportunities for professional development and improvement of the knowledge and skills of the employees and for their career development only according to their personal qualities and achievements in the work process.

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TRANSITION TO THE EURO AND THE EXPECTED IMPACT ON THE BULGARIAN ECONOMY

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ABSTRACT. The transition from BGN to the euro is likely to be a fact for Bulgaria in the next 5-10 years. This publication summarises and gives an overview of the expectations for the effect of this on the national economy. Prognoses for the development of the process are presented as well as the risks related to internal and external factors. Influence is expected on: interest rates, financial fees, inflation, foreign trade and the political climate. The experience of other countries where the transition to the euro is linked with a subsequent crisis occurrences is also commented on.

Key words: BGN, euro, inflation, interest, economy, politics, expectations

ЗАМЯНАТА НА ЛЕВА С ЕВРО И ОЧАКВАНТО ОТРАЖЕНИЕ ВЪРХУ ИКОНОМИКАТА НА БЪЛГАРИЯ

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РЕЗЮМЕ. Преминването от лева към еврото най вероятно ще стане факт за България в следващите 5-10 години. Настоящата публикация разглежда и обобщава очакванията за ефекта от това върху националната икономика. Представени са прогнози за развитието на процеса и рисковете, свързани с вътрешни и външни фактори. Очаква се влияние върху: лихвите, финансовите такси, инфлацията, външната търговия и политическия климат. Коментира се и опита на други държави, в които въвеждането на еврото се свързва с последващо развитие на кризисни явления.

Ключови думи: лев, евро, инфлация, лихви, икономика, политика, очаквания

Introduction

Formed officially in 1999, the euro had lasted for three years in a "virtual" form, with twelve European countries replacing its national currencies on January 1, 2002. That is when the first waves of dissatisfaction with the change in mass commerce began. The Germans gave it the name: teuro – from teuer, expensive. Many Italians will confirm to this day that the end of their welfare came in 2002 with the fist touch with the "new money". The opinions for and against the euro are controversial: Angela Merkel calls it "our common destiny". Politicians across the broad spectrum from Emmanuel Macron to Viktor Orban consider it the most important institution of united Europe. At the same time, former British Foreign Secretary William Haig describes the euro as "a burning building without any exits". "Although it was an experiment designed to unite them, nothing really divided Europe as much as the euro", says the Nobel Prize winner Joseph Stiglitz. Generally, the euro is the eternal source of controversy in Europe. And in the next few years it is highly probable that Bulgaria would be in the focus of these disputes (Tomov, 2019).

The influence of the euro on pricing interest rates

There seems to be a difference between the statistical data and how the consumers perceive the transition to the euro.

There are many speculations about the matter, for example, according to statistics – the change of currency does not increase inflation, while consumers claim the opposite in countries like Germany and Greece. This controversy, in fact, has a simple explanation: significant price increases only affect certain sectors and commodities without being able to significantly change the metrics of the large customer basket, considered by the statistics. But at the same time, there are daily goods and services, where the change in price is most noticeable. There is nothing mysterious in the mechanisms of price increase. The most important of these is the rounding of prices in the new currency so they look attractive (Tomov, 2019). According to most forecasts, we should not expect a huge overall inflation rate in Bulgaria. Some commodities can rise significantly, and this will create a sense of reduced purchasing power. Similarly to consumers in countries like Germany and Greece, price increase of some goods might be detected in Bulgaria which is elusive for the statistics.

Some opinions about Bulgaria's entry into the Euro zone are optimistic. For example: Levon Hampartzoumian commented that Bulgaria's accession to the euro zone would not affect the Bulgarian economy badly, as many goods and services are currently traded in euro. He also reminded that the BGN has been in a currency board to the euro for 20 years. The process of joining the euro zone is more important than the EU accession itself. In his words, Bulgaria has been a member of the zone for 20 years since the currency board policy was implemented. According to him, the dispute whether

the BGN is correctly converted to the euro is insignificant. He added that if there was a dramatic distortion of the BGN-EUR ratio, the Bulgarian currency would have been converted to another foreign currency. Hampartzoumian adds if there was a dramatic distortion of the BGN-EUR ratio, the Bulgarian currency would have been converted to another foreign currency. According to his prediction, nothing bad will happen when the euro is adopted. Its positive effects will be felt by the "most economically active people" – those with business (Hampartzoumian, 2018).

A negative opinion about Bulgaria's joining the euro zone is expressed by the financial expert Steve Hanke, a professor at the Johns Hopkins University in the US, known in our country as the father of the currency board. He makes an analogy with the fate of Greece, if Bulgaria takes up this path. Hanke said that currently, with the currency board system, Bulgaria is unofficially a member of the euro zone and the BGN is a clone of the euro. According to him, the idea of official entry into the euro zone is bad for several reasons. First of all, because of the moral hazard. "If you enter the euro zone, you will face the moral danger Greece is facing. Bulgaria will say. Look, we can be a bit more relaxed about our fiscal situation in Bulgaria because if we get into difficulty, the EU has no other option than to save us". That's what the Greeks thought. Greece was officially in the euro zone and was spending money like crazy. Greek politicians did not spend money, they stole money.

According to him, the Bulgarians will not win anything if they adopt the euro but will lose the power of the currency board and will face the moral hazard that Greece had. "If you enter the euro zone officially, you will be just like Greece," Hanke is convinced. Joining the euro will not be a magical solution to all the problems in Bulgaria. "These are nonsense because the BGN is unofficially in the euro zone, nothing will change, except that Bulgaria will lose a lot of sovereignty, it will be officially in the euro zone, something without exit." That's why I say it is like in the song of "Eagles", "Hotel California" – You can check any time you like, but you can never leave" (Yuseliiev, 2018).

Inflation has an indirect effect on exchange rates through its impact on interest rates. When interest rates in one country are higher, capital from low-interest countries is being channelled to it. That's why the currencies of Australia and New Zealand are now rising and the US one is getting cheaper. Bulgaria also has the advantage in terms of interest rates as compared to the Euro zone. The difference in recent years is about 1% for household deposits in BGN and EUR, with no currency risk involved. This has been a factor in supporting the price increase of the BGN over the last 10 years, including the strong growth of the economy. But there are also market forces that would act on the reduction of the BGN price. These are the trade balance of the country and the direct foreign investments. The foreign trade deficit "drains" the foreign exchange reserves of the country and requires capital flows. A permanent foreign trade deficiency would lower the exchange rate, which would make imports more expensive and make exports more competitive. This deficiency is not necessarily a negative factor because it may be due to imports of machinery and equipment to be financed by foreign direct investment and subsequently to contribute to the country's GDP growth, including through exports. This happened in Bulgaria when there was a large foreign trade deficit. The crisis in consumption and the

recovery of foreign markets have changed this. In the course of two years, the deficit has fallen from 1.5 billion BGN a month to several tens of millions. The deficit did not impact the stability of BGN, because it was financed by foreign investments. Even if the BGN had been depreciated before 2008, the change in the foreign trade balance since then would have strengthened the BGN.

There are statements from 2008 that the BGN is underestimated or it would have risen in recent years if the exchange rate was determined on a market principle. Most likely the crisis would have caused speculators to sell BGN very actively at the end of 2008. This would have improved the foreign trade more and now the currency of Bulgaria would grow due to a positive balance. Periods of depreciation of the BGN would have been short, however, the large currency movements would have increased the business insecurity and minimised all benefits without taking into account the loss of confidence in the banking system or the BGN due to the lack of a currency board (Tsachev).

The acceptance of the euro is obligatory for all EU members, with the exception of Denmark (and the UK as far as it is still in the Union). But our country is now in a truly unique position: countries like the Czech Republic and Sweden are knowingly trying not to meet the criteria in order not to enter the euro zone; Bulgaria covers them and wants to enter but cannot. Many technocrats in the European institutions and in some more influential national governments believe that the acceptance of the euro should not be rushed. At least until the incomes in Bulgaria are a bit closer to the average for the Union. Not many people in our country realise that "convergence" means growth not only of salaries but also of prices. So far, the introduction of the euro has not led to major inflationary processes - according to official statistics. However, that is not so according to the subjective perceptions of the people.

"There will be no inflationary impulses above the healthy levels - neither in ERM II nor in the acceptance of the euro," emphasises Dimitar Radev, the Governor of the Bulgarian National Bank, in an interview with Bulgarian National Television (BNT). "However that does not mean that prices will remain unchanged. We are in the process of a real convergence. This process, inter alia, means getting closer to the average income and price levels in Europe. "If in Slovakia, say, a loaf was 49.99 crowns before the change, then it should have become 1.66 euro - a not quite "convenient" price. To achieve the same "attractiveness", merchants raised it up to 1.99 euro. In theory, rounding should work in both ways - some things should rise, others should get cheaper. In practice, however, there is no case of rounding down. There are two other factors. First, the transition to the euro entails certain costs for traders, which in general (says a Deutsche Bundesbank study) they tend to transfer directly to their customers. Second, the change of currency leads to the so-called "phenomenon of rational inattention" – forced to constantly calculate prices, most people at a certain moment stop to pay attention to the changes, even when they are at their disadvantage.

"It can be expected that the change in the currency will lead to significant price increases in a number of sectors, especially notably in those related to entertainment" they warned at the time. The effect on overall measured inflation (according to the so-called Harmonised Index of Consumer

Prices, or HICP) is not big – Huffner and Koske rated it at no more than 0.32%, but it is very noticeable because it refers to everyday necessities: coffee, cigarettes, newspapers. Not accidentally the Swiss economist Hans Wolfgang Brahringer invented the so-called "index of perceived inflation" and showed that according to consumer perceptions in Germany, the inflationary effect of the euro was four times higher than the one measured by statistics. All the studies on the subject show that the most serious rise is in spheres of publishing, restaurants, hairdressing and tickets for cinema. The effect is the strongest for middle-income and higher-income people spending more on entertainment. This was the case even in Lithuania that accepted the euro at the end of a deflationary cycle with record low interest rates. Eurostat reported the most visible price adjustments in cafes, hairdressing salons, housing and home repairs. Entry into the euro area is expected to reduce interest rates on loans and to decrease part of the risk premium on bonds. The National Bank of Lithuania estimates that in the first year only, the benefits for citizens from lower interest rates exceeded 40 million euro. Plus another 18 million were saved because of the decrease in transfer and exchange fees. The latter is particularly important for Bulgaria, where remittances from the Diaspora abroad are a major economic factor. On the other hand, the first of these effects can be offset by the global rise in interest rates. As for the Diaspora, a significant part of the transfers to Bulgaria comes from non-European countries such as the United States, Canada and the UK. The access to cheaper money hides risks and can seriously loosen up the financial discipline of the Bulgarian government. The example of Greece and the other South European countries in this aspect is very eloquent. The situation can be illustrated with a quote by Alan Greenspan: "When the euro zone was created, everyone decided that the South would behave like the North and the Italians would start spending as Germans. That did not happen" (Tomov, 2019). The risk of abuses in particularly large sizes is expected to increase, following the removal of the currency board.

In view of the above, the following conclusions can be made:

No huge leaps in inflation are expected. However, some commodities will become more expensive due to optimal price rounding by the sellers. At first, the prices will rise, but the situation will gradually return to normal. The rising dynamics in

prices, inflation and business will bring the economy of Bulgaria closer to that of Europe.

Unfortunately, financial concussions, similar to those in Greece, can occur. It is important to note that the problem is not the change of currency but the loosened control, corruption and financial abuses in particularly large sizes which often accompany such currency change.

Conclusion

Entry into the euro zone may be advantageous for the Bulgarian economy. Expected positive effects are: reduction of bank fees and interests as well as an ease of the foreign trade with the euro zone economies. As a negative effect should be mentioned the increased opportunities for financial abuse by Bulgarian politicians. It is reasonable to expect some increase in inflation, but it is likely to be moderate and temporary. The worst course, which at this stage seems unlikely, is to reach a crisis requiring reverse introduction of the BGN. Failure, success, or both – the future will show.

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NON-FINANCIAL REPORTING IN THE EXTRACTIVE INDUSTRY - REGULATIONS AND APPLICATION

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ABSTRACT. The extractive industry constitutes about 5% of Bulgaria's GDP, and the gross value added per person employed for 2016 is 47.19 thousand BGN, which assigns it a significant position in the business statistics of this country. At the same time the environmental and social matters occupy a central place in assessing the activities of enterprises in this industry. The aim of this publication is to substantiate the need to introduce uniform practices in disclosing non-financial information on the part of enterprises in the extractive industry and the ways in which the management of these enterprises communicates that information to stakeholders. The article reviews the financial statements of the ten largest companies in the industry according to the amount of realised revenue for 2017. It was found that despite the importance of the issues of environmental and social nature, the enterprises in this industry are not obliged to prepare a non-financial declaration (statement) within the meaning of the Accountancy Act, and the information disclosed by them in management reports is primarily descriptive in nature. As a result of this a proposition is put forward that, with regard to the enterprises in this industry, a requirement for the preparation of a non-financial declaration should be introduced, whereby the main part of the disclosed non-financial information is to be "structured" and appropriately linked to the financial indicators of the enterprise as part of a single integrated management report.

Keywords: non-financial reporting, extractive industry, non-financial declaration (statement), regulation

НЕФИНАНСОВО ОТЧИТАНЕ В ДОБИВНАТА ИНДУСТРИЯ – РЕГУЛАЦИИ И ПРИЛОЖЕНИЕ

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РЕЗЮМЕ. Добивната промишленост формира около 5% от БВП на България, а брунтната добавена стойност на един зает за 2016 г. е 47,19 хил. лв., което й отрежда значимо място в бизнес статистиката на страната ни. В същото време екологичните и социалните въпроси заемат централно място при оценката на дейността на предприятията от този отрасъл. Целта на тази публикация е да се обоснове необходимостта от въвеждане на единни практики при оповестяване на нефинансова информация от предприятията в добивната индустрия и начините, по които ръководствата на предприятията комуникират тази информация със заинтересованите страни. В тази публикация сме изследвали финансовите отчети на десетте най-големи компании в отрасъла според размера на реализираните приходи за 2017 г. Установихме, че въпреки важността на въпросите от екологичен и социален характер, предприятията от този отрасъл не са задължени да изготвят нефинансова декларация по смисъла на Закона за счетоводството, а оповестената от тях информация в докладите за дейността има основно описателен характер. В резултат на това се застъпва тезата, че за предприятията от този отрасъл следва да се въведе задължение за изготвяне на нефинансова декларация, като основната част от оповестената нефинансова информация следва да бъде „структурирана“ и подходящо обвързана с финансовите показатели на предприятието като част от единен интегриран отчет за дейността.

Ключови думи: нефинансово отчитане, добивна индустрия, нефинансова декларация, регулиране

Introduction

The reporting of corporate social, ecological and economic information has widened its scope in the last decade. Through the very reporting of specific non-financial information to all stakeholders, enterprises respond to the expectations for greater transparency with regard to the way in which they impact the value of the business, the development strategy adopted by them, the operations and the long-term outlook on the environment, the social sphere, the management, the overall business model of the enterprise, as well as other non-financial factors. In this context non-financial reporting aims at bridging the gap between the financial indicators of the activity and potential stakeholders' assessments of the value of the business, by providing the much needed additional internal view on performance, the prospects for development and the creation of value by each and every enterprise. The need to

introduce non-financial reporting was noted also by the EU, which in 2014 by means of Directive 2014/95/EU introduced the requirement for compulsory disclosure of specific non-financial information by undertakings, and determined the environmental and social matters for the main areas of reporting.

The indicated environmental and social matters hold a central place in assessing the activities of the enterprises of the extractive industry, which - according to NSI (National Statistical Institute) data for 2016 - accounts for about 5% of Bulgaria's GDP (Gross Domestic Product), whereas the gross value added (GVA) per person employed is 47.19 thousand BGN, (NSI, 2019) which assigns it a significant position in the business statistics of the country. Moreover, as Velev notes, the data on the consumption of mineral resources make it possible to conclude that a sudden change in the attitude towards the utilisation of these resources is necessary. (Velev, 2018). At the same time these undertakings remain outside the

scope of mandatory reporting, within the meaning of the Directive, which, we believe, ought to be refined. The above circumstances determined that, within the range of the study the ten largest enterprises in the industry should be included, classified according to the amount of their revenue in 2017. The aim of the present work is to justify the need to introduce uniform practices in disclosing non-financial information on the part of enterprises in the extractive industry, and the ways in which the management of the enterprises communicates this information to interested parties.

Materials and methods

In the course of the study the publications of leading researchers and international organisations which have to do with non-financial reporting have been used, such as: the International Integrated Reporting Council (IIRC), the Global Reporting Initiative (GRI), etc., as well as legislative acts that have a bearing on these issues. In the study the existing normative framework, set by Directive 2014/95/EU and the Accountancy Act (AA) has also been examined in respect of the enterprises which are to prepare a non-financial declaration (statement).

As regards the application of non-financial reporting by the surveyed enterprises in sector Extractive Industry, publicly accessible information has been researched, disclosed in the financial statements and performance reports of the ten largest enterprises, according to the amount of their revenue, as well as information from their corporate sites and other public sources, pertinent to non-financial reporting.

Analysis of existing regulations

The disclosure of non-financial information can be divided into two main varieties: voluntary and mandatory disclosure. It is precisely the significance of the matters concerning non-financial reporting that proves to be the moving force in the legislative regulation within the European Union regarding mandatory disclosure. EU legislation requires of large companies to disclose specific information on the way they operate and manage social and environmental challenges. In 2014 the European Parliament and the Council of the European Union adopted Directive 2014/95/EU regarding the disclosure of non-financial and diversity information on the part of certain large undertakings and groups, with which the EU effectively admitted the importance of the disclosure of information connected with sustainability, such as social and environmental factors, on the part of the undertakings, in order to assess the risks to sustainability and build the confidence of investors and consumers. The rules underlying the EU Directive with regard to non-financial reporting do not give rise to obligation for application by all undertakings, rather they are of compulsory nature only to large companies which are public-interest entities with more than 500 employees. This, according to EU's own estimates, includes around 6000 large companies and groups across the EU, including public companies, banks, insurance companies, other companies designated by national authorities as public-interest entities, etc.

Directive 2014/95/EU requires that companies publish annual reports on the policies they implement in a few key areas:

- ✓ environmental protection;
- ✓ social responsibility and treatment of employees;
- ✓ respect for human rights;
- ✓ anti-corruption practices;
- ✓ diversity in the boards of companies (as regards age, gender, education and professional experience).

Of certain interest is the fact that Directive 2014/95/EU does not prescribe a mandatory format of disclosures, rather it provides undertakings with considerable flexibility in disclosing the respective information in a manner they consider most useful. Individual undertakings may refer to international, European or national guidelines and frameworks of disclosure in order to present the relevant information identified by them, such as: the UN Global Compact, the OECD Guidelines for Multinational Enterprises, ISO 26000, the International Integrated Reporting Framework, the Global Reporting Initiative, the Sustainability Accounting Standards Board, etc.

The implementation of the Directive has been transposed also in our national legislation with the introduction of the requirement for the composition of a non-financial declaration by a certain group of enterprises. In Art. 41 of the Accountancy Act (3C4, 2019) (TN: AA, 2019) the class of the liable persons is specified, who are to include in their management report a non-financial declaration as well. It is accepted that the enterprise has fulfilled the requirements of the law, if the management report includes information and analysis, which, in terms of content, cover the substance of the non-financial declaration, or if a separate report has been prepared about the information required for the non-financial declaration, provided that this report:

- a) is published along with the management report;
- b) is publicly available until 30th of June the following year, on the Internet page of the enterprise, and this circumstance has been indicated in the management report.

In broadest terms the non-financial declaration should include the following information, as specified in Art. 48, Para 2 of the Accountancy Act:

1. a brief description of the business model of the enterprise - goal, strategy, organisational structure, infrastructure, products, policies pursued in relation to the primary and ancillary activities of the enterprise and others;
2. a description of the policies adopted and followed by the enterprise in respect of the environmental and social issues, including the activities performed during the reporting period and the results thereof;
3. the objectives, risks and tasks that lie ahead in terms of environmental and social policies, including a description of activities that would have an adverse impact on ecology, employees or other social issues;
4. a description of the key indicators of the results of the activities related to environmental and social issues.

As regards the liable persons who are to prepare a non-financial declaration, the Accountancy Act stipulates that those would be public interest enterprises, specified in the Act, which are large enterprises within the meaning of the same Act and the number of employees in them exceeds 500.

The introduced requirements for disclosing relevant information on the abovementioned issues pose certain challenges not only to corporate managers, but also to the

drawers of financial statements, since the indicated areas of disclosure require interdisciplinary knowledge in various areas, as well as familiarity with the overall business strategy of the enterprise. This, on the one hand, will allow the drawers of statements and reports on the activity to implement adequately the non-financial information with the disclosed financial data, but, on the other hand, it also poses the question of the preparedness of the management as well as the financial and accounting experts to provide the appropriate non-financial information.

The existing normative regulation does, on the one hand, lay the foundations of the mandatory disclosure of non-financial information, but on the other it confronts the enterprises and the users of such information with certain challenges, which are connected with a great number of unclear points in respect of the applicable framework for disclosing the information, the lack of specificity with regard to the form of disclosure, the exclusion of entire industries in which the matters of social and environmental nature are quite essential, etc. These facts impose the view that the current requirement for drawing up a non-financial declaration is a sort of a solution in the field of non-financial reporting, but it is only partial. We believe it is important that all aspects of the activities of the enterprise should be logically linked in a report, which would articulate the entire model of creating value, the assessment of the risks and the prospects for development of the business. The fact that the present format of the non-financial declaration does not prescribe specification and does not entail a requirement for structured presentation of the information, provides the chance for formal fulfilment of the requirements of the European Directive. Furthermore, the requirements for disclosing more information on the business as a whole entail a more comprehensive knowledge of the business itself, and the environment in which it operates, on the part of the teams engaged in the drawing up of the financial statements, part of which is the non-financial declaration, as well as greater involvement on behalf of the management of the enterprises in meeting the requirements laid down in the European Directive.

The need for non-financial reporting

The increased needs of stakeholders in the area of non-financial information has led to developments in the search for ways of reporting various types of non-financial information, and in this regard a multitude of frameworks, classifications, instructions and indicators have been developed connected with non-financial reporting, which quite frequently either overlap, or do not contain the necessary specificity. The sort of "invasion" of non-financial reporting, which is observed after 2010, can be attributed to the fact that, in many cases, the traditional financial indicators "tell" only part of the value of the company, without being able to provide an explanation of the ways in which the enterprise creates value.

The disclosure (mandatory and voluntary) of corporate information (financial and non-financial) is an important tool, which the management can use in order to announce the results of the activities and the management of the enterprise

to stakeholders. From this point of view, the information satisfies the needs of a wide range of users and its disclosure could be regarded as part of the entire management strategy for reaching a greater number of interested parties, who – based on the disclosed information – can obtain an adequate estimation of both the financial aspects of the activities of the enterprise, and of the non-financial factors, which are of importance in the decision-making process on their part.

The abovementioned proposition is also upheld by Beyer et al., according to whom corporate disclosure has a dual dimension. The first role refers to the possibility to disclose information, which would allow investors and providers of capital to assess the potential return on investment. Disclosure allows us to define the system of corporate governance and track the use of capital resources (Beyer et al., 2010). Ultimately, corporate disclosure is used by the management as a mechanism to deal with market imperfections, thus lessening the information asymmetry between managers and investors. Corporate disclosure, however, also has to do with the inner need of a company to reveal correctly the information on its performance on the market, thus lowering the uncertainty for investors and as a result – the cost of capital (Lambert & Verrecchia, 2015).

At the same time, in one of their research works Root and Grumman arrive at the conclusion that "the reputation of the company can only be improved if the disclosure of information is reliable"(Root & Grumman, 1998).

It can be said that at the basis of present-day non-financial reporting there are various initiatives with regard to sustainability reporting. Brown et al. point out that, globally, there are more than 30 international frameworks for sustainability non-financial reporting (Brown, 2009). Given the variety of frameworks for reporting and disclosure pertaining to non-financial information, enterprises very often face difficulties in determining which one of them to use in order to report the specifics of their activities. These frameworks differ in their purpose and some authors try to categorise them according to their characteristics and to assess them based on the dimension on which they are focused. This fact is at the root of the defended proposition that the disclosure of non-financial information should not be overdone, as this may lead to the so-called "information overload" referred to by Eppler and Mengis (2004).

The presented arguments allow us to believe, that the quality of disclosure is a decisive factor for bridging the information gap between companies and stakeholders, who are interested in quantitative-qualitative data. High quality disclosure reduces the information lapses of this kind and perfectly meets the requirements of stakeholders, both with regard to mandatory documents, such as those of economic and financial nature, and in terms of voluntary documents like, for instance, sustainability reports, social responsibility reports, etc.

According to a survey conducted by ACCA (2013), 92% of investors share the view that the financial and the non-financial information must be integrated, which, in their opinion, is turning into a new business trend, since most of the non-financial information can be disclosed along with the financial statements.

Non-financial reporting in the extractive industry – the results

According to data provided by the NSI and the Bulgarian Chamber of Mining and Geology, the extractive industry constitutes about 5% of the country's GDP, it has recorded labour productivity that is 2.5 times higher than the average figure for the industrial sector, provides direct employment to approximately 30,000 people and to a further 120,000 individuals in related activities, the export of production to third countries amounts to 5.5 bln BGN, and the gross value added (GVA) per person employed is 47 thousand BGN (NSI, 2019)(BCMG, 2019). These economic indicators assign the industry a significant position in the national business statistics, turning it into a structurally defining industry for the economy and one of the drivers of economic development.

One peculiar aspect of the industry is that it relies on development by means of efficient, comprehensive and long-term utilisation of ores and minerals in compliance with the requirements for sustainable development, encompassing the three main aspects: economic, environmental - green mining industry, social - corporate social responsibility. This commitment has been declared by members of the BCMG, which in 2012 introduced the Standard for Sustainable Development of BCMG, drawn up with the help of consultants in the field of sustainable development and in collaboration with representatives of the industry, academia and non-governmental organisations. It is the property of BCMG and is provided for voluntary use to all companies from the mineral and raw materials industry in Bulgaria. The Standard is based on several major international documents, among which: a) the principles of the United Nations Global Compact; b) the standards of the International Organisation for Standardisation (ISO); c) the guide on sustainable development reporting by the Global Reporting Initiative (GRI) and the appendix to it on the mining industry; d) the guiding principles of the European Association of Mining Industries, Metal Ores & Industrial Minerals (EUROMINES) for sustainable development; e) the framework for sustainable development of the International Council on Mining and Metals (ICMM); f) the requirements of the Extractive Industries Transparency Initiative (EITI) (BCMG,

2019). An interesting fact is that the Standard was introduced in 2012, which is two years before the adoption of Directive 2014/95/EU and shows that the companies from this industry are prepared to walk along the path of voluntary non-financial reporting and even go beyond the requirements of the national and the European legislation in this area.

The present study encompasses the ten largest enterprises according to the amount of their revenue in 2017 (Table 1)

Table 1. Rankings of enterprises by revenue amount for 2017

Position	Company	Revenue (thousand BGN)	
		2016	2017
1	MINI MARITZA-IZTOK	544,547	586,410
2	ELATZITE MED	452,510	548,046
3	ASAREL-MEDET	373,087	417,303
4	DUNDEE PRECIOUS METALS	332,400	400,910
5	KAOLIN	154,006	159,089
6	VARBA ELATSITE	46,119	57,857
7	LYKI INVEST	32,628	39,732
8	GORUBSO MADAN	36,690	37,806
9	RODOPI EKO PROJECTS	29,194	37,632
10	MINI OTKRIT VAGLEDOBIV	28,163	32,774

Source: TN: Kapital 100, www.capital.bg

In the present study publicly available information has been examined, which was disclosed in the financial statements and reports on the activities of the specified enterprises, as well as information from their corporate sites and other generally accessible sources, that is relevant to non-financial reporting. The results have been summarised and presented in Table 2. The order of the enterprises in the latter does not match that of the positions in Table 1.

Table 2. Non-financial information disclosed by the companies for the years 2017-2018

Enterprises	Mandatory issuance of NFD	Other Sources of the NFI	Information disclosed	Used Non-financial KPI	Used disclosure framework
Enterprise 1	No obligation	Management report, Company web site, other materials	HR, social, ecological, environmental	Not specified	Not specified
Enterprise 2	No obligation	Management report, Company web site, other materials	HR, social, ecological, environmental	Not specified	Not specified
Enterprise 3	No obligation	Management report, Company web site, other materials	human capital, social, ecological	Number of trainings & qualification of the staff	Not specified

Enterprise 4	No obligation	Sustainability report, Management report, Company web site	business model, Organizational effectiveness and accountability, social, ecological	GRI indicators	GRI, UN SDGs
Enterprise 5	No obligation	Management report, Company web site, other materials	HR, social, ecological, environmental	Not specified	Not specified
Enterprise 6	No obligation	Management report, Company web site	sustainability, environmental, HR, social	Not specified	Not specified
Enterprise 7	No obligation	Company web site	sustainability, environmental, HR, social	Not specified	ICMM
Enterprise 8	No obligation	Management report, other materials	sustainability, environmental, HR, social	Not specified	Not specified
Enterprise 9	No obligation	Company web site	ecological	Not specified	Not specified
Enterprise 10	No obligation	No	No	No	No

Source: Own calculation based on company management report, annual financial statement, web sites, etc.

As a result of the conducted study the following generalisations and conclusions can be made:

✓ For the enterprises from the extractive industry under study there is no obligation for making up a non-financial statement, since they do not meet the set of criteria, specified in the Accountancy Act. The main reason is that they do not fall within the range of public interest enterprises, something, we believe, ought to be refined by legislators, having in mind the importance of this industry for the national economy and the social environment in this country;

✓ Although they are under no obligation to prepare an NFD, 9 out of 10 of these enterprises disclose certain non-financial information through various channels, the principal ones being the management report and the company website. One of the enterprises did not disclose any relevant NFI, and another one of the enterprises under study announces such information only by means of its website;

✓ The prime information that is disclosed is connected with their performance in the area of human resources, social and ecological activities. It should be pointed out that only one of the enterprises presented information about its business model, and one enterprise presented no relevant information at all;

✓ One major conclusion of the conducted study is that there is no specific information on individual measures characterising the non-financial reporting in the enterprises under study. Only one of the enterprises in the study pointed out specific indicators in respect of NFI, using GRI reporting indicators. Another enterprise reported particular information regarding the conducted training and

qualification courses for its staff and the specific costs incurred during their realisation;

✓ Despite the fact that 9 out of 10 of the enterprises disclose a certain set of non-financial information, there is no uniform framework for disclosure which enterprises could use. Even though almost all of them are ISO certified, not a single one provides information on the model measures under ISO 26000:2010. Only one of the enterprises uses two of the well-known frameworks for reporting NFI, namely the GRI and UN SDGs;

Potential for improvement

The issues of non-financial reporting have already been included also in the agenda of the IASB, which, being the principal regulator of financial reporting, has realised that it must adapt to the changing world of corporate reporting by raising the efficiency of communication of financial statements, facilitating the electronic consumption of financial data and promoting integrated reporting.

In solving these issues we think that all regulatory bodies (national, international, governmental, non-governmental, etc.) ought to provide an answer to an essential question, namely: should the tendency toward separate reporting outside the annual report of the enterprise be encouraged, while using the appropriate guarantees in order to reduce to a minimum the risk of undermining the usefulness of the annual report to investors, and are the advantages of a uniform, comprehensive and reliable means of corporate communication with a wide circle of stakeholders more important?

That is why, we propound the thesis that the mix of financial and non-financial reporting, or financial and non-financial information, respectively, which would be disclosed by

a company, can be an excellent example of a symbiosis, when it pursues the same goals and is built and logically linked with the ways in which the enterprise creates value, both for the individual "capital providers", and for society as a whole. The realisation of this symbiosis passes through the creation of adequate integrated statements, which would link together, in one place, the financial and non-financial information. The requirement for publishing an NFD is a step in the right direction, but the circle of enterprises and industries, which are obliged to prepare one, should be widened.

The enterprises from the extractive industry could only benefit from the introduction of such a requirement, since their activities will be more transparent for potential stakeholders, both in terms of attracting, retaining and maintaining a satisfied workforce, and also in terms of managing the risks, improving the efficiency and the management of processes, enhancing the image of the business, etc. A similar view has Minev, who believes that the range of enterprises required for preparing the NED should include medium-sized enterprises of the mining and timber industry from primary forests (Filipova et al., 2017).

The availability of logically linked non-financial information leads to higher awareness on the part of investors, which makes the risk assessment they conduct more accurate and may help raise the efficiency of investment decisions. In this regard it is necessary to introduce requirements with respect to the disclosed non-financial information. That is why, we believe that the information currently disclosed through various channels of communication confuses the users, therefore it ought to be channelled and reduced for the most part to structured information, which must be linked directly with specific financial indicators for the relevant activity.

Conclusion

We share the view that, despite the increased demand for non-financial information, the benefits connected with its disclosure seem to some stakeholders long-term and difficult to accurately recalculate in quantitative units, whereas short-term expenses are both visible and easily measurable. Some enterprises - although in principle they recognise the benefits of non-financial reporting - are not inclined to actively pursue policies in this area, precisely because of that view.

The results of the conducted study show that the companies in the extractive industry in Bulgaria disclose only limited non-financial information mainly on social and environmental matters and do this voluntarily, since for them there is no statutory duty on that. The introduction of the Standard for Sustainable Development of the BCMG leads to the implementation of some of the best international practices, which, however, are used rather sparingly.

The serious interest in the area of study of the causes for the creation of corporate value and the possibilities for the future development of companies give us confidence that financial statements will remain a prime cornerstone for investors in their assessment of a particular company and precisely the existence of logical links between the disclosed financial and non-financial information is of great importance for their successful development.

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THE PRODUCTION FUNCTION OF A MINING ENTERPRISE AS AN ANALYTICAL TOOL FOR THE PRODUCTION OPTIMISATION

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ABSTRACT. The paper presents the production optimisation by applying the two-factor Cobb–Douglas production function. The function is derived from a database of a functioning mining enterprise in the country and the isoquant map is analysed. The obtained ex-post production function shows the replacement capabilities of the enterprise and it is a tool for analysing, planning and forecasting the business.

Keywords: Cobb–Douglas production function, mining enterprise, isoquants.

ПРОИЗВОДСТВЕНАТА ФУНКЦИЯ НА МИННО ПРЕДПРИЯТИЕ КАТО АНАЛИТИЧЕН ИНСТРУМЕНТ ЗА ОПТИМИЗАЦИЯ НА ПРОИЗВОДСТВОТО

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РЕЗЮМЕ. Статията разглежда оптимизацията на производството чрез прилагане на двуфакторната производствена функция на Коб-Дъглас. Функцията е изведена на база данни от действащо минно предприятие в страната и е анализирана картата на изоквантите. Получената производствена функция ex_post показва заместващите възможности на фирмата и е инструмент за анализ, планиране и прогнозиране на дейността.

Ключови думи: производствена функция на Коб-Дъглас, минно предприятие, изокванти.

Introduction

The production model in the most synthesised form can be presented as a system that processes different types of resources into finished products. The dependence between the volume of finished products and the costs for the different types of resources needed for this production is called a production function.

Modern growth models and theories have different hypotheses about production functions (Walters, 1963). The difference between the ex-ante production function and the ex-post production function is important. The first collects a full set of replacement capabilities for the enterprise when choosing the mode of production, and the second shows the available options with already selected mode of production.

Another significant difference is the object of the production function - an individual enterprise or a separate sector.

The paper examines the ex-post production function for a mining enterprise in Bulgaria.

Production function

The resources for production may be: labour costs; energy costs; concentrate costs, transport costs, etc. The most popular two-factor production function is the Cobb-Douglas function with costs of the materials and labour costs, which was published in an article by the American scientists Charles

Cobb and Paul Douglas in a study of the American economy in 1928 (Cobb, Douglas, 1928). Volume production F is dependent:

$$F(K, L) = A \cdot K^{\alpha} \cdot L^{\beta}, \quad (1)$$

on the condition:

$$\alpha + \beta = 1, \quad (2)$$

where:

A – production coefficient;

K – costs of basic capital investments;

L – labour costs;

α – elasticity coefficient of the costs of capital investments;

β – elasticity coefficient of labour costs.

One production function is neoclassical if it meets the following requirements:

1. There is a positive effect of an increase in production factors – each production factor contributes to the production and the increase in the quantities used from this factor leads to higher production.
2. The law of diminishing returns is in force - the increase of each resource leads to an increase in production, but with an increase in the quantity of the resource at fixed volumes of the other resources, the effect is a decrease in the rate of increase relative to it.

3. There are constant returns in terms of scale – if the inputs are increased λ times, the production will also increase so many times, as the production function is positively linear homogeneous of first degree:

$$F(\lambda . x_1, \dots \lambda . x_n) = \lambda . F(x_1, \dots, x_n), \quad \forall \lambda > 0 . \quad (3)$$

4. The conditions of Inada are met – if the i -th production factor is insufficient, it becomes very valuable and its marginal product becomes very large /i.e. a small increase in the quantity used leads to a large increase in production/; if the production factor is already used in large quantities, the use of a little more of it almost does not change the production:

$$\lim_{x_i \rightarrow 0} F_{x_i} = +\infty; \quad \lim_{x_i \rightarrow +\infty} F_{x_i} = 0. \quad (4)$$

Isoquants are curves of production indifference and identify all effective combinations of two production factors that produce the same quantity of output (Fig. 1).

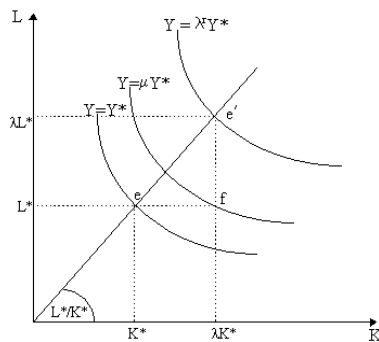


Fig. 1. Isoquants of production function

Main features of the production function are:

- average capital and labour productivity:

$$A_1 = A . K^{\alpha-1} . L^{\beta}; \quad A_2 = A . K^{\alpha} . L^{\beta-1} . \quad (5)$$

- marginal capital and labour productivity:

$$M_1 = A . \alpha . K^{\alpha-1} . L^{\beta}; \quad M_2 = A . \beta . K^{\alpha} . L^{\beta-1} . \quad (6)$$

- partial elasticities and total elasticity:

$$E_1 = \alpha; \quad E_2 = \beta; \quad E = \alpha + \beta . \quad (7)$$

- technological replacement rate:

$$R_{12} = (\alpha . L) / (\beta . K) . \quad (8)$$

The Cobb Douglas production function does not take into account technical progress as a factor of economic growth along with labour and capital costs. This was later done in Robert Solow's neoclassical economic growth model with a modified Cobb-Douglas production function.

The output of a production function by data is the basis for further analytical calculations; an assessment of the effectiveness and expediency of using additional resources in production; forecasting the volume of output produced at

different amounts of resources; management decisions about the forthcoming development of the object of research.

Methodology of calculating production function

The study conducted on the production function of a mining enterprise includes the following stages:

- selection and justification of function indicators;
- determination of primary data for the study;
- defining methods for approximation of the function;
- selecting a programme environment for output function;
- verifying the adequacy of the model and the quality of the obtained function (coefficient of determination, correlation coefficient, Durbin-Watson criterion, Fisher's, Student's);
- conducting the computational experiments;
- logical and mathematical analysis of the qualities of the obtained function.

The nonlinear multiple regression method was selected in PTC Mathcad and applied to the Cobb-Douglas function with defined coefficients. In the general case, the coefficients a_0, a_1, \dots, a_k are calculated by the condition for a minimum of the function through the method of least squares:

$$F(a_0, a_1, \dots, a_k) = \sum_{i=1}^n (y_i - \hat{y}_i)^2, \quad (9)$$

where:

$\hat{y}_i = S(a, x_{i,1}, x_{i,2}, \dots, x_{i,k}), i = 1, \dots, n$ are the values of the empirical dependencies at set values of the independent variables.

To minimise this function, the built-in Minimise function in PTC Mathcad is selected (Maxfield, 2014). The programme's solve block capabilities are used to set constraints of the coefficients searched a_0, a_1, \dots, a_k with Boolean operators and solving the problem of conditional minimizing of the function.

Production Function of Varba-Batantsi AD

Varba-Batantsi AD has been operating since 2011 with main subject of activity - mining and processing of lead-zinc ores and production of lead-zinc concentrates. In 2012 the mining enterprise acquired the shares of Gorubso Madan AD (Sabev, Yordanov, 2014). The concession contracts for mining of lead-zinc ore from the Krushev dol and the Petrovitsa deposits belong to Gorubso Madan AD, and Varba-Batantsi AD has a concession contract for mining from the Varba-Batantsi deposit.

Using data from the consolidated annual financial statements of Varba-Batantsi AD for capital [thousand BGN], labour [number of workers] and production volume [thousand BGN] for six years from 2013 to 2018 according to the methodology a two-factor production function in the PTC Mathcad programming environment is derived (Fig. 2).

The function F is minimised in a solve block of the programme by introducing the additional condition with Boolean operators and the calculated coefficients result a_0, a_1, a_2 is derived in a vector form.

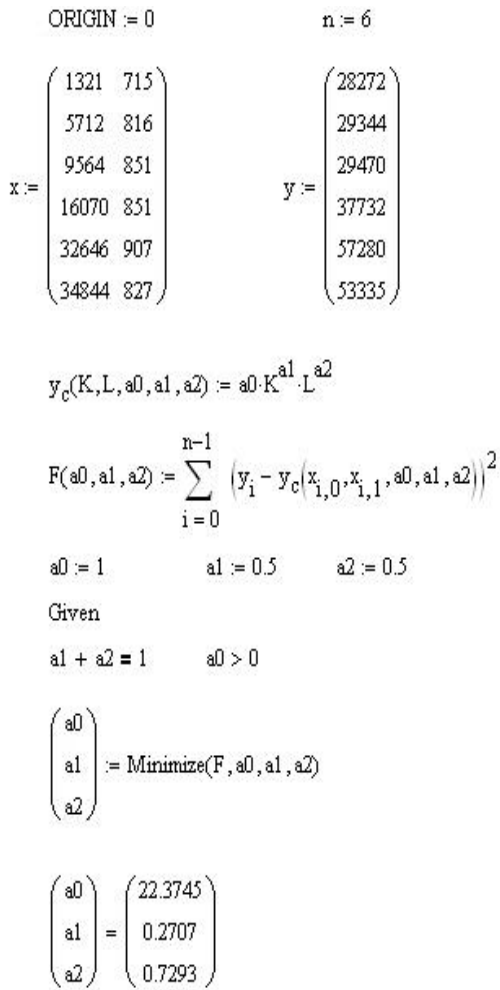


Fig. 2. Worksheet for calculating the production function in PTC Mathcad programming environment

The matrix of the production function for the calculated coefficients and its isoquant map are shown in Figures 3 and 4.

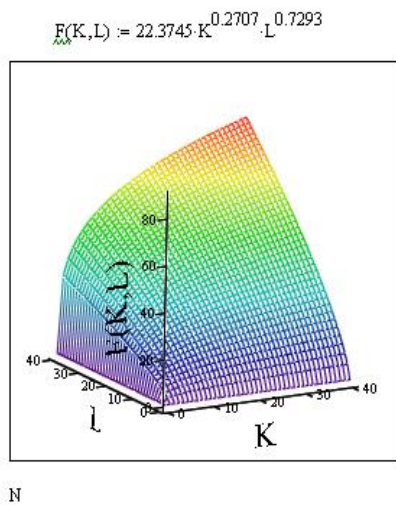


Fig. 3. Production function

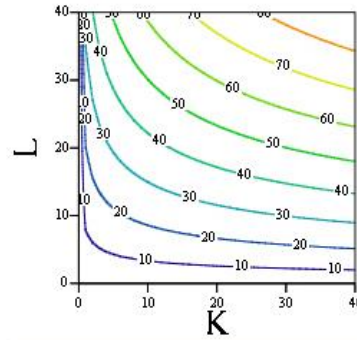


Fig. 4. Isoquants map

The main features of production function of the mining enterprise for the studied period with formulas from 5 to 8 are derived in Table 1.

Table 1. Main features of the production function

t	A ₁	A ₂	M ₁	M ₂	E ₁	E ₂	E	R ₁₂
2013	14.2996	26.4193	3.8709	19.2676	0.2707	0.7293	1	0.2009
2014	5.4128	37.8897	1.4652	27.6330	0.2707	0.7293	1	0.0530
2015	3.8324	43.0706	1.0374	31.4114	0.2707	0.7293	1	0.0330
2016	2.6248	49.5667	0.7105	36.1490	0.2707	0.7293	1	0.0197
2017	1.6398	59.0232	0.4439	43.0456	0.2707	0.7293	1	0.0103
2018	1.4619	61.5940	0.3957	44.9205	0.2707	0.7293	1	0.0088

The analysis of the main features of the production function in a mining enterprise shows that, over time, capital productivity and technology replacement rate are decreasing and labour productivity is increasing. The values of elasticities are constants equal to the corresponding parameters of the production function.

Conclusions

The parameters of the Cobb-Douglas ex-post production function were evaluated using data for a six-year period from a functioning mining enterprise in Bulgaria.

On the basis of the outputs can be solved optimisation problems with budget constraints, maximising profits or maximising the total income between mines, and analysing management decisions.

The obtained production function is an analytical tool for optimal scenarios related to the future effective activity and investment policy of the mining enterprise.

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SOCIO-ECONOMIC AND REGIONAL DIFFERENCES IN THE LABOUR MARKET IN BULGARIA AND THE EUROPEAN UNION

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ABSTRACT. The presentation of socio-economic differences in the labour market in the Member States of the European Union will make it possible to highlight the regional imbalances in the labour market in the individual administrative-territorial units. In this way, the current trends in improving the skills of the working population in the underdeveloped regions of the European Union will be outlined as well as the specific reasons leading to the increase of the migration flows to the more developed regions of the European Union. On the other hand, identifying labour market disparities will give us an answer to the socio-economic profile of individual municipalities and settlements and will outline the prospects for the development of the clustering process between regions with clear comparative advantages for achieving regional economic growth based on the application of innovation in trade and production and the creation of opportunities to increase the competitiveness of the region.

Keywords: labour market, competitiveness, regional development, socio-economic development, clustering

СОЦИАЛНО-ИКОНОМИЧЕСКИ И РЕГИОНАЛНИ РАЗЛИЧИЯ НА ПАЗАРА НА ТРУДА В БЪЛГАРИЯ И ЕВРОПЕЙСКИЯ СЪЮЗ

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РЕЗЮМЕ. Представянето на социално-икономическите различия на пазара на труда в страните членки на Европейския съюз ще даде възможност да се открият регионалните диспропорции на пазара на труда в отделните административно-териториални единици. Като по този начин ще се очертаят съвременните тенденции при усъвършенстване на квалификацията на трудоспособното население в слабо развитите региони на Европейския съюз, както и конкретните причини водещи до увеличаване на миграционните потоци към по-развитите региони на Европейския съюз. От друга страна идентифицирането на различията на пазара на труда ще ни даде отговор за социално-икономическия профил на отделните общини и населени места, както и ще очертае перспективите за развитието на процеса на клъстеризация между отделните региони притежаващи недвусмислени сравнителни предимства за постигането на регионален икономически растеж основан на приложението на иновациите в търговията и производството и създаването на възможности за увеличаване на конкурентоспособността на региона.

Ключови думи: пазар на труда, конкурентоспособност, регионално развитие, социално-икономическо развитие, клъстеризация

Introduction

The labour market must be seen as one of the most regulated and at the same time politically sensitive markets in the economy of every single country, which implies that the main priorities pursued through the implementation of specific employment policies are to reduce unemployment, the process also involves the creation of subsidised employment. But it is undoubtedly one of the main problems in the individual regions of the country that there is long-term unemployment, which is a structural factor on the labour market and therefore its elimination implies the implementation of a reform programme aimed at liberalising the markets and increasing the qualification and mobility of the workforce. It is definitely to be assumed that the creation of high levels of support for the long-term unemployed reduces their incentives to find work, and that an effective policy for the long-term unemployed must be linked to the provision of various forms of retraining, to be accompanied by the provision of additional services to find a job. In addition, a thorough rethinking of the funding system for employment policies should be followed as the level of funding

and the objectively achieved results of individual labour market interventions must be linked, which also implies the rationalisation of new indicators reflecting the relationship between financing and effectiveness in reducing unemployment on a regional level in order to target the resources needed to undertake measures of higher added value, efficiency and performance of the labour market.

Bulgaria has a major problem because, according to the World Bank estimates, by 2050 its population will fall by over 40% and it will about 4.5 million people. These statistics do not take into account Bulgarian citizens who live permanently in the EU and abroad and their children do not bear Bulgarian names and do not have Bulgarian citizenship. There is an unpredictable and beyond the control possibility for a refugee wave to Europe that does not have the necessary territory and conditions to shelter and integrate the incoming people. The factual situation requires an adequate response of the international community and its authorities to prevent escalation, terrorist acts and the prosperity of cannabis. The increasing migratory pressure creates the need to redirect significant financial and organisational resources to address

the situation and to avoid creating direct risks to the emergence of a humanitarian crisis (Ivanov, Naydenov, 2018). Migration is a global problem that will remain in the future. Coping with the increasing migratory flows of people is one of the main problems at the beginning of the 21st century. In many countries there is a serious conflict between the economic and demographic case for expanded labour migration, and public resistance to increased migration. European states have dealt with this problem in different ways. In most cases, governments have been able to introduce liberalising legislation or programmes. Most of these have been for high-skilled and skilled migrants, in the form of points systems, streamlined procedures for recruitment in particular sectors or occupations, or facilitating labour market access for foreign graduates (Naydenov, 2018).

Socio-economic differences in the labour market in Bulgaria

The situation in Bulgaria with regard to the demographic crisis and the coming changes in the economy are partly due to the increased life span, combined with the low birth rate and emigration, which lead to the aging of the age pyramid of the population at the top, as well as the increase of the coefficients of age dependency. The economic sectors involved in the engagement of low-skilled workforce are experiencing the largest contraction in the economic crisis, but we must also note the activities that require highly qualified labour such as financial and business services and information and communication technologies. Undoubtedly, the labour market in Bulgaria still does not respond adequately to the demographic challenge, which is mainly due to the growing discrepancy between the demanded and the offered skills, especially given the development of the demographic situation in the country, it is assumed that its economic development will be proportionate to the commitment of available human resources. It is, of course, a fact that our country has the opportunity to mitigate the challenge of increasing dependency ratios by attracting to the labour market the groups that are not sufficiently used at this time, such as young people (and in particular the Roma) and the older population, that is where the potential reserve of the country is hidden of a labour force that can be involved in the labour market. The Bulgarian labour market is not working well, which has an impact on 68.6% of the "Relatively Low Level of Economic Activity (LFPR), and is second only in the EU at the level of young people who neither study nor work or train (NEET) (*Report of the World Bank*, 2016). It is noteworthy that employers often encounter difficulties in finding candidates with appropriate education and skills, especially in innovative sectors such as IT and high value added industries. As a result of the increase in skills gap, the gap between the unemployment rates of the more highly qualified and the under-qualified, as well as the steadily increasing number of long-term unemployed persons is widening. It is definitely difficult for our country to prepare for the next generations to enter the labour market, as about 40% of 15-year-olds are functionally illiterate in mathematics and reading. The picture we described implies that national and regional policies should aim at raising the skills of the economically active population at the moment, as well as a significant increase in the investment of the growing

population, as appropriate policies in this direction must be related to providing lifelong learning opportunities and developing the skills of marginalised groups.

A positive element in the future development of the labour market by state institutions may be a timely early investment in skills as this investment will have the highest returns. Given the demographic profile of the country, the access to pre-school and early childhood education programs for children from vulnerable groups and disadvantaged communities needs to be broadened and the process should be accompanied by adaptation of the curriculum and teaching methods to overcome gaps in the skills of disadvantaged communities, and targeting students in profiled, general and vocational schools. On one hand, at this stage of the socio-economic development of the country, it is vitally necessary to increase the quality of the basic education of all students and the development of the vocational/dual training system. On the other hand, the participation of the population in labour market programmes needs to be strengthened, and this must be improved and maintained in close contact with employers.

The development of a culture of lifelong learning and education in the economically active population in the country can help in bringing Bulgaria closer to other EU member states. The continuing contraction of the working-age population, coupled with the rapid aging of the population, leads to an increase in the age-dependency ratio. Bulgaria needs to adapt to the changing demographic situation by looking for opportunities to preserve its long-term economic prospects, which is directly dependent on how its labour resources are used. In the long run, a major impediment to employment and the growth of the country's economy is the continuing aging, rising emigration rates and inactivity in the economically active population. As a natural result of the outlined trends, it should be noted that in the future, it is necessary to predict an increase in the cost of health, long-term care and pensions, with anticipated fiscal problems in the coming decades. According to World Bank reports, given the shrinking labour force in the country, the GDP growth is expected to be around 0.7% per annum by 2050. We can assume that, in the medium term, economic and social development will be determined by how human resources are deployed at regional and national level. The economic crisis has revealed the weaknesses of the labour market in Bulgaria, especially looking at the data for 2013, where our country with a labour market participation rate of 68.6% is below the European Union average during the period, where the average is 72.1%.

In the country, young and under-educated workers are more vulnerable to rising unemployment during the crisis, which is complemented by data on the preservation of low rates of economic activity among young people, which, on one hand, is the result of national culture for full-time education for this age group. Regional increase in poverty and inequality is seen at regional level in view of the problems of the labour market in the different municipalities in the country. In the small municipalities in the country, inactivity and unemployment are disproportionately highly concentrated in the households that receive the lowest income, which is why the unemployment rate in small municipalities is often observed to be around 25%. But even those who have a job usually work part-time and take low-paid jobs performing low-skilled jobs. Here again, the extent to which the average wage in all sectors shows

objectively the situation among the poorest and the most vulnerable segments of the population is debatable. On one hand, low wages are more widespread and are often close to the minimum wage for the country, while the higher remunerations amount to several tens of thousands of leva, as a result of which the objective picture of the remuneration changes in the country. For example, an average wage in the economic activity "Finance and Insurance" in 2017 is about 1800 BGN, but about 90% of the employees in this economic activity receive an average of about 900 BGN, while the remaining about 10% of the employees receive remuneration several times higher than the average salary of 1800 BGN. With this example, it is logical to ask whether the use of the average wage by economic activity in the country is reliable and provides correct information about the imbalance in the remuneration from the labour activity in the individual administrative-territorial units in the country. In recent years, highly skilled labour sectors such as information and communication technologies, financial services and real estate, and business services have been intensively developing, but there are indications that unemployment among the low-skilled is rather structural than cyclical, since the average length of the out-of-work period in recent years is increasing. Therefore, the potential for addressing the demographic problem can be highlighted by increasing the economic activity rate of young people, the Roma population and the elderly, as it should not be overlooked that young and often low-skilled Roma will become a significant source for labour market participants as the Roma population provides 9 to 19% of the new workers in the individual regions (de Laat, Bodewig, 2011), and given the rising population of Roma origin, we can expect an increase in the importance of integrating the Roma population into the economically active population. Consequently, these data require rethinking policies and creating opportunities to remove the restrictions on Roma participation (wherever they exist) in their implementation on the labour market. Through the successful realisation of the Roma labour market, the pressure of the current demographic situation can be partially mitigated.

The necessity to change the skills of the workers on the labour market in Bulgaria

One of the main labour force problems in Bulgaria is the lack of skills that are being sought on the labour market, which is why employers in the country are extremely concerned about the future development of their companies, especially employers in more innovative sectors, such as the information technology, electronics and facilities, etc. Certainly, employers in Bulgaria have difficulty in finding suitable candidates for the jobs they offer, one of the reasons being the lack of socio-emotional skills. Attention should be paid to the implementation of a reform in the country's education system, as perhaps the early targeting of pupils in different schools has a rather negative effect on pupils' performance. The very early selection of pupils based on their abilities starts from the first and fourth grades and applies to the whole system after grade 7, resulting in more than half of the 15-year-old students in vocational schools being functionally illiterate compared to nearly 1/3 of the secondary schools. And it should not be forgotten that skills are developed throughout life, starting in early childhood and continuing in the formal education system and beyond. Often

the formation of early childhood skills is perceived as fundamental but skills can also be developed at a later stage through targeted education and inclusion in specific educational and social programmes. Naturally, the types of skills continue to develop during the younger age, as in the process of growth, a person is shaped by both education and work experience and the influence of the immediate surroundings. When working on skills analysis by the working population, they must be measured beyond the diploma content. The characteristic of all cognitive and socio-emotional skills, apart from the mental attitude, is that people with lower education have lower standardised results, but by acquiring a bachelor's degree, skills related to work style, training and lifelong learning life, as well as interpersonal relationships can be developed. The acquisition and development of better skills in each field, is often linked to the acquisition of a master's degree or a higher degree by but one must not overlook the fact that during the life cycle of a person, the combination of skills changes for the young, but also for middle-aged and older Bulgarians. There is a tendency for older adults to have a greater fixed mindset than younger groups, but they have better interpersonal skills. It is definitely worth noting that three of the socio-emotional personality traits, namely good faith, goodwill, and emotional stability, improve with age.

Regarding the development of the labour market in Bulgaria, attention should be paid to the educational outcomes of the Roma, which are probably related to their unequal position in society. It should be noted that Roma children face both obstacles related to their ethnic background and the implementation of the process of transmission of low educational outcomes between the generations. This process is the result of lower education of parents who have lower incomes and at the same time the Roma have a worse job realisation, which is why the Roma population may perceive that the economic return from education is low and additionally discourages these groups which show no interest in investing in raising their education. On the other hand, those who have a job have better skills than those who do not, so we can point out that the unemployed and inactive people have worse cognitive skills than those who work. In cognitive and socio-emotional skills between the unemployed and the inactive persons there are no serious differences in any aspect, but for the economic activity education is the most important. For the economic activity of the population, education is the main driver, and neither cognitive nor socio-emotional skills are of great importance as the degree successfully conveys the knowledge and socio-emotional skills which, on the other hand, affect the motivation to search for work. Often child-care responsibilities are an obstacle to the economic activity of women, as there is a correlation between the presence in the household of children up to 5 years of age and of adults over the age of 65 and the lower economic activity of women. Both cognitive and socio-emotional skills and the functional linguistic and mathematical literacy are important for the employment of men, because not only mental capabilities are important for the employability of men in Bulgaria, but also skills such as self-discipline, insistence, decision making and spatial orientation. Typically, working-minded, development-oriented women with very good work and learning skills are more likely to be employed in the private sector, while the typical public sector is the one that attracts women, who have better interpersonal skills. While there is a difference in skills and employment

among women in the different sectors of the national economy, the evaluation of the necessary skills in both the public sector and the government is similar in men. It is not surprising that working women in the public sector have better interpersonal skills than women in the private sector. In addition, the public sector offers many jobs traditionally occupied by women, while the probability that the private sector in Bulgaria attracts and retains working men with higher education than average is one of the main problems in seeking opportunities for increasing productivity in the national economy. Remuneration of both men and women with better cognitive skills is higher even when the level of education is taken into account, so formal education does not seem to fully capture the skills that attract higher incomes in Bulgaria.

With the continued aging of the population, it will be extremely important to attract marginalised Roma to the group of economically active people, as the education and employment of the Roma population will be of prime importance given the fact that it will soon be more and more part of the labour force in the country. In the longer term, it will be crucial for Bulgaria to ensure that the next generation of workers have the skills they need to build their efforts from an early age, so expanding access to early childhood education will be vital to acquire the basic skills that will be useful to them throughout their lives. In order to harness the potential workforce, the education system must pay special attention to young people, and the curriculum and teaching methods must be adapted to overcome skills gaps and at the same time build a lifelong learning habit. As there is no culture of lifelong learning in Bulgaria, it is also essential to increase the qualification and retraining of the working-age population by providing better incentives. The World Development Report 2018 (Education) states that education is one of the strongest tools to reduce poverty and achieve overall social stability. In today's world, the importance of education as a factor for a better life is constantly growing in the face of dynamic economic and social changes, which is why the acquisition of sound fundamental knowledge and skills by children is becoming a guarantee that the future workforce can be improved through the entire working life. The link between the education system and the labour market is becoming increasingly narrow as the educational characteristics of the workforce affect the quality of the labour market and the growing inequalities formed on the basis of various signs reduce the opportunities for effective labour market functioning in each country or region. In the current conditions, dynamic labour market developments should analyse the existing educational imbalances, outlining their depth and outlining opportunities for overcoming the trends of their deepening and reducing them. In this respect, lifelong learning policy issues are essential as they can help to literate, acquire skills and qualifications to make this inequitable group more suited to labour market needs. When improving learning becomes a priority, great progress is possible. Progress like this requires a clear-eyed diagnosis, followed by concerted action, what can be done to fulfil education's promise, that too many young people are not getting the education they need, how change is possible if systems commit to "all for learning," drawing on examples of families, educators, communities, and systems that have made real progress (*Report of the World Bank*, 2018).

Conclusion

Given the steadily declining number of economically active people on the labour market and a significant gap between business needs and the knowledge and skills of the available workforce as well as in terms of employee education, the development of the overall labour market must not be neglected in terms of continuing training and development, flexibility and mobility in the country's population, with the end result being that the skills and qualifications acquired by the workers do not exactly match the job site requirements, which is why Bulgarian industrial companies believe that their economic growth and expansion is threatened by the lack of suitable skilled workers. However, skill shortages are definitely observed in all economic sectors in Bulgaria, especially in the sectors requiring more specialised technical skills, which combined with the inadequacy of qualifications and lower or higher qualifications, necessitates the active market development measures applied of work to focus on creating opportunities for newly created jobs which should target people with higher secondary or higher education at the sustained pace of technological modernisation in economics of the country. Especially considering the forecasts for the working-age population (15-64) by 2022, when it is expected to be 4381.7 thousand, i.e. 182.1 thousand less compared to 2018, which is a real decline of 4.0 %. This contraction process will have a negative impact on the labour market and the estimated employment for 2022 is 3151.2 thousand, the employment rate of the population will be 71.9%, but in the long run the number of the population in the working age (15-64) will decline. In 2032 the expected decrease is 403.4 thousand, which is a drop of 11.6% compared to 2018, and the number of employed in 2032 is expected to be 2965.7 thousand. The labour market convergence process of the EU Member States implies convergence in the socio-economic development of European economies and restructuring of both the private and public sectors. The restructuring process will be the result of changes in the external environment and the development of European markets that affect private sector development, while public sector restructuring will be the result of a targeted education, health and government policy (*Report of the Ministry of Labour and Social Policy*, 2019).

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PROBLEMATIC ASPECTS OF THE PROCESSES OF DECENTRALISATION AND DECONCENTRATION IN LOCAL SELF-GOVERNMENT IN BULGARIA

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ABSTRACT. This article will attempt to outline the problematic aspects of the processes of decentralisation and deconcentration in the field of local self-government in Bulgaria. Decentralisation should definitely be seen as a prolonged, multidimensional and complex process that requires both strong and committed management by the central executive and local authorities and all other key stakeholders. When analysing the stakeholders in the process of decentralisation and deconcentration, account should be taken of the multifaceted and often contradictory interests of each of the parties. The unifying and fundamental challenge in the Bulgarian context is the lack of a clear and widely shared vision of the future development of the regions and settlements in implementing reforms aimed at decentralisation and deconcentration. In identifying the problems in the field of decentralisation and deconcentration in Bulgaria, additional attention should be paid to the analysis of the development of e-Government in order to facilitate the services for the business and the population in the regions of the country, as well as to stimulate their socioeconomic development.

Keywords: local self-government, decentralisation, deconcentration, regional development, e-government

ПРОБЛЕМНИ АСПЕКТИ ПРИ ПРОЦЕСИТЕ НА ДЕЦЕНТРАЛИЗАЦИЯ И ДЕКОНЦЕНТРАЦИЯ В МЕСТНОТО САМОУПРАВЛЕНИЕ В БЪЛГАРИЯ

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РЕЗЮМЕ. В настоящата статия ще бъде направен опит да се очертаят проблемните аспекти при процесите на децентрализация и деконцентрация в областта на местното самоуправление в България. Определено децентрализацията трябва да се възприема като продължителен, многоизмерен и комплексен процес, който едновременно изисква силно и ангажирано управление, както от страна на централната изпълнителна власт, така и от страна на органите на местното самоуправление и всички останали ключови заинтересовани страни. При изготвянето на анализ на заинтересованите от процеса на децентрализация и деконцентрация трябва да се отчете наличието на многостранни и често противоречиви интереси на всяка една от страните, където обединяващо и основно предизвикателство в българските условия е липсата на ясна и широко споделена визия за бъдещото развитие на регионите и населените места при осъществяването на реформи насочени към процесите на децентрализация деконцентрация. Допълнително внимание при идентифицирането на проблемите в областта на децентрализацията и деконцентрацията в България трябва да се обърне и върху анализа на развитието на електронното управление с цел облекчаване на обслужването на бизнеса и населението в регионите в страната, както и да се стимулира социално-икономическото им развитие.

Ключови думи: местно самоуправление, децентрализация, деконцентрация, регионално развитие, електронно управление

Introduction

Looking at the processes of decentralisation and deconcentration in local self-government, the direct dependence between the number and size of the main administrative-territorial units should be highlighted, as well as the type and volume of competences, competencies and functions they perform. Indeed, the decentralisation of the functions is more extensive and, in general, the municipalities with a larger territorial scope have a stronger autonomy, but this autonomy is also determined by the structures built at the regional level. Decentralised government structures in individual countries often use governmental acts to create them. There are three models for organising and managing deconcentrated state structures on a local level. In the first model, the deconcentrated state structures are under the authority of the regional authorities, while in the second model the deconcentrated structures are subordinated to the central executive power and are managed directly by them and the

third model is associated with the creation of special administrative units through a normative act. One of the practices used in European countries is the division of executive and representative functions into local self-government, which is subject to a common legal framework regulating this division. The transfer of responsibility into the competences of local authorities is the result of a decentralisation process that relatively weakens the vertical link and creates links on the horizontal, there is an opportunity to develop connections between municipalities. The process of decentralisation can be seen as representing the state interest in building a solidarity society and implementing a fair social policy, as decentralisation is a corrective of the administration's classical behaviour linked to centralisation and an increase in the level of bureaucracy. The responsibility of the local administration in the current conditions for the management of the administrative-territorial units is also related to the tracking, preparation and implementation of a number of projects that can be financed by the Structural Funds, as well as to the

agenda of the local community, and the bodies of the central executive of a number of economic and social issues directly affecting the interests of the population of the administrative-territorial unit. Enhancing the process of harmonisation, pooling in the context of the development of the European Union puts the agenda on the issue of the degree of local autonomy of the territorial units in the development of the integration process and the tendencies towards centralised management at European Union level. On the one hand, increasing the degree of coordination in decision-making through the use of complex and comprehensive procedures leads to an increase in the level of programming justified by efficiency gains. Therefore, it is important to question the preservation of local autonomy in the development of a highly integrated system in the provision of services, regulation of the economy as well as social and environmental issues and as a result the fulfilment of the natural and recognised rights and powers of the administrative-territorial units (i.e. municipalities) can remain practically "emptied of content," as local government bodies that are part of the public administration are "reflection of the institutional foundations of the way in which states are governed" (Holmberg, Rothstein, 2012) and not only, but also the way in which the European Union is managed.

Creating levels of local self-government

The levels of local self-government in Europe are mainly created as a result of significant territorial and structural changes that result from socio-economic development and the slow growing process of territorial concentration, resulting in some municipalities being so small that they are no longer able to solve the whole spectrum of issues related to the problems and lives of the population inhabiting the territory. In addition, there is a general tendency for the liberalisation of government, which leads to the territorial decentralisation of certain state functions. Often, municipalities voluntarily transfer to their upper territorial self-government those functions that they are unable to perform on their own due to objectively changed circumstances, which is perceived as a process of preserving decentralisation at the municipal level. The proclaimed idea of building a Europe of Regions further enriches the regional self-government, where a key issue is related to the definition of the territorial scope of these regional units, resulting in Europe's regionalisation burdening regional self-government and new pan-European content. An attempt to restructure the European area on a regional basis is the draft European Charter on Regional Self-Government proposed by the Committee of the Regions to the European Union (Shishmanova, 2010), where the principle of decentralisation of the powers of the central state authority and the introduction of local self-government, as local self-government allows citizens and their elected authorities in municipalities to solve their own problems themselves. Consequently, the term local self-government means the right and the real ability of local authorities to effectively regulate and manage the territory and human activity within the framework of the law, and to define the framework of a substantial part of public affairs on their own responsibility and in favour of their own population.

Problems in planning and implementation of local self-government in Bulgaria

Very often, an error is made in mixing and/or replacing concepts such as "local authority", "local self-government", "local autonomy", "deconcentration" and "decentralisation" concepts, therefore it is necessary to observe and correctly use different terminology concepts. A key position in the definition of local government is allocated to the territory as it is a key element in defining the main features describing the specificity and self-identity of the local administrative unit, which requires the use of geographic features to describe the territorial unit. Moreover, when defining the concept of local government, it is essential to define the institutional and functional significance in the territorial unit. At the local level in terms of functional significance in the distribution of tasks and functions, management differences are observed compared to those at the central level. Mixing self-government with autonomy is common, but one should not overlook the fact that the "autonomy of local government" itself refers to the degree of autonomy with regard to central and regional government. In terms of terminology, there is also a conflict in the shifting of the concepts of decentralisation and deconcentration, but it must be borne in mind that decentralisation is a process of transferring powers and resources to exercise them from higher to lower levels of public governance, which is linked to the release of the state to a certain extent in accountability to citizens for the quality and efficiency of the public services offered, as well as to the resolution of local problems in an area in the daily life of the population. Of course, it should not be overlooked that the competence of the state is the creation of common standards and legal guarantees in defining justice and equality between different municipalities in the fulfilment of their functional responsibilities related to the service of the population. While the deconcentration process is based on the creation by the state of authorities and divisions of the state administration whose purpose is the more efficient performance of the state functions on the ground, the deconcentrated subdivisions of the state power act in a strictly subordinated administrative-management hierarchy and obey the decisions and the instructions of the central government. Practically, in deconcentration there is a transfer of functions from the central state bodies to the local authorities, which are centrally subordinated, where the activity of the deconcentrated administration is in full compliance with the principle of hierarchical coexistence. The administrative and territorial reforms carried out in the country are in search of opportunities for consolidation of the modern functional structure and in the search for opportunities for strengthening the processes of decentralisation in the formation of viable territorial communities on the territory of the country. In this respect, the implementation of the decentralisation process is entirely in the public interest because, through the creation of laws and regulations, the state pursues the implementation of the principles of justice and solidarity, whereby the decentralisation by the state can become an advantage in the construction of a solidarity society and the realisation of a fair social policy on the territory of the country.

Regional policy in striving to create mechanisms for generating financial resources

Under the current conditions, the resources allocated to the country from the European Union should be used, and therefore, substantial attention should be paid to the implementation of effective regional policy in the creation of reliable mechanisms for local financial resource generation. Successful use of financial resources by local authorities passes through fiscal decentralisation in order to reduce the role of the executive power in determining the financial resources to municipalities in solving the problems of the population. One of the main reasons for individual municipalities to compete with each other instead of co-operating to carry out joint projects lies in the not yet implemented fiscal decentralisation as the system for budget transfers is currently focused only on the individual municipality. The municipalities' own revenues are in most cases insufficient, so the implementation of joint projects by neighbouring municipalities implies medium- and long-term planning as well as financing, especially with regard to long-term infrastructure projects or stimulating the business initiative of local businesses. In implementing the long-term planning process, it is necessary for municipalities to anticipate and manage their budgets in the medium term, which are based in their main part on own revenues, as it will be able to predict the behaviour of the local business and determine its role in the regional economy of the territorial unit. The fact that the regional economy is always strictly specific for a given territory, both as scope, specialisation, sectoral structure as well as opportunities and potential for development of the economy in the region, determines the regional economy to be considered as a factor for the solution of numerous and diverse in their content tasks that have uninterrupted dynamics, although they may conditionally be distinguished as specific, resource, methodical and interdisciplinary for the local territory and space. Regional (local) business needs to create conditions for development, which conditions can also be fulfilled by implementing a reform in the field of strategic spatial planning and strategic planning of regional development. In making such a reform, its focus should be on linking strategic planning and programming of regional development, and at the same time covering the strategic spatial planning of the country. It is essential that the local business is also involved in the process of spatial development planning, both by participating in the system for the updating of spatial development documents at national, regional and municipal level and by taking into account the territorial potential and the principles of balanced sustainable development of municipalities that reflect current challenges. In the next programming period, the development of the new regional development parameters should be based on its own policy based not only on the implementation of specific, purely urban development policies, but also on the discussion and practical implementation of local self-government reform.

Currently, the public sector management system in Bulgaria can be described as too centralised and remote from the best European and world practices of local self-government, which is also evident at the level of national regulation. For example, what must be done, is that the national regulation should be a result of a mandatory consultation process with municipalities,

or that the regulatory framework at national level should only comprise the basic parameters of the socio-economic activity on the territory of the municipalities and at the same time the municipalities themselves should limit the regulations and licenses on their territory. However, this process should not be implemented at the expense of increasing the total volume of regulations and licenses, which would further hamper the economic activity in the municipality. By the way, with in-depth analysis of the relative number of licensing and regulatory regimes on the territory of the country, it can be seen that they do not decrease, but on the contrary, even increase or there is a transfer of procedures from licensing to regulatory regime and vice versa. A major problem in the management of the municipalities in Bulgaria is the lack of the necessary financial resources, which is why municipal governments are forced to postpone indefinitely in the future the necessary investments in the improvement of the infrastructure and as a result there is a deterioration of the quality of the provided services to the population for satisfying people's everyday needs. A significant shortcoming regarding the development of local self-government on the territory of Bulgaria is also due to the not well-developed structures of active civil society and the participation of non-governmental and civic organisations in solving the problems of the inhabited settlement. Improving the local administration's potential to tackle the problems of small settlements can be linked to the development of volunteering activities of the local community, which are a consequence of the socio-demographic characteristics of the territorial community and reflect the directions of development of the civil sector in the administrative-territorial unit.

Undoubtedly, in the programming period 2021-2027 attention should be focused on increasing the role of the municipalities as a generator and catalyst of economic policy in two main directions. The first is to create the conditions for real stimulation of the local business, i.e. of small and medium-sized enterprises, which must go hand in hand with the second main direction, which must be related to improving the public services provided by the municipal administration. The possibilities for setting up business centres and industrial zones in the municipalities, provided that existing buildings and infrastructure can be used, are also not at a sufficiently high level. Significant efforts should be directed towards relieving all administrative procedures related to doing business in the respective municipalities, as well as stimulating the business and the joint participation of businesses and municipalities in projects funded by the European Union. Current state investment policy challenges are directly linked to the fundamental challenges of national and regional investment policies, which definitely need to improve mechanisms to reconcile interests, both at national and regional level, where the tools used are in line with the development of the investment potential on the territory of the country. In the present circumstances, our country faces the necessity, on one hand, to seek a compromise between the classical objective of state regional policy, which is aimed at reducing interregional disparities, and on the other hand, the pursuit of the objectives related to the increase of the economic growth is being realised faster in the highly developed and rapidly adapting to the new socio-economic conditions regions and the formed economic centres on the territory of the country. In the Member States of the European Union, the change of the territory and the boundaries of the respective administrative territorial units

is done by a normative act, in most of the countries this process is regulated by a separate law or by independent legislation, but regardless of the normative regulation, the procedure for the adoption of changes to the territorial boundaries result from consultations and coordination with stakeholders and the local population inhabiting the territorial unit. It is more and more common that this process is accompanied by respect for the wishes of the population, which affects the proposed reforms for the development of local government and especially the more frequent use of the referendum as a form of consultation with the local population. While the principles of building deconcentrated state administrative structures in the individual member states of the European Union differ and usually the creation of these administrative structures is done with governmental acts but with different models of organisation and management. For instance, in some cases deconcentrated administrative structures are under the authority of regional or local authorities, in other cases they are subdivisions of the central executive power and are directly managed by it, and there is a variant which creates special administrative units with a statutory act and regulated independent annual budget. When defining the governance and organisation of local and regional authorities, an important place in the process should also be the definition of the system of constitution of representative decision-making bodies, the formation of executive bodies, and the designation of the political and administrative heads of the respective local and regional authorities. Regardless of the different modifications in the different countries, the representative decision-making body of the municipality, which manages its overall activity, namely the municipal council, is placed at the basis of the municipal self-government and its democratic legitimacy. There are differences in the system of election and allocation of mandates, as well as in the way in which constituencies are formed, the length of the mandate and the number of municipalities, which is determined by the law, and which is in most cases dependent on the number of the local population. There is a distinction between executive bodies in municipalities that can be both collective and sole, but in most countries the executive power is entrusted to collective bodies that differ in the name, mode of formation and leadership of the collective executive body. A major problem in the development of local self-government is that decentralisation of self-government must not be confused with the territorial deconcentration of the state executive power. Because of the openness, the question about seeking the most appropriate way to combine, on one hand, the special competence of the central executive and the deconcentrated administration and, on the other hand, the local interests in the formation of the financial burden on the municipalities, remains. A possible solution here is to seek the reconciliation of the interests of state and local authorities, expanding the powers of local authorities and increasing the degree of financial decentralisation. On the other hand, our "country continues to lag severely in both public and private research and innovation funding. Other serious problems include the relatively low-skilled labour force, and the economic exclusion of people with low educational attainment and some minority groups. Three main challenges in this area remain, namely reform of the education sector to produce a more adequate skills base; negative demographic trends which, given the existing health care and pension systems, continue to squeeze

the labour market; and the need to further increase labour-market flexibility" (SGI, 2018). The provision of sound policies by individual governments in the European Union can be analysed analytically by examining individual indicators for sustainable governance (SGI, 2018), which also includes the social partners' involvement and oversight competences. It is definitely noteworthy that there are major disparities within the European Union in terms of performance and accountability resulting from the fact that a significant number of countries still practically do not apply their formal regulations to produce better quality policies, and this undoubtedly also affects the processes of decentralisation and deconcentration in the area of local self-government, especially given that "the public sector is the largest" sector in the European Union, occupying it and around 75 million people, accounting for about 25% of the workforce, and public spending totalled nearly 50% of gross domestic product (Report – European Semester – Thematic Information Document, Quality of Public Administration, 2016). The implementation of European policies and instruments for spatial planning and regional sustainable development help regions and local communities to tackle the socio-economic problems that exist in them. In addition, spatial planning provides the opportunity to achieve regional economic growth, thus fulfilling the tasks set to achieve the objectives of the European Resource Efficiency Initiative set out in Europe. Additionally, Public awareness on the protection and management of spatial development should be further enhanced by working in a coordinated and joint European Union context. The results show that there are countries in the various regions of the world which demonstrate good practices with regard to the use of information and communication technologies to provide services and to create citizens' ownership of the decision-making processes. An important trend in recent years has been the development of people-driven services, which simultaneously reflect the needs of people and have been suggested by them.

On the other hand, disparities between countries also lie in the lack of access to technology, the high poverty and disadvantages of significant population groups in individual countries that we can relate to preventing people from benefiting from the benefits of information and communication technologies and management (Naydenov, 2017). In our country, attempts have been made to curb the demographic decline of the nation, as the main strategic objective is to slow the pace of reduction in the number of the population with a view to achieving a trend of stabilisation in the long term and of ensuring high quality of human capital (Naydenov, 2017) Particular attention should be paid to the demographic factor in the shaping of social and economic development programmes and the implementation of regional economic and social policies.(Naydenov, 2017). Naturally, one of the most important elements is investment in people, which is why significant efforts should be made by state institutions to provide opportunities for qualifications and re-qualification of the population, especially in backward areas, where "unfortunately, the collaboration between the educational institutions and the private sector is far from satisfactory. The appropriate link between theory and practice has not been established yet. Many employers are not satisfied with the practical skills that the graduates have. It is especially important to increase investment in human capital with the state employers, local authorities and regional communities sharing the burden

without ruling out individual responsibility. Concrete tools for implementing the policy of continuing vocational training and life-long learning could be: the establishment of sectoral funds for improving the qualification of the employed and setting up individual training accounts (Naydenov, 2017)".

Conclusion

A priority issue for both Bulgaria and some EU Member States is to increase the participation of young people in the labour market and employment, given the high levels of youth unemployment and the high proportion of inactive young people. The determination of the causes of this phenomenon, namely the high levels of youth unemployment and the desire to be timely overcome provokes in individual countries as well as at European Union level high-level actions involving the implementation of policies to reduce youth unemployment and increase the inclusion of young people in the labour market and in employment through student/student internships for four months after graduation with a guarantee that they are being offered safe conditions and high-quality work experience, finding work through the European Job Mobility Portal (Eures), and supporting actions to promote employment, especially for young people, but to prevent inequality in the labour market, stimulate quality employment, and so on. The labour market must be seen as one of the most regulated and at the same time politically sensitive markets in the economy of every single country, which implies that the main priorities pursued through the implementation of specific employment policies are to reduce unemployment and the process also involves the creation of subsidised employment. But undoubtedly, one of the main problems in the individual regions of the country that there is long-term unemployment, which is a structural factor on the labour market and therefore, its elimination implies the implementation of a reform programme aimed at liberalising the markets and increasing the qualification and mobility of the workforce. It is definitely to be assumed that the creation of high levels of support for the long-term unemployed reduces their incentives to find work, and that an effective policy for the long-term unemployed must be linked to the provision of various forms of retraining and to be accompanied by the

provision of additional services to find a job. In addition, a thorough rethinking of the funding system for employment policies should be followed as the level of funding and the objectively achieved results of individual labour market interventions must be linked, which also implies the rationalisation of new indicators reflecting the relationship between financing and effectiveness in reducing unemployment on a regional level in order to target the resources needed to undertake measures of higher added value, efficiency and performance of the labour market.

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AN ECONOMIC AND MATHEMATICAL MODEL FOR DETERMINING OPTIMAL MINING WITH PRE-DETERMINED QUALITY INDICATORS IN A MINING ENTERPRISE

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ABSTRACT. Ore mining in a mining enterprise has different contents of useful and harmful components. For further processing, the ore quality is required to be within a certain range, and it is necessary to plan the mining process. This article proposes an economic and mathematical model describing the planning and management of ore mining according to pre-defined indicators. The model is applied to the conditions of a mining enterprise in Bulgaria.

Keywords: model of mathematical economics, linear programming, mining, mining enterprise

ИКОНОМИКО-МАТЕМАТИЧЕСКИ МОДЕЛ ЗА ОПРЕДЕЛЯНЕ НА ОПТИМАЛЕН ДОБИВ ПРИ ЗАДАДЕНИ ПОКАЗАТЕЛИ ЗА КАЧЕСТВО В МИННО ПРЕДПРИЯТИЕ

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РЕЗЮМЕ. Добивът на руда в минно предприятие е с различно съдържание на полезни и вредни компоненти. За следващото му преработване се изисква качество на рудата в определен диапазон и е необходимо планиране на добива от рудници или участъци. В настоящата статия е предложен икономико-математически модел, описващ планиране и управление на добив на руда по зададени показатели. Моделът е приложен за условията на минно предприятие в България.

Ключови думи: икономико-математически модел, линейно програмиране, рудодобив, минно предприятие

Introduction

The specificity of work in a mining enterprise is the ore mining from separate areas of the mine or separate mines with different contents of useful and harmful constituents of the ore. The further processing of the ore requires a metal content within a certain range "in the input" of an enrichment plant. Therefore, it is necessary to plan the mining from each mine or area in such a way so that the total flow corresponds to specified requirements for mining and/or processing.

In mining enterprises these problems in the planning and management of mining are solved with linear optimisation. Linear models, in which the objective function and all its constraints are linear, adequately describe the processes in the mode of average indicators (Lalova et al., 1980; Reklaitis et al., 1983).

Model

The creation of an economic and -mathematical model for determining the optimal mining from several mines with specified capacities of each one and the requirements for the ore quality is based on linear programming and refers to the class of mixed problems.

The control parameters are:

- x_i - volume of mining of i - th mine / $i = \overline{1, n}$;

- α_i - content of the 1st component in i - th mine;
- β_i - content of the 2nd component in i - th mine;
- γ_i - content of the 3rd component in i - th mine;
- Q_i^{max}, Q_i^{min} - respectively maximum and minimum volume of mining of i - th mine;
- c_i - mining costs in the in i - th mine;
- Q_{pl} - planned volume of ore mining;
- α_{pl} - planned content of the 1st component;
- β^{min}, β^{max} - minimum and maximum permitted content of the 2nd component;
- γ^{max} - maximum permitted content of the 3rd harmful component.

The model is with minimising the objective function:

$$\sum_{i=1}^n x_i \cdot c_i \rightarrow \min. \quad (1)$$

The limitations are:

- by the productivity of each mine:

$$Q_i^{max} \geq x_i \geq Q_i^{min}. \quad (2)$$

- by the total volume of work:

$$\sum_{i=1}^n x_i \geq Q_{pl}. \quad (3)$$

- by the ore quality:

$$\frac{\sum_{i=1}^n x_i \cdot \alpha_i}{\sum_{i=1}^n x_i} = \alpha_{pl}; \quad (4)$$

$$\beta^{max} \geq \frac{\sum_{i=1}^n x_i \cdot \beta_i}{\sum_{i=1}^n x_i} \geq \beta^{min}; \quad (5)$$

$$\frac{\sum_{i=1}^n x_i \cdot \gamma_i}{\sum_{i=1}^n x_i} \leq \gamma^{max}. \quad (6)$$

- by the positive values of the volume of mining for each mine:

$$x_i \geq 0, \quad i = \overline{1, n}. \quad (7)$$

Application of the model for the conditions of Varba-Batantsi AD

Varba-Batantsi AD and Gorubso-Madan AD are enterprises located in South Central Bulgaria. Their activity is mining of lead-zinc ores from three concession areas: Petrovitsa, Krushev dol and Varba-Batantsi situated in the Madan ore field. The owners of the first enterprise are KCM 2000 Group AD and Minstroy Holding AD, with equal participation, while the majority ownership of the second enterprise is held by Varba-Batantsi AD (Sabev, Yordanov, 2014).

By common characteristic, the Madan ore deposits are polymetallic with a basic content of lead and zinc, and accompanying precious components such as silver, gold, copper, etc.

Vein and metasomatic ore bodies in Petrovitsa, Krushev dol and Varba-Batantsi deposits are mainly composed of sulphide - galena, sphalerite, pyrite, chalcocopyrite, etc. and non - metallic - quartz, calcite, rhodochrosite, etc. (Georgiev et al., 2007).

The mining of lead-zinc ore is carried out underground and amounts to 353074 tonnes per year from the three mines for 2018. The metal content of lead-zinc ore is low and direct metallurgical processing is unprofitable. The ore is subjected to a preliminary processing by applying a flotation method in an enrichment plant in the town of Rudozem /owned by Varba-Batantsi AD/. The daily production capacity of the enrichment plant is processing of 1765 tonnes of ore. The result from the processing is as follows: lead concentrate with lead content 70%, zinc concentrate with zinc content 52-54% and waste. Lead extraction is 94-96%, and zinc - about 82%. The produced lead and zinc concentrate is transported to KCM 2000 Group AD - Plovdiv where they are metallurgically processed and the final technological waste is deposited in a tailings dam.

The economic and mathematical model is calculated with data from the Consolidated financial statements of the mining enterprise for 2018 (Consolidated financial statements of Varba-Batantsi AD, 2018). The enrichment plant processes lead-zinc ore from the three mines with an annual processing volume of 353074 tonnes. The requirement is that the content of lead should be in the range: 1.9 ÷ 2.6%, and the zinc content: 2.2%.

According to the presented model, the annual planned mining volumes of the plant are searched at specified quality in Table 1 with minimal costs.

Table 1. Parameters of the ore

Indicators	Mine 1 "Petrovitsa"	Mine 2 "Krushev Dol"	Mine 3 "Varba- Batantsi"
Mining costs per 1 tonne of ore, [thousand BGN]	105	111	129
Maximum volume of mining, [thousand tonnes]	126.567	127.341	99.166
Content of Pb in ore, [%]	2.54	3.25	2.45
Content of Zn in ore, [%]	1.71	2.95	1.88

The annual volume of mining for each mine is: x_1, x_2, x_3 .
The objective function to minimise mining costs is:

$$Z = 105 \cdot x_1 + 111 \cdot x_2 + 129 \cdot x_3 \rightarrow \min, \text{ [thousand BGN]}, \quad (8)$$

At limitations:

- by maximum capacity of each mine:

$$x_1 \leq 126.567; \quad x_2 \leq 127,341, \text{ [thousand tonnes]}. \quad (9)$$

- by total volume of work:

$$x_1 + x_2 + x_3 = 353,074, \text{ [thousand tonnes]}. \quad (10)$$

- by the quality of the ore:

✓ minimum and maximum percentages of lead in the ore:

$$\frac{2.54 \cdot x_1 + 3.25 \cdot x_2 + 2.45 \cdot x_3}{x_1 + x_2 + x_3} \geq 1.9, \text{ [%]}; \quad (11)$$

$$\frac{2.54 \cdot x_1 + 3.25 \cdot x_2 + 2.45 \cdot x_3}{x_1 + x_2 + x_3} \leq 2.6, \text{ [%]}. \quad (12)$$

✓ maximum zinc content in the ore:

$$\frac{1.71 \cdot x_1 + 2.95 \cdot x_2 + 1.88 \cdot x_3}{x_1 + x_2 + x_3} \leq 2.2, \text{ [%]}. \quad (13)$$

- by positive values of the volume of mining for each mine:

$$x_1 \geq 0, \quad x_2 \geq 0, \quad x_3 \geq 0, \text{ [thousand BGN]}. \quad (14)$$

The solution of the optimisation problem in PTC Mathcad worksheet is presented in Figure 1. In the solved block, the objective function and constraints with Boolean operators are entered and built-in function Minimise is used to minimise the function through the method of the least squares (Maxfield, 2014).

The solution of the objective function is 41574 thousand BGN with an optimised mining respectively from the first mine - 126567 tonnes; second mine - 51963 tonnes and from the third mine - 174544 tonnes.

In case that the mining enterprise requires the use of uniformity criteria or minimum fluctuations in quality, the problem is changed and refers to non-linear programming.

```

ORIGIN := 1

Z(x1, x2, x3) := 105·x1 + 111·x2 + 129·x3
x1 := 1      x2 := 1      x3 := 1

Given


$$\frac{2.54 \cdot x_1 + 3.25 \cdot x_2 + 2.45 \cdot x_3}{x_1 + x_2 + x_3} \geq 1.9$$



$$\frac{2.54 \cdot x_1 + 3.25 \cdot x_2 + 2.45 \cdot x_3}{x_1 + x_2 + x_3} \leq 2.6$$



$$\frac{1.71 \cdot x_1 + 2.95 \cdot x_2 + 1.88 \cdot x_3}{x_1 + x_2 + x_3} \leq 2.2$$


x1 + x2 + x3 = 353.074

0 ≤ x1      0 ≤ x2      0 ≤ x3

x1 ≤ 126.567      x2 ≤ 127.341

R := Minimize(Z, x1, x2, x3)

R =  $\begin{pmatrix} 126.567 \\ 51.963 \\ 174.544 \end{pmatrix}$ 

Z(R1, R2, R3) = 41573.611

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Conclusions

The mining plan in a mining enterprise with several mines or areas under the conditions of a corresponding common flow with specified requirements and effective processing in an enrichment plant is a problem of the mining practice of a Bulgarian company.

The paper presents an algorithm and a solution of the economic and mathematical model for the average quantity mode of linear programming in PTC Mathcad programming environment. The model simulation results can be used to make future more effective solutions.

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Fig. 1. Worksheet of the problem in PTC Mathcad

TOURISM IN GREEN ECONOMY – SOME KEY ISSUES

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ABSTRACT. Tourism has significant potential as a driver of growth for the world economy. The development of tourism is accompanied by significant challenges. Green tourism has the potential to create new, green jobs. Travel and tourism are human resource intensive, employing directly and indirectly 8% of the global workforce. It is estimated that one job in the core tourism industry creates about one and a half additional or indirect jobs in the tourism related economy. The greening of tourism, which involves efficiency improvements in energy, water and waste systems, is expected to reinforce the employment potential of the sector with increased local hiring and sourcing and significant opportunities in a tourism oriented toward the local culture and the natural environment. Tourism development can be designed to support the local green economy and reduce poverty.

Keywords: tourism, green economy, sustainability

ТУРИЗМЪТ В ЗЕЛЕНАТА ИКОНОМИКА – НЯКОИ КЛЮЧОВИ ВЪПРОСИ

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РЕЗЮМЕ. Туризмът има значителен потенциал като двигател на растежа за световната икономика. Развитието на туризма е съпроводено със значителни предизвикателства. Зеленият туризъм има потенциал да създаде нови, зелени работни места. Пътванията и туризмът са интензивни за човешките ресурси, които наемат пряко и косвено 8% от глобалната работна сила. Смята се, че една работа в основната туристическа индустрия създава около една и половина допълнителни или непреки работни места в икономиката, свързана с туризма. Навлизането на зелените идеи в туризма, което включва подобрения в ефективността на енергийните, водните и отпадъчните системи, се очаква да засили потенциала за заетост на сектора с увеличено местно наемане и набиране на ресурси и значителни възможности в туризма, ориентирани към местната култура и природната среда. Развитието на туризма може да бъде насочено към подпомагане на местната зелена икономика и намаляване на бедността.

Ключови думи: туризъм, зелена икономика, устойчивост

Regardless of the initial approaches to the green economy, the main importance for it is the integration of economic and environmental policies, where opportunities for new sources of economic growth are at the forefront while avoiding pressure on nature that leads to unsustainable consequences for the quality and quantity of natural assets. All of this involves a wide range of measures, ranging from economic instruments such as taxes, subsidies and trade schemes, as well as regulatory policies, including standard setting to non-economic measures such as voluntary approaches and the provision of information.

The term "green economy" was first used in the work "Green Economy Project" (Blueprint for a Green Economy, Pearce et al., 1989), which is the programme text for supporters of this still emerging discipline, the focus of which is sustainable development economy. The most authoritative and widely used definition of this concept is formulated by UNEP (UNEP, 2011a): A green economy is an economy that provides long-term improvement of human well-being and reducing inequalities, while allowing future generations to avoid significant risks to the environment and its depletion (*Tourism in the Green Economy*, 2012).

A green economy is a system of economic activities related to the production, distribution, and consumption of goods and services that lead to an increase in human well-being in the

long term, while not exposing future generations to significant environmental risks or ecological scarcity.

A green economy can also be viewed as a system of principles, goals, and measures. As a rule, among the basic principles of a green economy are the following (ECLAC, 2010; EEA, 2010; UNEP, 2011a; OECD, 2011a):

- equality and fairness both within one generation and between generations;
- compliance with the principles of sustainable development;
- applying the precautionary principle to potential impacts on society and the environment;
- adequate accounting of natural and social capital, for example, through internalisation of external social and environmental effects, green accounting, cost accounting throughout the life cycle, and improved governance with the participation of stakeholders;
- sustainable and efficient use of resources, consumption and production;
- contributing to the achievement of existing macroeconomic goals through the creation of green jobs, the eradication of poverty, increased competitiveness and growth in key sectors of the economy (*Tourism in the Green Economy*, 2012).

Green economy includes industries that create and increase the natural capital of the earth or reduce environmental threats and risks. If a traditional economy combines labour, technology and resources to produce end-use goods and waste, then the green economy must return the waste back to the production cycle, causing minimal damage to nature.

The United Nations Environment Programme (UNEP) has identified ten key sectors for transition to a green economy: agriculture, housing and utilities, energy, fisheries, forestry, industry, tourism, transport, waste management and water management. One of the priority themes for the green economy is tourism. The ability of tourism to create jobs, stimulate economic growth, accumulate foreign exchange, improve infrastructure, and promote environmental protection makes this industry an attractive tool for alleviating poverty and accelerating local development. With proper management, the development of tourism will benefit not only the country as a whole, but also individual regions and local communities. The tourism planning process needs to take into account employment opportunities and decent working conditions for the local population, as well as such important factors for local communities as infrastructure improvement, access to water supply, sanitation, health care, and education. The development of tourism provides women, youth and disadvantaged groups with disabilities a significant opportunity to become producers of tourism services.

The tourism sector, in general, can play a significant role in the process of transition to a green economy, including through the development of depressed regions. Regions can get various synergistic and multiplicative effects. However, it is necessary to remember about the possible exacerbation of environmental problems caused by the growth of tourist flows: an increase in anthropogenic pressure on local ecosystems and biodiversity; increased water and food consumption, waste and pollution in tourist areas; increase in greenhouse gas emissions due to increased traffic movements, etc. Ecologisation of tourist activities is a long-term, phased process of introducing environmentally friendly and safe forms of technological support for the provision of tourist services based on innovative technologies and products, and taking into account cultural, historical and other traditions.

UNEP and the World Tourism Organisation (UNWTO) believe that tourism in the context of a green economy means tourism activities that take full account of current and future economic, social and environmental impacts, as well as meeting the needs of consumers of services (tourists), industry and local communities. This is not a separate form of tourism - all types of tourism should become "green" and sustainable, namely:

- 1) make optimal use of environmental resources, which are a key element for the development of tourism, support key environmental processes and promote the conservation of natural resources and biodiversity;

- 2) respect the sociocultural identification of local communities, help preserve their cultural heritage and traditional values;

- 3) ensure sustainable long-term economic activities that provide socioeconomic equitable benefits for all parties involved, including tourist satisfaction, stable employment, and opportunities for income and social services to host communities.

Studies show that the choice of tourists is increasingly influenced by environmental considerations - more and more people take into account the health of the environment when planning trips and prefer to stay in an environmentally friendly hotel. Such consumer preferences give additional impulses to initiatives to introduce green tourism. Currently, the transition to a green economy is one of the priorities of the world community on the path to sustainable development. Tourism is an important sector where transformation is necessary and possible. Tourism has significant potential as a driver of growth for the world economy. The development of tourism is accompanied by significant challenges. Green tourism has the potential to create new, green jobs. Travel and tourism are human resource intensive, employing directly and indirectly 8% of the global workforce. It is estimated that one job in the core tourism industry creates about one and a half additional or indirect jobs in the tourism related economy. The greening of tourism, which involves efficiency improvements in energy, water and waste systems, is expected to reinforce the employment potential of the sector with increased local hiring and sourcing and significant opportunities in tourism oriented toward the local culture and the natural environment. Tourism development can be designed to support the local economy and reduce poverty. Developing green tourism requires the informed participation of all relevant stakeholders, as well as strong political leadership to ensure wide public participation in the decision-making process and consensus building. The growth of tourism is of great economic importance for the least developed countries. In about half of these countries, it accounts for more than 40% of GDP and is the most important source of foreign exchange. In addition to the source of foreign exchange for destinations and job creation, the tourism sector has other positive direct and indirect impacts on the global economy, such as providing incentives for small, medium and micro enterprises to trade, income growth and entrepreneurship (especially in the service sector). This activity also causes the creation of a new public infrastructure that preserves and finances the preservation of the natural and cultural heritage. Practical leading projects around the world demonstrate the positive changes that can be achieved through sustainable tourism practices, making tourism an exemplary sector for the green economy. The greening of the tourism sector strengthens its employment potential with increasing recruitment of local staff and expanding opportunities in tourism oriented towards the local culture and natural environment (*Sustainable Tourism for Development Guidebook*, 2013).

There are several challenges in front of tourism development. Under normal business practices (without reducing emissions), by 2050 tourism growth will imply an increase in energy consumption (154%), greenhouse gas emissions (131%), water consumption (152%) and solid waste disposal (251%) (Towards the Development of the 10YFP Sustainable Tourism Programme). The tourism industry is faced with many serious problems associated with "greening" and sustainable development. Specific tasks to be solved are related to the following areas:

Energy and greenhouse gas emissions

Tourism is an important source of greenhouse gas emissions globally. The development of tourism is associated with an increase in energy consumption (mainly based on

renewable energy) in travel, including transport, in places of residence and in the provision of tourist services. All this contributes to the exacerbation of climate change. Worldwide tourism accounted for 8% of global greenhouse gas emissions from 2009 to 2013. Tourists contribute to climate change in a number of ways – through travel by air, rail and road, for example, and by consuming goods and services, such as food, accommodation and souvenirs (Lenzen, M. et al. 2018). All this, in turn, negatively affects the prospects for the development of tourism, increasing uncertainty and risks for its development.

Water consumption

Tourism accounts for a minor share of global water use. In comparison to agriculture, which constitutes an estimated 70% of total water consumption, tourism is far less relevant at 1% (Gössling, 2002). Thus, according to UNEP, in Europe an average of 300 liters of fresh water per day is consumed per tourist, and in expensive hotels up to 880 liters. For comparison: the average per capita water consumption for each European is estimated at 241 liters per day. Water in tourism is used both directly for drinking people and hygiene, as well as for landscaping landscapes, in the hotel industry, catering facilities, laundries, swimming pools, spas, health centers, etc. With regard to geographical location, hotels in the tropics are more likely to have irrigated gardens and swimming pools – the two most significant individual sources of water demand in this sector – while hotels in rural areas will usually occupy larger areas than their urban counterparts. High-rise hotels will have lower water use levels than resort style hotels, and campsites are likely to consume considerably less water than five star hotels, specifically hotels associated with golf courses, which can consume up to 1 million m³ of water per year. Such distinctions can be of major importance in regional planning and water management (Gössling, 2013).

Waste and waste water

According to UNEP estimates, every international tourist in Europe in the mid-2000s generated at least 1 kg of solid waste per day, and in the US – up to 2 kg. Globally, at the expense of domestic and international tourism in the world 35 million tons of solid waste are generated per year. Tourism can also directly affect water quality, for example, by discharging untreated sewage. This often happens in developing countries, but it also happens in relatively rich developed countries. For example, according to the WWF, in the mid-2000s wastewater discharges from hotels directly into the sea have been a common practice in the Mediterranean region, and only 30% of these have been cleaned before.

Loss of biodiversity

Tourism and biodiversity are closely linked both in terms of impacts and dependency. Many types of tourism rely directly on ecosystem services and biodiversity (ecotourism, agri-tourism, wellness tourism, adventure tourism, etc.). Tourism uses recreational services and supply services provided by ecosystems. Tourists are looking for cultural and environmental authenticity, contact with local communities and learning about flora, fauna, ecosystems and their conservation. On the other hand, too many tourists can also have a negative, degrading effect on biodiversity and ecosystems and the increased tourism forecast to biodiversity hotspot countries will

require careful planning and management to avoid negative impacts on biodiversity (*Tourism Sector and Biodiversity*, 2010). There are many examples where large-scale tourism has a negative impact on biodiversity, including coral reefs, coastal wetlands, forests, arid and semi-arid mountain ecosystems. Coral ecosystems have been severely affected by the use of corals for building materials for hotels; fish populations are reduced due to over-fishing for feeding tourists; habitats of many species are disturbed due to improper placement of tourist buildings, parking lots, golf courses. Flora and fauna also suffer from the creation of beaches. The preservation of biological diversity is recognised by the world community as the most important task on which the survival and development of mankind depends. In addition to the destruction of the global and local natural environment, problems in this area narrow the possibilities for the development of the local economy and generate conflicts with the local population. At the same time, the situation in biodiversity largely depends on how tourism develops, especially in developing countries. In this regard, the world has a lot of work on the integration of sustainable development principles in the tourism planning process. For example, UNWTO and the Convention on Biological Diversity (CBD) have developed the CBD Guidelines on Biodiversity and Tourism Development.

Cultural heritage

The tourism and cultural sectors have emerged worldwide as leaders in the revitalisation of redundant buildings and open spaces for contemporary purposes, providing opportunities for sustaining traditional and contemporary cultural values (*WTO*, 2004). Tourist interest in unique cultures can lead to negative consequences and serious destruction of local communities. The number of negative examples of the deterioration of the situation in unique places is growing due to the large number of visitors, the commercialisation of traditions and the threat to the cultural survival of communities due to unplanned and uncontrolled tourism. Tourist destinations are often created by outsiders (usually with government approval) in areas that indigenous or traditional communities consider to be theirs and where the development of tourism would be, from their point of view, undesirable. This creates conflict situations that make cooperation and obtaining mutual benefits very difficult. Recently, awareness of the problem of the impact of tourism on cultural heritage from government, international and non-governmental organisations, as well as the tourism industry, has begun to grow.

Conclusion

According to the UN Green Economy Report, the greening of tourism, which involves significant investment in efficiency improvements in energy, water and waste systems, would stimulate job creation, especially in poorer communities, with increased local hiring and sourcing, and have a positive spill-over effect on other areas of the economy. The direct economic contribution of tourism to local communities would also increase; maximising the amount of tourist spending that is retained by the local economy. Finally, a green tourism economy would ensure significant environmental benefits including reductions in water consumption, energy use and

CO₂ emissions. Given tourism's sheer size and reach, even small changes towards greening can have significant impacts (UNWTO and UNEP, 2008). In order to move to a green economy, tourism requires: a focus on the private sector, the development of relations with representatives of the tourism sector, management, planning and development of tourist destinations, fiscal policy and economic instruments, and investment in green tourism (Khalil, 2018).

In order for such tourism development to be ecologically acceptable and cost-effective, infrastructure arrangements are needed for recreational facilities and the environmental education of the holidaymakers themselves in accordance with the principles of green economy and sustainable development.

Optimisation of the tourism industry in the region or countries, in the transition to a green economy, should be based on the preferential development of those types and forms of tourism that allow the maximum and comprehensive use of available resources. A distinctive feature of this development is to focus on the launch of small projects aimed at the development of the tourism industry in cities and regions. Projects may be aimed at supporting the activities of district and city administrations in the development of the tourism sector, the development of tourist routes, the training of specialists, the development of information and marketing materials and teaching aids, the promotion of tourist products, the construction of small tourist infrastructure, the reconstruction of rural houses and information technologies. They can use the six elements of socio-ecological mechanisms and the four financial-organisational mechanisms for the transition to a green economy presented above. At the same time, from a certain pool of projects supported at the regional and local levels, there can be significant economic, social and environmental effects for the territory and population.

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SERVICE ORIENTED APPLICATION FOR RENDERING REPORTS ON THE TRAINING WORKLOAD AT THE UNIVERSITY OF MINING AND GEOLOGY "ST. IVAN RILSKI"

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ABSTRACT. The aim of this article is to present the work of a team from the Department of Informatics on developing and enhancing an information system for rendering reports on the training workload of the academic staff at the University of Mining and Geology "St. Ivan Rilski". The focus is on the evolution of the application from desktop to server-oriented and on the user account management.

Keywords: information system, database, object-oriented programming

СЪРВЪРНО ОРИЕНТИРАНО ПРИЛОЖЕНИЕ ЗА ОТЧИТАНЕ НА УЧЕБНАТА ЗАЕТОСТ В МГУ "СВ. ИВАН РИЛСКИ"

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РЕЗЮМЕ. Целта на настоящата статия е да представи работата на екип от катедра "Информатика" по разработване и усъвършенстване на информационна система за отчитане на учебната заетост в МГУ "Св. Иван Рилски". Акцентираща се на еволюцията на приложението от десктоп към сървърно ориентирано и управлението на потребителските акаунти.

Ключови думи: информационна система, бази данни, обектно-ориентирано програмиране

Introduction

2018 saw the formation of a team at the Department of Informatics whose task was the development of an information system (IS) for rendering reports on the training workload of the academic staff. The idea was to develop the IS within a series of diploma theses of prominent students taking a Master's degree in the course of study in *Computer Technologies in Engineering* under the supervision of Assoc. Prof. Trifonova and Assoc. Prof. Yanev. The first step in the implementation of such application was presented in Eng. Milen Kiryakov's diploma thesis which was successfully defended in the summer of 2018. The aim was to develop an IS for the automatic generation of the "Planning/Report" template form used at the University of Mining and Geology (UMG) "St. Ivan Rilski". The choice of software products was MS Access for the implementation of the database and C# as a means of developing the user interface.

Having analysed the results obtained, a decision was taken to extend the scope of the system which implied the generation of various types (roles) of system users, respectively the implementation of a Log-in system.

To achieve the new goals, MS Access as the database management tool needed to be replaced by a server-oriented database management tool. The main reason for this was the limited abilities of MS Access for multiuser access (Deliyska et al., 2017).

Our team's choice was the MySQL database server and was prompted by a number of reasons, the most important of

which were:

- The popularity of MySQL. According to DB-Engines Ranking (2019), MySQL ranks second in popularity among modern database management systems and first among those that are distributed for free;
- High security level. The protection and privacy of personal data is the main focus of the work of all institutions dealing with such data, due to the implementation of Regulation 2016/679 of the European Parliament and of the Council of Europe. MySQL largely incorporates the good practices in this area described by Toncheva-Pencheva et al. (2018);
- Excellent response time and performance;
- The significant experience in working with this system gained by the members of the department.

Data migration from MS Access to MySQL

Capabilities of the MS Visual Studio for handling databases

Two data access models are used in building information systems: connected and disconnected. The connected model has a permanent connection to the database, and in the case of the disconnected model the database connection it is not permanent: it is carried out briefly and the work with the data is performed offline by retrieving the data which are downloaded and stored on the local machine. Due to its indisputable advantages (better performance, more precise control of

competitive access in the multiuser mode of operation, working with the current version of data, etc.), the connected model is preferred when working with relational databases. The .NET Framework uses ADO.NET to access databases.

ADO.NET is a collection of data libraries included in the .NET Framework. These data can be relational, hierarchical (e.g. XML), etc. Libraries include classes, interfaces, structures, and other types and are designed to access various data sources. ADO.NET is entirely based on the .NET Framework and has many of its features: multi-language support, automatic memory management, object-oriented design, a common type system and naming convention. Funds are provided that make it possible to work with the data regardless of the source (Nakov, 2006).

ADO.NET offers a software model for handling data that goes with both data access models - the connected and the disconnected one. In addition, the object model of ADO.NET offers very precise control over the source connection, the command execution, and the data processing. In ADO.NET, a clear distinction is made between data access and data manipulation (ibid.).

The various classes and interfaces provided by ADO.NET are divided into several main namespaces:

- System.Data - this contains the main architectural classes of ADO.NET. It includes, for example, the DataSet, DataTable, and DataRow classes;
- System.Data.Common - this namespace contains classes that are used independently of data sources, such as DataAdapter;
- System.Data.SqlClient - this includes specific SQL Server connection classes that allow to connect to MS SQL Server, to retrieve data, and to execute commands. Some of the classes in this namespace are SqlConnection, SqlCommand, SqlDataReader, etc.;
- System.Data.SqlTypes - this comprises classes that match the types of data embedded in the SQL Server and are a faster and more secure alternative to the other types. It includes SqlInt32, SqlDouble, SqlDateTime, and others ;
- System.Data.OleDb - this provides classes for connecting to an OleDb data source. It includes, for example, the classes of OleDbConnection, OleDbCommand, OleDbDataReader, etc.;
- System.Data.Odbc - these are ODBC connection classes. For example, OdbcConnection, OdbcCommand, etc. are contained;
- System.Xml - this namespace contains classes that support XML data processing and the relationship between the relational model and XML. For example, the XmlDocument and XmlDataDocument classes are often used.

The so-called data providers are used to access the various databases. They are specific to the particular database, but adhere to the programming model of ADO.NET by implementing the interfaces defined in it.

Fig. 1 shows the main components of ADO.NET (ibid.).

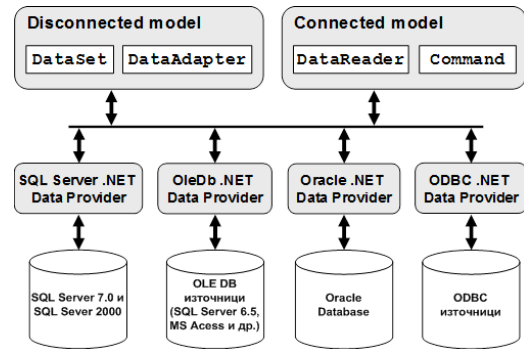


Fig. 1. Components of ADO.NET

Integrating MySQL to MS VisualStudio

MS VisualStudio does not have an integrated MySQL support; therefore, the installation of the appropriate driver was necessary (MS VisualStudio Data Providers, 2019). The natural choice for such a driver was MySQL Connector/NET, the one officially offered by MySQL.

MySQL Connector/NET is a driver supporting the ADO.NET interfaces. These are required when working with .NET applications that access MySQL (Dubois, 2006).

MySQL Connector / NET allows .NET applications to use MySQL. It is not based on the C client library. It is written in C# and directly implements the client-server communication protocol. Connections can be made via TCP/IP, Unix socket files, named channels, or shared memory (MySQL for Visual Studio, 2019).

Microsoft has provided a convenient graphical method for adding the MySQL library to VisualStudio. In its essence, this is adding References after the successful installation of the driver and after applying it from the Data Connection option (Fig. 2)

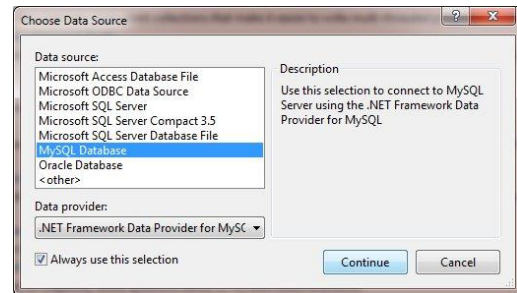


Fig. 2. Choice of database type from a C# medium

The C# classes that are most commonly used for communicating with the MySQL database are the following (MySQL Connector/NET, 2019):

- MySqlConnection: Represents an open connection to a MySQL database;
- MySqlConnectionStringBuilder: Aids in the creation of a connection string by exposing the connection options as properties;
- MySqlCommand: Represents an SQL statement to execute against a MySQL database;
- MySqlCommandBuilder: Automatically generates single-table commands used to reconcile changes made to a DataSet object with the associated MySQL database;

- **MySqlDataAdapter:** Represents a set of data commands and a database connection that are used to fill a data set and update a MySQL database;
- **MySqlDataReader:** Provides a means of reading a forward-only stream of rows from a MySQL database;
- **MySqlException:** The exception that is thrown when MySQL returns an error;
- **MySqlHelper:** A helper class that makes it easier to work with the provider;
- **MySqlTransaction:** Represents an SQL transaction to be made in a MySQL database;
- **MySQLMembershipProvider:** Manages storage of membership information for an ASP.NET application in a MySQL database;
- **MySQLRoleProvider:** Manages storage of role membership information for an ASP.NET application in a MySQL database;
- **MySqlIEFConfiguration:** Adds the dependency resolvers for MySQL classes;
- **MySqlExecutionStrategy:** Enables automatic recovery from transient connection failures.

Data transmission

The existing database required significant changes, both in extending the existing tables and in adding ten new tables (Trifonova, 2019). Therefore, our team decided to rebuild the database in the MySQL environment.

In view of user management, two new tables were added - Users and Role (Fig. 3).

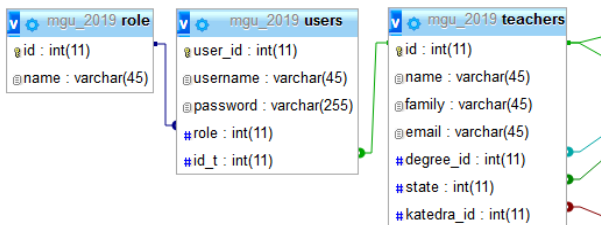


Fig. 3. The “Users” table and the relations associated with it

The “users” table contains information about the users of the system. MySQL function SHA2 (str, hash_length) is used to store the password. The SHA-2 family of hash functions (SHA-224, SHA-256, SHA-384, and SHA-512) is calculated. The first argument is the plaintext string to be hashed. The second argument indicates the desired bit length of the result, which must have a value of 224, 256, 384, 512, or 0 (which is equivalent to 256). If either argument is NULL or the hash length is not one of the permitted values, the return value is NULL. Otherwise, the function result is a hash value containing the desired number of bits. SHA2() can be considered cryptographically more secure than MD5() or SHA1() (MySQL 5.7 Reference Manual, 2019).

The “Role” table describes the role of the user. At this stage, eight roles are envisaged:

- **admin** - this user has access to the management of the accounts within the system and of the role definition;
- **teacher** - the main function of this role is student assessment;

- **rector** - this role allows the user to provide references to all the available data in the system;
- **d_MEMF, d_MTF and d_GPF** – reports on the workload of lecturers and departments, as well as the management of curricula, but only of those of the respective faculty: the Faculty of Mining Electromechanics (or MEMF, as is the abbreviation in Bulgarian) the Faculty of Mining Technology (or MTF), or the Faculty of Geology and Exploration (or GFP);
- **UO** – this role allows the management of the training workload of each lecturer;
- **Secretary** (or sekretar, if the Bulgarian equivalent is used) – departmental level information provided by secretaries.

Upon successful login, a form opens that corresponds to the role of the respective user. In addition, any user who has successfully connected to the system can change their password.

Development of a graphical interface

Log-in system

The user authentication to the information system is accomplished by entering a user name and password (Fig. 4). Data from the two text controls (User name and Password) are validated in order to avoid database compromise via SQL injection.

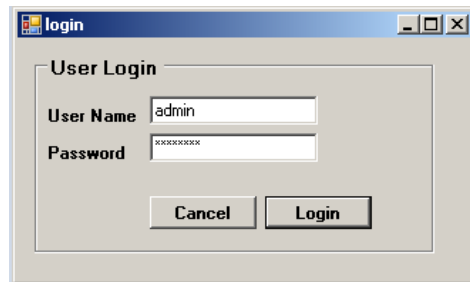


Fig. 4. Log-in form

The user account is employed for the successful login to the system, and then a new form is opened containing data to which the user has access.

User data are stored and accessible until the user logs out.

Admin panel

After the “admin” user has successfully logged in the system, a user management form opens. It includes three sub-sections (tabs):

- **Users** (Fig. 5) – users are added, removed and edited from this tab. The parameters are the name, the password, and the role. If the role is “Teacher”, an additional control opens whose purpose is to allow the selection of a lecturer who is already in the “Teachers” table but who has not been tied to a specific role yet;

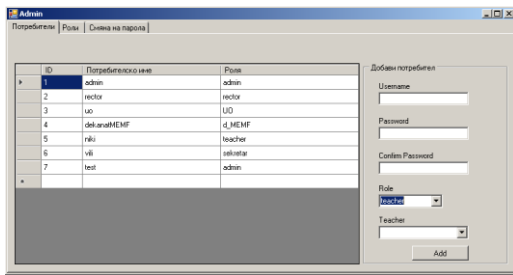


Fig. 5. The "Users" tab

- Roles (Fig. 6) - a new role is added from this tab;

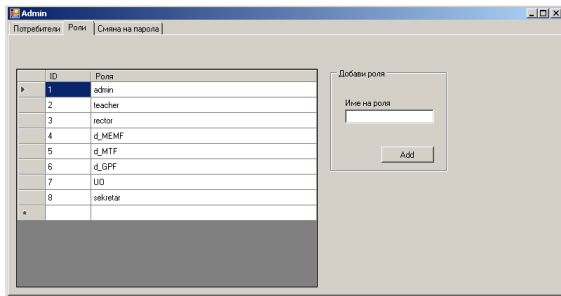


Fig. 6. The "Roles" tab

- Password change (Fig. 7) - the change of password is performed by entering the current password and repeating the new password twice. Such a tab is visible to every user who is successfully connected to the system (Trifonova, 2019).



Fig. 7. The "Password Change" tab

Conclusion

The management of the training process is an elaborate task that requires the expertise and capabilities of all employees who are entrusted with its implementation. Building an information system that digitizes, manages, and archives this process would greatly facilitate the work of the respective experts, and would also enable people with lower qualifications to successfully work with the system.

To date, no such system exists at the University of Mining and Geology "St. Ivan Rilski". The information system developed by a team from the Department of Informatics at UMG has been a decisive step towards the solution to this problem.

The transfer of the database to a server-oriented application, like MySQL, has allowed us to take advantage of such benefits of the client-server technology as the centralised data storage, the multi-user access, a higher level of logical and physical independence of the data, etc.

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EXPANDING THE FUNCTIONAL ABILITIES OF MECHANICS ADD-IN FOR MS EXCEL WITH EXAMPLES IN THE FIELD OF STATICS

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ABSTRACT. MS Excel is one of the most popular products for storing, processing and visualising data in a tabular form. Apart from the wide range of around 500 in-built functions, MS Excel provides the opportunity for creating custom tools, which can be used for solving engineering tasks. This article presents the developed additional functions and macros to the Mechanics add-in. A planar and a space truss task have been solved numerically, as well as a sizing task of bodies with different Young's modulus in tension-compression.

Keywords: MS Excel, modelling, add-in, bar truss, Young's modulus

РАЗШИРЯВАНЕ ФУНКЦИОНАЛНИТЕ ВЪЗМОЖНОСТИ НА ADD-IN MECHANICS ЗА MS EXCEL С ПРИМЕРИ ОТ ОБЛАСТТА НА СТАТИКАТА

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РЕЗЮМЕ. MS Excel е един от най-популярните продукти за съхраняване, обработка и графично представяне на информация в табличен вид. Освен богатият набор от около 500 вградени функции, MS Excel дава възможност за създаване на потребителски инструменти, които могат да се използват при решаване на инженерни задачи. Настоящата статия представя разработените допълнителни функции и макроси към add-ins Mechanics. Числено са решени равнинна и пространствена задачи от статика на ставно-прътови конструкции, както и задача за оразмеряване на тела с различни модули на опън и натиск.

Ключови думи: MS Excel, моделиране, add-in, ставно-прътови конструкции, модул на Юнг

Introduction

MS Excel is one of the most popular products for storing, processing and visualising data in a tabular form. With its wide range of around 500 in-built functions as well as plenty of add-ins, MS Excel provides opportunities for solving a variety of engineering tasks. However, it does not have in-built modules for direct solving of tasks from the field of statics. Because of the widespread use of MS Excel, including in the field of teaching, two years ago add-in Mechanics was developed (Trifonova, 2017). It can be used for modelling some types of mechanical constructions. This module was developed in the Visual Basic for Application language and can be applied for solving some tasks of the mechanics curriculum.

The current article has the purpose of supplementing the add-in Mechanics with examples about the statics of a space truss, as well as an example about the sizing of bodies with different Young's modulus in tension-compression.

Engineering tasks

Space truss

A space truss is a construction of rods which are considered weightless. Load force is only applied on the joints so the *method of joints* can be used to solve for the unknown forces acting on members of a truss. When the whole construction is

in equilibrium any isolated joint is in equilibrium as well. For each isolated joint, all forces acting on it are typed in, so that equilibrium equations for each joint can be written out:

$$\sum_{i=1}^n X_i = 0; \sum_{i=1}^n Y_i = 0; \sum_{i=1}^n Z_i = 0. \quad (1)$$

Force components

For determining the equilibrium equations, two types of expressions are used: for a rod lying in the XZ plane and for a rod lying in the plane described by the rectangle OO₁B₁B in a cuboid with side lengths a, b and c. (Fig.1).

For rods lying in the XZ plane of the cuboid in Figure 1, the angle α_1 is the angle between the X-axis and the rod. Accordingly, the following expressions are valid for the components of the S₁-rod:

$$S_{2x} = S_2 \cos \alpha_2 \cos \beta, S_{2y} = S_2 \cos \alpha_2 \sin \beta \quad (2)$$

$$S_{2z} = S_2 \sin \alpha_2$$

where

$$\cos \alpha_1 = \frac{a}{\sqrt{a^2 + c^2}}; \sin \alpha_1 = \frac{c}{\sqrt{a^2 + c^2}}.$$

The equations are similar for a rod lying in the YZ-plane.

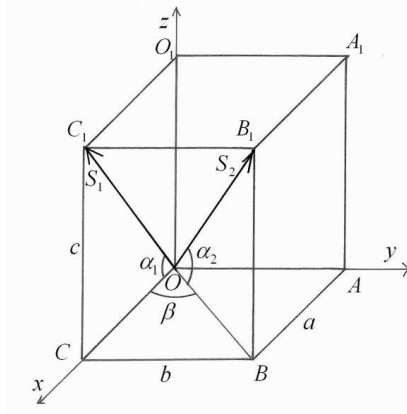


Fig. 1. Forces on the rods S_1 and S_2

When the rod lies in the OO_1B_1B -plane of the cuboid, *double projection* is applied. Then, the force components are described as follows:

$$\begin{aligned} S_{2x} &= S_2 \cos \alpha_2 \cos \beta, \quad S_{2y} = S_2 \cos \alpha_2 \sin \beta \\ S_{2z} &= S_2 \sin \alpha_2 \end{aligned} \quad (3)$$

where

$$\begin{aligned} \cos \alpha_2 &= \frac{\sqrt{a^2 + b^2}}{\sqrt{a^2 + b^2 + c^2}}; \quad \sin \alpha_2 = \frac{c}{\sqrt{a^2 + b^2 + c^2}}; \\ \sin \beta &= \frac{b}{\sqrt{a^2 + b^2}}; \quad \cos \beta = \frac{a}{\sqrt{a^2 + b^2}}. \end{aligned}$$

Here α_2 is the angle between the S_2 -rod and the XY -plane, and β is the angle between the rod's projection on the XY -plane and the X -axis. The expressions (3) are also valid, if the rod lies in the AA_1C_1C -plane of the cuboid.

Analogous equations (2) are applied in (Stoyanov, 2012), and similar to equations (3) – in (Stoyanov, 2016). In these studies the matrix form of the equations is presented.

This method can be applied for teaching students at technical universities.

Algorithm for solving space and plane truss tasks

The classic algorithm for solving statically determined space and plane truss tasks goes as follows (Bachvarov et al., 1990):

- The joints of the described truss are analysed.
- Expressions (2) or (3) are applied for determining the components of the forces in the rods as well as for solving for the external reacting forces acting on the truss structure.
- The equilibrium equations (1) are written out in their analytical form for every joint.
- If there are multiple forces acting on a single joint, the forces need to be added in order to determine the equilibrium equations of the net force in the joint.
- The equilibrium equations with the components of the force in each joint are written out in a matrix form and solved.

- Through solving the matrix equation the unknown forces in the rods and supports are calculated.

The current article uses the matrix method suggested by (Stoyanov, 2012; 2016) rather than the classic one.

Dimensions of the cross section of bodies

Apart from truss constructions, expressions (2) and (3) can be applied on reduction of a force system and for equilibrium of a rigid body (Bachvarov et al., 1990). In order for the body to be in equilibrium, the net force vector and the net moment vector of the system of active (external) forces and reactions on the rigid body have to equal zero. After determining the external forces for every part of the body, the equations for the internal forces are written out. These forces are used for determining the tensions and the dimensions of the cross section of the body.

In most cases, real bodies are modelled as homogeneous and isotropic with identical Young's modulus. There are materials for which the Young's modulus is significantly different for tensile and for compressive forces. Therefore, analytical expressions for the stresses are developed, according to the art of the force: concentrated moment (Trifonova-Genova, 2014) and concentrated force (Trifonova-Genova, 2019). These stresses aren't equal in the zones of tension and compression. This requires a description of the stages that pass to determine the cross-sectional dimensions.

Algorithm for determining the dimension of the cross section of the body with different Young's Modulus in tension-compression

- The maximum moment, the admissible stresses of tension and compression, the Young's modulus of tension and compression and the relationship between the height and width of the cross section of the beam are set;
- The mean value of the admissible stress that corresponds to the material with the identical modulus in tension and compression is calculated;
- From the strength condition, the width is selected and the height of the cross section is determined;
- The height of the tensile zone is calculated by the stress equation in both zones (Trifonova-Genova, 2014);
- The moments of inertia are determined and the maximum values of the stresses in the two zones are calculated;
- The resulting maximum stresses are compared to the permitted tensile and compressive stresses. If they are smaller than the permissible stresses, then the section sizes are final;
- If the maximum stresses are greater than the permissible ones, the width should be increased and the height needs to be calculated. Go to *determine the height of the tensile zone*.

Numerical examples

The added functionality in add-in Mechanics is expressed by adding three macros: Truss2, Truss3 и Beam. The purpose of the first two is solving plane and space truss tasks, respectively. The third macro is used for calculating the size of bodies with different Young's modulus for tensile and compressive stress.

In order to better illustrate the work with the three macros, three example tasks have been solved.

A. Truss2

First, the following data have to be entered in a new sheet in MS Excel, starting from cell A1 and using different lines:

- Number of joints;
- For each joint in one line type in 3 values: x and y-coordinates of the joint as well as 0 or 1 depending on whether it is a support (0) or not (1);
- Number of rods;
- For each rod in one line type in 2 values, which are the numbers of the joints on both sides of the rod;
- Number of forces;
- For each force type in 3 values: number of the joint in which the force is applied and the projections of the force on the axes.

On Figure 2 a part of the input data for Truss2 is given. The values correspond to the example in Figure 3, which is borrowed from Stoyanov (2012).

	A	B	C
1	7		
2	0	0	0
3	3	5	1
4	6	0	1
5	9	6	1
6	12	0	1
7	15	6	1
8	18	0	0
9	11		
10	1	2	
21	3		
22	2	8	-50
23	4	0	-70
24	6	0	-90

Fig. 2. Part of the input data for Truss2

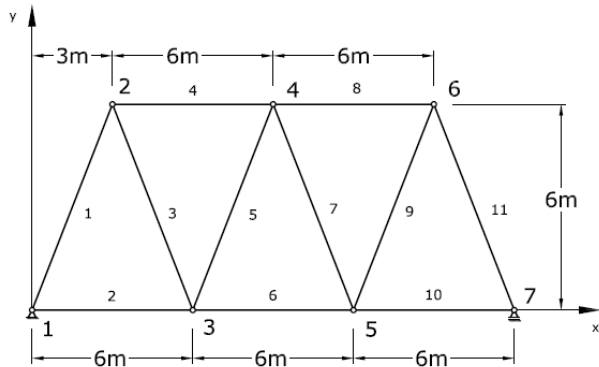


Fig. 3. A plane truss

Solving the task involves generating and solving a matrix equation of the type

$$A \cdot X = B, \tag{4}$$

where matrix A and the column vector B are generated automatically from the input data of the task. The column vector B contains the projections of the external forces and the matrix A results from the incidence matrix of the construction (Stoyanov, 2012).

Apart from visualising the resulting column vector X, the programme can also visualise the values of the elements of A and B from (4), if the user wants to track and check the solution.

Figure 4 shows the resulting values of the solution. The values of the stresses in the rods are within the range E1:E11, and the values of the elements of the matrices A and B are given in ranges G1:Q11 and S1:S11, which the programme calculates in the process of solving the task.

	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	-99.6526		-0.447	0	0.447	1	0	0	0	0	0	0	0		-8
2	52.5000		-0.834	0	-0.834	0	0	0	0	0	0	0	0		50
3	43.6242		0	-1	-0.447	0	0.447	1	0	0	0	0	0		0
4	-72.0000		0	0	0.834	0	0.834	0	0	0	0	0	0		0
5	-43.6242		0	0	0	-1	-0.447	0	0.447	1	0	0	0		0
6	91.5000		0	0	0	0	-0.834	0	-0.834	0	0	0	0		70
7	-34.6756		0	0	0	0	0	-1	-0.447	0	0.447	1	0		0
8	-76.0000		0	0	0	0	0	0	0.834	0	0.834	0	0		0
9	34.6756		0	0	0	0	0	0	0	-1	-0.447	0	0.447		0
10	60.5000		0	0	0	0	0	0	0	0	-0.834	0	-0.834		90
11	-135.3463		0	0	0	0	0	0	0	0	0	-1	-0.447		0

Fig. 4. Solution of the task in Fig. 3, calculated with macro Truss2

B. Truss3

The input data is entered the same way as in Truss2.

The macro is tested with the example shown in Figure 5, which is borrowed from Stoyanov (2016).

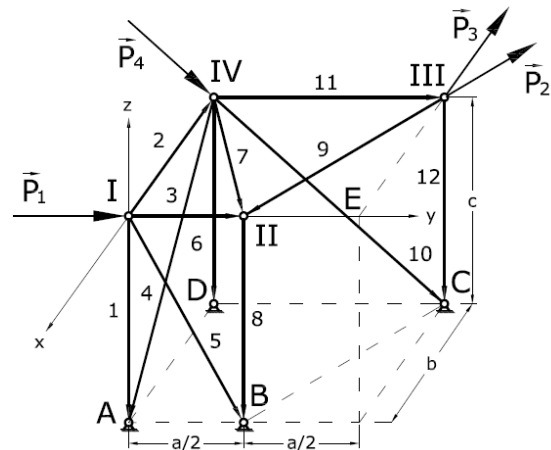


Fig. 5. A space truss

As a result of the calculations, the following values are generated (the transposed vector X is shown).

1	201.207	9.092E-15	43.836	94.833	-217.975	-95.572	-81.893	0	51.893	-24.068	-13.889	0
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C. Beam

The geometry of the structure for the third example is shown in Figure 6.

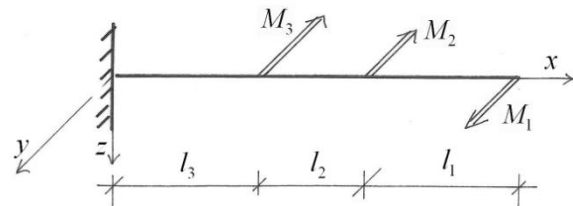


Fig. 6. The cantilever beam

In order for the macro to work, the following values are typed in the first line in a new sheet in MS Excel:

- Maximum moment as an algebraic sum of the given moments;

- Permissible tensile stress and permissible compression stress;
 - Young's modulus for tension and for compression;
 - Ratio height to width of the cross section;
- For this example, the following values have been entered:

	A	B	C	D	E	F
1	10	160	240	9.327E+04	1.2436E+05	1.5

The results from the above shown data are as follows:

- Maximum tensile stress: $\sigma_t = 160$ MPa;
- Maximum compression stress: $\sigma_c = 179.5$ MPa;

This result took three iterations to calculate.

As seen from the results, the distribution of the normal stresses is not symmetrical.

Conclusion

Advantages of solving the given tasks using add-in Mechanics:

- The time consuming process of solving a system of equations is overcome;
- In contrast to the manual solution, no joint with two unknown forces in the rods has to be chosen;
- The possibility of making mistakes in the calculations is eliminated;

The advantages of using computer calculations become clearer when analysing trusses with multiple rods and many forces in the joints, or when multiple iterations are needed for calculating the stress in cross sections.

In order to properly work with add-in Mechanics, no special knowledge about MS Excel is needed. Basic skills in working with the product, which are taught at school, are sufficient.

The developed programme can be used for teaching as part of the mechanics curriculum.

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DESIGNING OF AN INFORMATION ADVISORY SYSTEM FOR ASSESSMENT OF MEASURES AGAINST WATER POLLUTION FROM MINING ACTIVITIES

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ABSTRACT. The report presents designing of information advisory system for assessment of measures against water pollution from mining activities. The system is based on economic model for benefit-cost assessment that is consistent with the European Water Framework Directive. It is necessary for the system to be adaptive and to develop information on different water bodies in order to help managers in effective decision making related to the water pollution reduction in mining regions. An information, functional and programme model of the system has been created. The proposed and analysed models will be used in the future implementation of the system.

Keywords: information advisory systems, cost-benefit analysis, software design

ПРОЕКТИРАНЕ НА ИНФОРМАЦИОННО СЪВЕТВАЩА СИСТЕМА ЗА ОЦЕНКА НА МЕРКИТЕ ПРИ ЗАМЪРСЯВАНЕ НА ВОДИ ОТ МИННА ДЕЙНОСТ

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РЕЗЮМЕ. Разглежда се проектиране на информационно съветваща система за оценка на мерките при замърсяване на води от минната дейност. Системата се базира на разработен икономически модел за оценка съобразен с рамковата директива за водите. Необходимо е системата да бъде адаптивна и да доразвива информацията за различни водни тела с цел подпомагане ръководни кадри, при вземане на ефективни решения, свързани с намаляването на замърсяването на водите в миннодобивните региони. Създадени са информационен, функционален и програмен модел на системата. Предложените и анализирани модели ще бъдат използвани при бъдеща реализация на системата.

Ключови думи: информационно съветващи системи, анализ разходи-ползи, софтуерен дизайн

Introduction

The administration of water bodies in the Republic of Bulgaria takes place at the national and the basin level. In 2012 a National Strategy for Water Sector Management and Development (DV, No. 97, 2012) was adopted, setting out the main development goals, milestones and methods till 2037. This strategy is based on the Water Framework Directive (WFD) 2000/60 of the European Union. Four directorates for the management of the water sector operate on the territory of Bulgaria: Danube, Black Sea, West-Aegean and East-Aegean regions. The Ministry of Environment and Waters has developed a River Basin Management Plan (RBMP), which includes an approved national catalogue of measures with appropriate standards for their cost. The Basin Directorates develop water management planning papers in their area, which are updated every six months. On an operational level, they prepare programmes for water protection areas and set of measures to achieve good status of water bodies. Experts from the basin directorates monitor the implementation of these measures. Actually, the measures are implemented by different stakeholders – municipalities, water users, industrial enterprises, etc. and depend on their activity and funding opportunities. A key point in water management policy is the reduction of pollution of water bodies.

One of the main tasks of RBMP is to determine surface and groundwater status through continuous data collection (monitoring). Currently, these data as well as the national catalogue of measures are in the form of MS Excel tables.

The aim of the present study is, on the basis of the developed economic model, to design and to implement in future an information advisory system, which will support the assessment of the adopted measures for the water protection and purification from mining activities.

Data from the East-Aegean region is used to design and develop the system. However, other basin directorates could apply the developed system. Analyses for the East-Aegean region under Programme BG02 "Integrated Marine and Inland Water Management", Project EARBDMINING (Financial Mechanism of the European Economic Area 2009-2014) show that mines and tailing ponds are significant sources of pollution. They account for 20% of point sources and 8% of diffuse sources of pollution.

Economic model for assessing water pollution

In terms of economic theory, the model developed (Radev, 2015; Radev et al., 2019) can be described as follows: the cost-effectiveness analysis selects the optimal (cost

minimising) combination of measures, which then is integrated into the cost-benefit analysis to assess the economic effectiveness of the proposed measures for individual water bodies, river basins and the area as a whole.

The main idea of the model is to analyse the complexity of the interrelations between different water bodies, as well as cross-correlations between measures and pressures (the pollution effects). Each water body has to be evaluated individually and in combination with other related water bodies, i.e., as part of a larger aggregate.

The most commonly used methods of economic evaluation of large investment projects for environmental protection are:

- **Cost effectiveness analysis (CEA).** This analysis compares monetary values of the costs and the physical benefits of the measures taken (i.e. the costs are compared with the reduced level of pollution).
- **Cost-benefit analysis (CBA).** Avoiding contradictions with the valuation of some intangible assets, such as the environment, this analysis is a preferred tool in the comparison of alternative measures.

The CBA compares monetary values of costs and benefits (costs are compared to the direct and indirect benefits of improved environmental status). Assessing not only costs but also tangible and intangible assets, the CBA method is appropriate for an overall assessment of the economic effectiveness of the adopted measures or a combination of measures.

The choice of benchmarks and thresholds of pressures and measures associated also with the selection of CBA and/or CEA methods.

According to CEA method, the costs that are required to achieve good environmental status, are effective when they are lower than the relevant thresholds. Exceeding the thresholds means that it is necessary either to reformulate the time horizon and/or to recommend measures with less ambitious environmental objectives.

When we combine the indicators from both CEA and CBA assessment methods, it is important to allocate the measures to places with the most correct estimates according to the two methods.

The meaning of the model can be summarised as follows: assessment of the effectiveness of WFD measures is done in terms of target water status through pre-selection of the actions with which this status can be achieved in the most effective way. They should be done by two parallel analyses – on the costs and on the benefits, respectively. The cost estimates are obtained after selecting the set of measures and calculating their unit and total value. Thereafter, the measures are revised until the minimum level of costs is achieved, i.e. the level at which no more economies are possible. The values of benefits are assessed on the basis of a pre-prepared classification of the positive effects of achieving the target status. When assessing the benefits and costs of the individual water body, aggregation is undertaken, and at each level through CEA and CBA methods, the efficiency is determined (Fig. 1).

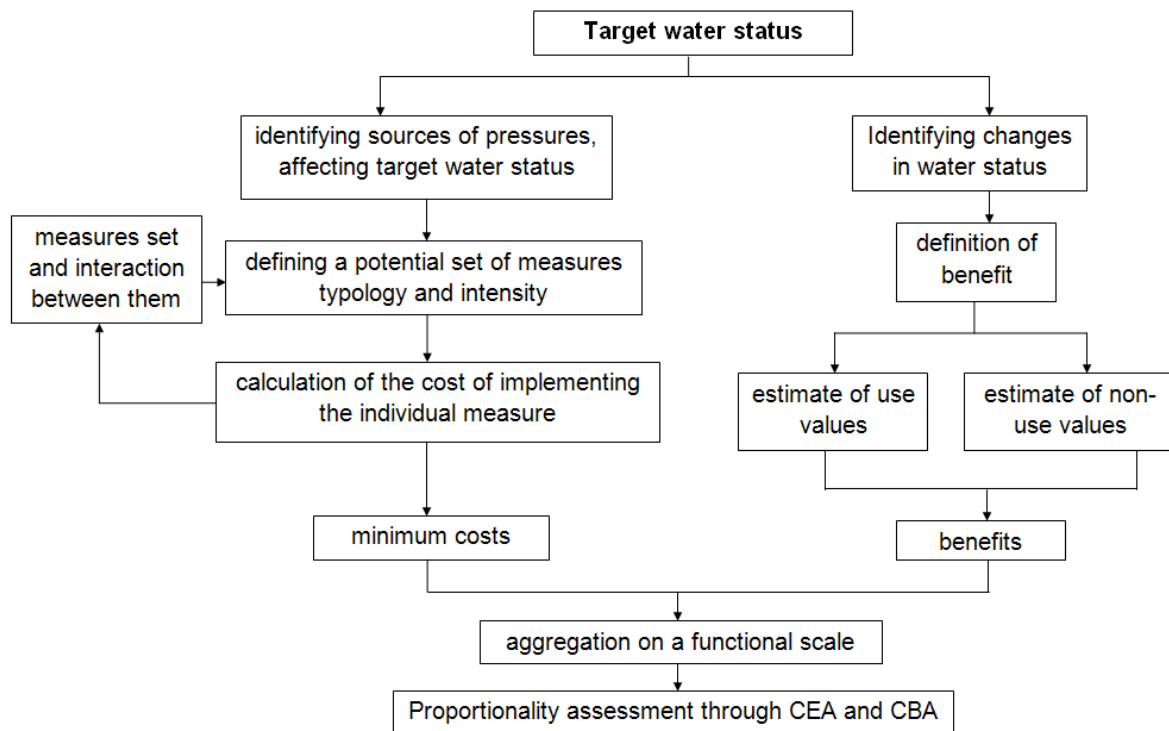


Fig. 1. Procedures for the application of AER and CBA

The choice of assessment methods and benchmarks is complemented by the choice of the most appropriate scale of economic analysis.

The final result of the cost benefit analysis is a B/C coefficient, which is determined as a ratio of benefits to costs per inhabitant of the water body area. This factor gives information about the profitability of the investment on the basis

of the taken measures. The investment is effective if the ratio is greater than 1, even though in some cases it is assumed to be smaller but close to 1.

Information advisory systems

The primary source of each solution is a problem. It can be classified as: structured, poorly structured or unstructured.

Management decisions can be taken at operational, strategic and tactical levels.

The decision-making process goes through several stages. The sequence of these steps is illustrated in Figure 2 (Tujarov, 2007). Successful implementation of each stage requires specific information that is achieved through data processing for decision-making.

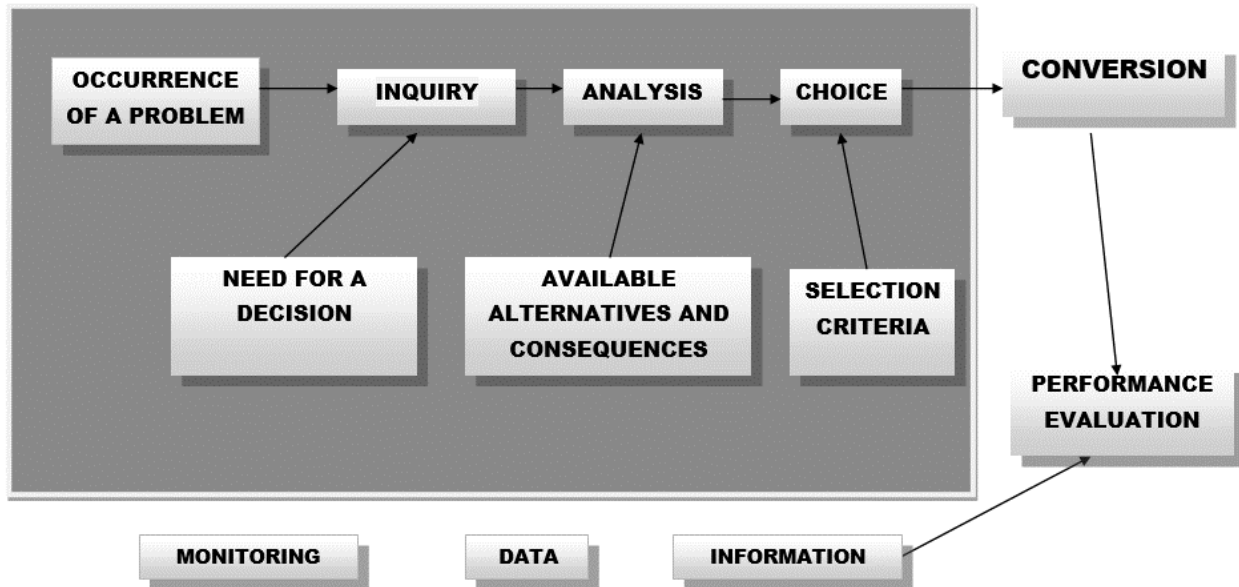


Fig. 2. Illustration of the decision making model

In order to cover the management processes, it is necessary to consider the decision-making area, the decision-makers and the way in which the information is used in the decision-making process. After problem identification, a study that generates alternatives is conducted; a variant according to certain criteria is chosen, a possible decision is selected and the results are evaluated.

According to how the necessary information is gathered and presented, how the analysis is performed and what the results are, the counselling systems can conditionally be divided into information advisory, decision support, and expert systems.

Information advisory systems contain mostly unstructured or poorly structured information about existing solutions in a given area. Their task is to select from the total amount, on the basis of some criteria, the necessary information and to provide it in a synthesised form to the decision makers.

Decision support systems contain mostly structured information – data in sufficiently large volumes. They contain various data about the mining methods that are used to find some characteristics of these data: classes, clusters, functional and statistical dependencies, extreme values. These characteristics determine the solutions that the system gives.

The system that is subject to design here is at the border between these two types, because it handles poorly structured

information related to assessments of good ecological water status.

Designing the information advisory system

As mentioned before, the measures with their characteristics and the description of water bodies with their ecological status are organised in MS Excel tables. Basin Directorates prefer to work with them. This allows the system to be developed in the MS Excel environment using Visual Basic for Application. This is a programming language oriented to expand MS Excel with executable modules – macros. A similar solution is applied in the French WFD-CBA system (Termignon, Devaux, 2014).

In order to apply the cost-benefit analysis in the system of the national catalogue of measures only those measures related to the pollution from mining activities are taken. They need to be processed in a form convenient for automated analysis. Data have to include: the measure code, description, numerical criteria for its application, the cost of the measure, a numerical evaluation of its benefit. The revised measures will be in a separate table. Descriptions of water bodies are in another table, they include their subdivisions, ecological status, number of inhabitants, possible pollutants, etc.

A functional model of the advisory system is given in Figure 3.

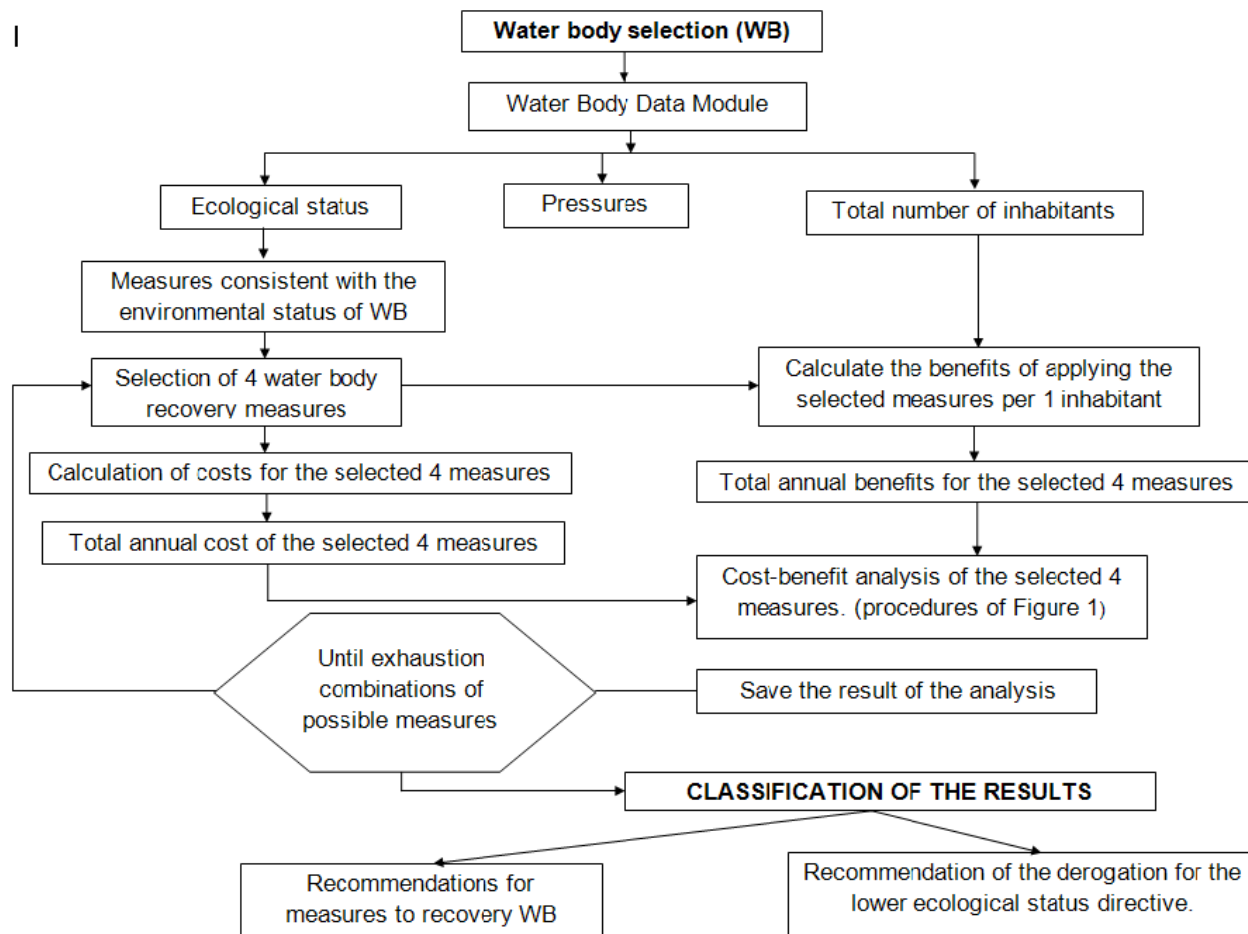


Fig. 3. Functional model of the Information Advisory System

In the "water body selection" module, the body or a section of it (sub body) for which the calculations will be performed is selected. The "Water Body Data Module" provides information to the user about the ecological status of the selected water body or sub body, possible pollutants (pressures) and the number of inhabitants living in its area.

From the table of measures, only those applicable to the respective ecological status of the selected body are separated. The measures are basic and additional. The analysis performed by the system is based on a selection of four measures. They may include one or two major measures, and the rest are additional. The system cyclically performs the cost-benefit analysis of all possible combinations of the four measures that are applicable to the status of the water body. The results are saved and sorted by the resulting cost-benefit ratio. The first few with the best ratio are presented to the user as the result. At each step, the benefits and costs of a resident according to quadruple measures are calculated. In order to study the sustainability of the results, an option with a 10% increase in costs is also calculated.

Conclusion

The development of this information advisory system would help decision-makers from the Basin Directorates and the Ministry of Environment and Waters to select more effective measures to achieve good ecological status of the waters in

certain mining areas. This means that with relatively smaller costs a better effect will be achieved.

If the system has a widespread application, it can easily be reworked as a Web based one.

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CONTEMPORARY APPROACHES TO DATA STORAGE AND PROCESSING

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ABSTRACT. The purpose of this article is to present modern approaches to data storage and processing. The NoSQL and NewSQL technologies are considered in which the focus shifts from common solutions (traditional relational database management systems) to individual ones. Attention is also paid to the data format so that they could be integrated into the information systems.

Keywords: information system, database, SQL, NoSQL, NewSQL

СЪВРЕМЕНИ ПОДХОДИ ПРИ СЪХРАНЕНИЕ И ОБРАБОТКА НА ДАННИ

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РЕЗЮМЕ. Целта на настоящата статия е да се представят съвременните подходи при съхранение и обработка на данни. Разглеждат се технологиите NoSQL и NewSQL при които фокусът се измества от общи решения (традиционни RDBMS) към индивидуални такива. Обръща се внимание и на формата на данните с оглед интегрирането им в информационни системи.

Ключови думи: информационна система, бази данни, SQL, NoSQL, NewSQL

Introduction

Contemporary databases operate with different data models. The aim is to represent the described real objects as accurately as possible. At the same time, the data form should allow their on-line, real-time processing (Fig. 1).

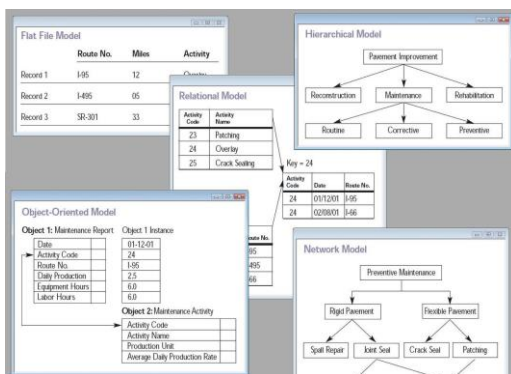


Fig. 1. Database models

In general, the evolution of database management systems (DBMS) can be described in three stages:

- Navigation systems – those were used in the 1960s and represented hierarchical and network models of data description;
- Relational - those were created in the 1970s and are used to this day. They are based on set theory and on relational algebra. The objects are described in the form of two-dimensional tables allowing for

connections (relations) between them. They use the SQL programming language;

- Post-relational – this category comprises a wide variety of data description methods. The object-oriented model was introduced in the 1980s, and the NoSQL and the NewSQL models have become popular in the recent decade.

The subject of this article is the final stage, and in particular the nature and application of the NoSQL and NewSQL databases and the major software tools and data formats used with them. While traditional relational database management systems are general-purpose (i.e. they provide uniform solutions to different types of problem), NoSQL and NewSQL solutions are intended for a specific problem, such as short-term Online Transaction Processing (OLTP) operations.

IDC predicts that the total amount of global data will grow from 33 ZB in 2018 to 175 ZB in 2025; the forecast is for an annual growth rate of about 60% (Reinsel, 2018). Cisco's forecast is similar: in 2022, the traffic generated will be higher than the total traffic during the first 32 years since the launch of the Internet (Cisco, 2019).

There are other remarkable stats for the year 2025:

- The storage industry will ship 42 ZB of capacity over the next seven years;
- 90 ZB of data will be created on Internet of Things (IoT) devices by 2025;
- By 2025, 49% of the data will be stored in public cloud environments;
- Nearly 30 percent of the data generated will be consumed in real-time by 2025.

The factors underlying such predictions are as follows:

- The ever-increasing computing power and data storage capacity of modern computers and smart devices;
- Promoting the Internet. The advent of Web 2.0 has enabled the passive user to become active, generating network distributed data;
- The increasingly accessible services offered by contemporary data centres and cloud computing;
- With the advent of Internet of Things (IoT) and Internet of Everything (IoE), it is not just the users who generate information; a huge part of the items we handle on a daily basis, too, begin to generate significant volumes of data that we can employ for various purposes;
- And last but not least, the business needs: industry needs more and more information to manage and analyse in order to maximise business benefits.

Inevitably, these trends result in a revision of classical data management methods. Collecting, storing, analysing, sharing, and visualising data, including unstructured and semi-structured data, has become increasingly difficult with the traditional tools and approaches. Thus, the need to effectively manage large data centres and cloud systems has led to the establishment of new methods and approaches in data modelling.

Mining industry is no exception to these trends. Besides, most of the tasks in the modern mining industry are characterised by a high degree of indefiniteness, non-linearity and multifactoriality (Eftimov et al., 2011) which hinders the application of classical analytical methods (makes them impossible to apply) to solve such tasks.

Approaches for the implementation of database management systems

SQL

The relational model was offered in 1970 by Dr. Edgar Codd. It was introduced massively in the 1980s and 1990s and has been dominant globally to this very day. According to DB-Engines Ranking (2019), four of the top five most popular data management systems are relational.

The relational model is based on set theory and relational algebra, and this rigorous mathematical basis leads to its main advantages: efficiency, simplicity and intuition (Codd, 1970).

The relational database management systems (RDBMS) describe the objects uniformly: through the rows of a two-dimensional table (Fig. 2). Each table contains unordered rows and named columns. The different tables can be linked together.

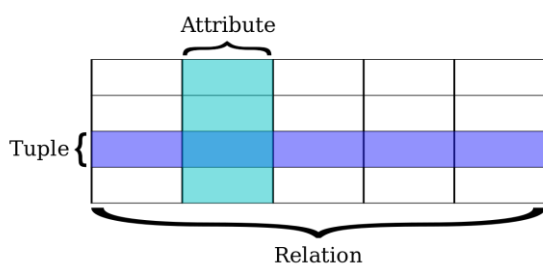


Fig. 2. Major elements in a relational table

The popularity of RDBMS is largely due to the fact that they allow multiple users to work simultaneously without compromising data integrity. This is achieved through strict adherence to ACID (Atomicity, Consistency, Isolation, and Durability) rules that describe the requirements for transactional systems (Gray, 1981):

- Atomicity – This is the ability of a DBMS to implement multiple commands as one. Database transactions must follow the all-or-nothing rule; if one part of the transaction fails, the whole transaction fails;
- Consistency - Each transaction changes the database from one state with consistent information to another such state; before and after the transaction the database must maintain its integrity;
- Isolation - This is a requirement that information in an operation which is being executed and has not been completed is not accessible; if the transactions are executed concurrently, none of them must affect the other. The transactions must be executed in complete isolation as if no other transaction was being performed. Contemporary databases adhere to this rule with some circumvention, through several different types of isolation level, and compromise is allowed in the name of reducing the number of deadlocks (READ UNCOMMITTED isolation level);
- Durability – Once verified as successfully completed, a transaction must be retained in the database even in the case of a power outage, or power crash.

The RDBMS use SQL as their basis. Most of the major developers of such systems (Oracle, IBM, Microsoft) have created their own SQL-based languages. Oracle, DB2, SQL Server, MySQL PostgreSQL, Access, etc. are popular RDBMS. Hence, another essential advantage of a RDBMS: SQL is standardised and there is a great deal of overlap among SQL implementations in various databases.

The most significant drawback of the relational model is the inability to scale horizontally due to the use of a relatively static object description scheme. Deterioration of the performance of a RDBMS is also observed with a significant increase in workload and the volume of work data.

NoSQL

Relational databases were not designed to handle the scale (Big Data), flexibility (web applications such as blogs, social networks, etc.) and real-time operation that are required by modern applications. In addition, they do not take full advantage of the low cost of storage devices, nor of the high performance of the machines we have at our disposal nowadays.

NoSQL encompasses a wide variety of database technologies that have been developed in response to the increasing amount of data stored for users, objects and products, the frequency with which this data is accessed, as well as the need of high performance in their processing.

The first NoSQL software appeared in the early 21st century: MongoDB (2009), Redis (2009), Cassandra (2008), etc. Today there is a wide variety of data models used in NoSQL systems. The most popular are shown in Figure 3:

- Key-value: here, information is stored in records of the “key-value” type and complex data structures, including XML, can be stored as “value”. The search

is performed via a key. Dynamo, Riak, Azure, Redis, Cache are such NoSQL databases;

- Document: the work data and related information are stored in documents, most often in the XML or JSON formats. This model resembles the key-value model, with the "value" being the document itself. Such models are MongoDB, CouchDB, Raven, BaseX, etc.;
- Wide column stores: again, a "key" is used, but this may point to a family of columns. Each record can have a different number of columns and can be placed in other columns called super columns. BigTable, Hbase, Cassandra, Accumulo are popular examples of column family database software;
- Graph: this works with graph structures. Data is modelled as a network of links between particular elements. Neo4J, Allegro, Virtuoso, Bigdata are such models;
- Multidimensional: Globals, SciDB, Minim DB.

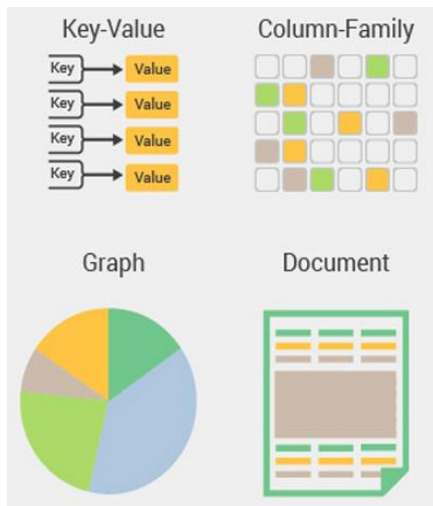


Fig. 3. Popular NoSQL models of data

Among the main advantages of NoSQL databases are: flexibility – they do not work with static schemes; scalability – they also allow for horizontal scaling; facilitated database transfer across multiple servers.

The biggest drawback to NoSQL systems is that they are not transitive.

Typically, NoSQL databases are used in distributed architecture systems, where the focus is on performance with the processing of large amounts of data. In such systems, the CAP Theorem (Brewer's Theorem) is observed (Brewer, 2000): "Up to two of the following categories can be guaranteed in a distributed system:

- Consistency (C): all database clients see the same information, even with competitive updates;
- Availability (A): all database clients can access any version of the information;
- Partition tolerance (P): The database can be partitioned over multiple servers.

The simultaneous provision of all three guarantees is impossible (Fig. 4).

The theorem proves that only two of these three pillars can be used to create such a system. In other words, we can have

a system of high consistency and expandability, or a system of high data availability and expandability, or a system of high consistency and high availability but expandability.

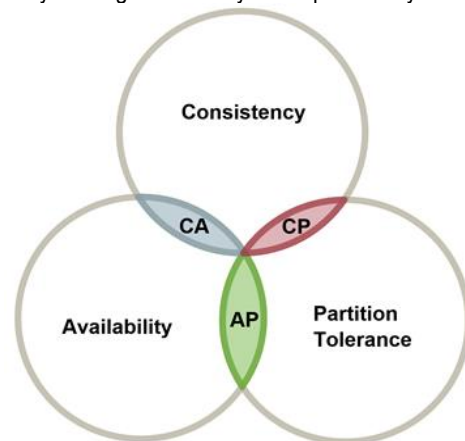


Fig. 4. The CAP theorem

Most NoSQL databases operate on the BASE (Basically Available, Soft-state, Eventual consistency) principle: choosing availability and partitioning at the expense of consistency and looking for the fastest and most reliable synchronisation among individual servers.

Numerous comparative analyses on the performance of RDBMS and NoSQL have been published. As a whole, NoSQL systems perform better when recording, deleting, and updating Bid Data sets.

NoSQL databases have limited application in specific areas; yet, the fact that they are used by IT giants like Google, Facebook, Amazon, and LinkedIn is a proof of their potential.

NewSQL

NewSQL databases have emerged in the past few years. The term NewSQL was proposed by Aslett (2010). These are databases that combine the benefits of SQL and NoSQL databases (Figure 5). NewSQL are horizontally and vertically extensible and transitive.



Fig. 5. Comparison between SQL, NoSQL, and NewSQL

The products described as NewSQL databases are very diverse. HANA was created to be a business reporting powerhouse that could also handle a modest transactional workload, a perfect fit for SAP deployments. Hekaton adds sophisticated in-memory processing to the more traditional Microsoft SQL Server. Both systems are non-clustering for now, and both are designed to replace or enhance OldSQL deployments directly. NuoDB set out to be a cluster-first SQL database with a focus on cloud-ops: it runs on many nodes across many data centres and lets the underlying system manage data locality and consistency for you. This comes at a cost in performance and consistency for arbitrary workloads. Other systems, such as MemSQL, focus on clustered

analytics. Distributed with MySQL compatibility, MemSQL often offers faster OLAP analytics than all-in-one OldSQL systems, with higher concurrency and the ability to update data as it is being analysed. VoltDB, the most mature of these systems, combines streaming analytics, strong ACID guarantees and native clustering. This allows VoltDB to be the system-of-record for data-intensive applications, while offering an integrated high-throughput, low-latency ingestion engine. It is a great choice for policy enforcement, fraud/anomaly detection, or other fast-decisioning apps (Piekos, 2015).

As a summary of the above, we can classify three major types of NewSQL databases:

- New architectures: databases that were designed to operate in a distributed cluster (Google Spanner, Clustring, VoltDB, MemSQL);
- SQL engines: highly optimised storage engines for SQL (MySQL Cluster, Infobright, TokuDB);
- Transparent sharding: they provide a sharding middleware layer to automatically split databases across multiple nodes (ScaleBase).

Very often, NewSQL databases are used for partial solutions within the context of RDBMS or NoSQL systems. The ultimate goal of NewSQL is to deliver a high performance,

highly available solution to handle modern data, without compromising on data consistency and high-speed transaction capabilities.

Conclusion

Although relational databases are one of the oldest technologies used in the IT industry, they are widely used nowadays. However, with the increase in the volume of data processed, and especially of those distributed in the web environment, some disadvantages of RDBMS have come to the fore that make them inapplicable in modern data storage and analysis systems, particularly when it comes to real-time processing of large arrays of data. Large companies increasingly prefer non-relational approaches when describing such data. If NewSQL databases still offer partial solutions, NoSQL has already established itself in certain areas as a better solution than classic RDBMS.

The trend of increasing the impact of NoSQL databases is also evident from the data on *DB-Engines Ranking* (2019) presented in Figure 6.

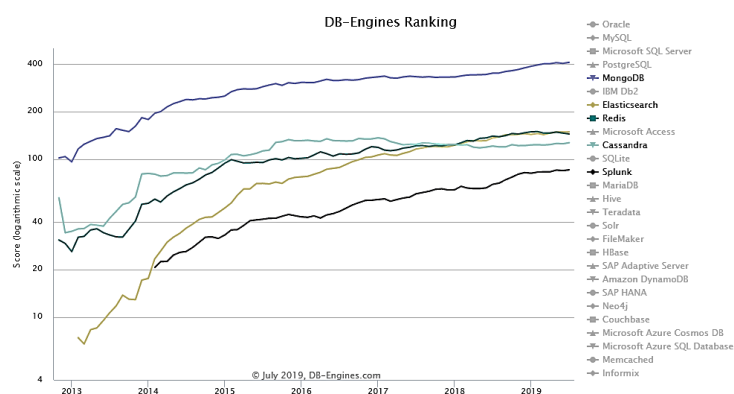


Fig. 6. Graph reflecting the popularity of the NoSQL systems used most often

The software used in the mining industry is characterised by diversity and specifics, both in terms of the type of mineral deposits and of the compliance with the requirements of the particular company (Kutzarov et al, 2012; Anastasova et al., 2016). This is a prerequisite for integrating NoSQL data models in it due to their flexibility.

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ANALYSIS OF APPROACHES TO CUSTOMISATION OF AUTODESK-PRODUCTS

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ABSTRACT. Some of the most popular CAD-systems worldwide are the products by the Autodesk company, and AutoCAD in particular. One of the reasons for this popularity is the variety of tools and methods for customising the product. This article is a review and an analysis of the methods and techniques for the customisation of Autodesk products. The focus lies mainly on the programming languages which can be used for this purpose.

Keywords: AutoCAD, custom settings, programming languages, shape, hatch pattern

АНАЛИЗ НА ПОДХОДИ ЗА ПОТРЕБИТЕЛСКИ НАСТРОЙКИ НА СРЕДАТА В AUTODESK-ПРОДУКТИ

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РЕЗЮМЕ. Едни от най-разпространените в света CAD-системи са продуктите на фирма Autodesk, в частност AutoCAD. До известна степен това се дължи на факта, че за тези продукти има развити средства и методи за тяхната потребителска настройка. В настоящата статия се прави обзор и анализ на начините и техниките за потребителски настройки на средата на Autodesk-продукти, като се акцентира главно върху езиците за програмиране, които могат да се ползват за целта.

Ключови думи: AutoCAD, потребителски настройки, езици за програмиране, шейпове, шаблони за шриховане

Introduction

The Autodesk Company is undeniably a world leader in producing graphic software. Its CAD-systems are some of the most commonly used worldwide. There are probably many reasons for this popularity, however one of them certainly is the ability to customise the products' settings and to extend them with additional functionality, in order for specific custom tasks to be solved. Autodesk provides various tools for this purpose.

Custom settings are useful in two aspects:

- They make work faster and easier for every single person;
- They facilitate team work when unifying the system settings for all participants in a given project.

Therefore, it is useful for users to be familiar with the customisation options.

The Autodesk company itself suggests 8 Top Ways to Customise AutoCAD (Top Ways to Customise AutoCAD, 2019):

- *Exchange Apps.* The Exchange Apps marketplace includes general productivity tools, drawing content, and applications created by third party publishers for specific disciplines. The apps are easy to download and install.
- *Scripts.* Script files are ASCII text files with the file extension .scr and can be edited using a simple text editor such as NotePad on Windows or TextEdit on Mac OS. If you can type commands and options at the command line, you can write a script file.

- *Action Recorder.* Use the Action Recorder to record commands and input values that you can play back as an action macro to automate repetitive tasks.
- *Command Aliases.* Command alias are shortened command names that can be entered at the Command prompt as an alternative to the standard full command name and are stored in a program parameter PGP-file.
- *Dynamic Blocks.* Dynamic blocks contain rules, or parameters, for how to change the appearance of the block reference when it is inserted in the drawing.
- *Customisable and expandable ribbon UI.* Customise and expand the ribbon tabs, panels, and tools to suit your needs and meet your company's standards. It's easy to do in the Customise User Interface (CUI) dialog box.
- *Profiles.* Profile settings can include information such as default search and project file paths, template file locations, default linetype and hatch patterns, and printer defaults.
- *Plotter Configurations and Plot Styles.* Create plot configurations to configure your output devices for publishing or plotting drawings. Use custom plot styles to specify how object properties such as colour and lineweight are represented when plotted.

Custom settings can be categorised in two main groups:

1. Settings in command CONFIG, changes in GUI and setting suitable values for the system variables in AutoCAD.
2. Creating new types of objects.

What is characteristic for the first group is that the settings are set mainly in a dialog mode. They are relatively well documented and are not subject of the current article.

The second group is more interesting, since the creation of new objects can lead to automating some elements of designing and thus increase effectiveness of the work. The current article introduces these customisation aspects.

To improve readability, from now on the term „Autodesk-products” will be replaced with AutoCAD. This is the first product of Autodesk and one of the most popular CAD-systems for universal use worldwide. Everything presented in this article is valid not only for AutoCAD, but also for the other products of Autodesk that allow programming. The light ("LT") versions of the products make an exception, since they do not provide programming options except for the language DIESEL.

Creating new object

The AutoCAD user is given the opportunity to create new objects like line types, hatch patterns, menus (changes in GUI of the system generally), shapes, additional commands. This article will not treat the changes in GUI of the system since there are suitable means this to be done. Creation of blocks, dynamic blocks and blocks with attributes will not be commented here either, since it is given in almost each AutoCAD course and is described in many books. Creation of libraries with graphic symbols can be found in (Guneva, Trifonova, 2001).

Autodesk offers a couple of programming languages for creation of new commands.

The definitions of new line types, hatch patterns and shapes are to be fixed in external text files under a defined format. Three commands: MkLtype, MkShape and SuperHatch (Fig. 1a, b) have been added in "Express Tools" module since 2010. The first two of them generate automatically the text files defining line types and shapes, respectively, and the third one hatches a given closed area without creating any file defining the hatch pattern.

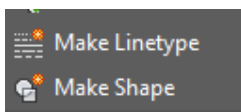


Fig. 1a.

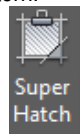


Fig. 1b.

"Express Tools" represent a set of functions, developed by Autodesk fans. The company spreads them under the explicit condition that it bears no responsibility for their good performance. "Express Tools" commands are available only if it is indicated explicitly in the course of AutoCAD installation that they should be installed.

It is a good idea Autodesk App Store to be checked for the available elements before undertaking creation of new objects. If the needed objects are available in Autodesk App Store they can be downloaded from there.

Creating shapes

Shapes are objects similar to blocks. Shapes are much more effective in the aspect of speed of visualisation and memory needed for saving, compared to the blocks. However, nowadays shapes are used only for the creation of complex types of lines due to the obstacles and limitations going along with their creation.

Contemporary versions of AutoCAD offer two ways for creation of shapes.

- using MkShape command (if Express tools is installed);
- manual creation of text file with extension shp.

The first approach is incomparably easier. It needs the shape image to be drawn first on the screen using AutoCAD commands then MkShape generates the shp-file and automatically compiles it to shx-file that AutoCAD is to use. Neither knowledge about the shapes description rules nor acquaintance with source shape files structures are needed. However, sometimes the results provided by MkShape are unsatisfying in the aspect of visualisation and are extremely ineffective. For example, to create a shape named Z2, representing a circle with a radius 1, MkShape generates the following content:

```
*1,58,Z2
4,101,4,99,3,125,3,5,3,64,002,9,(4,0),(0,0),001,9,(-1,2),
(-2,2),(-2,0),(-2,-2),(-1,-2),(1,-2),(2,-2),(2,0),(2,2),(1,2),(0,0),
002,9,(-4,0),(0,0),001,4,64,4,5,4,125,3,99,3,101,0
```

While it may be defined as follows:

```
*2,7,Z2
2,010,1,10,(1,000),0
```

Both definitions of the shape Z2 generate all the same image – a circle with a radius 1 and base point - the centre of the circle. In principle, the effectiveness of the visualisation depends on the count of the numbers in the description of the shape. That is why it is desirable this count to be minimised. In the example above the shape Z2 description contains 7 numbers in the case of the manual generation and 58 - in the case of the automated one.

On Figure 2(a, b) the visualisation of this shape is shown, resulting from the first and the second definitions, respectively.

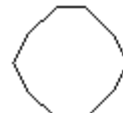


Fig. 2a.



Fig. 2b.

The example above shows, that the command MKShape (when available) needs to be used very carefully. Its application has to be reduced to private needs. If it is necessary to create shapes for other clients, it is recommended to take the manual approach. The rules for defining these objects need to be respected. They can be found in (AutoCAD documentation, 2019).

Creating linetypes

Although AutoCAD contains more than 80 in-built linetypes, they do not cover the standards in many countries, including Bulgaria. For different purposes, e.g. for the needs of the cadastre, telecommunications, architecture and others, new types of lines need to be created. There are two kinds of linetypes: simple and complex. They are described in text files with the extension lin.

Similar to the work with shapes, in all contemporary versions of AutoCAD, provided Express Tools are installed, linetypes can be created in two ways: manually and automatically, using the command MkLtype. Experiments show that the results of working with the command MkLtype correspond to the results of manually generating linetypes to a sufficient degree. This makes the command comfortable to use

and thus, there is no need to be familiar with the structure of lin-files.

Creating hatch patterns

Two text files are attached to AutoCAD, each of them containing the definitions of more than 60 hatch patterns. Yet, in many cases the creation of new hatch patterns is necessary. In Figure 3 some patterns created for the needs of geology are shown.

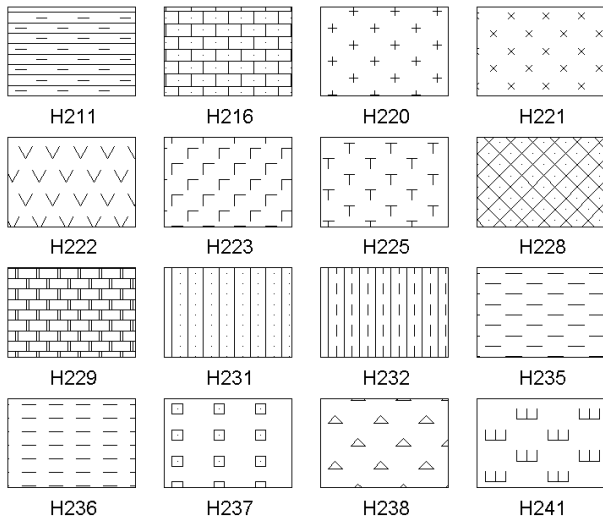


Fig. 3.

Definitions of hatch patterns are written in a text file with the extension pat. Creating such files is a difficult and time consuming process. For example, the definition of the in-built SWAMP hatch pattern in AutoCAD consists of the following text:

```
*SWAMP, Swampy area
0, 0,0, .5,.866025403, .125,-.875
90, .0625,0, .866025403,.5, .0625,-1.669550806
90, .078125,0, .866025403,.5, .05,-1.682050806
90, .046875,0, .866025403,.5, .05,-1.682050806
60, .09375,0, .5,.866025403, .04,-.96
120, .03125,0, .5,.866025403, .04,-.96
```

This is one of the simple patterns, since it contains only 6 lines of description. There are hatch patterns with more than 40 lines in their definitions (e.g. GRAVEL).

SuperHatch command of Express Tools can be handy when hatching. It doesn't generate a file defining the hatch but directly hatches the closed area of the current drawing. This command is especially useful when a closed area is to be hatched with a kind of texture.

When the hatch pattern is an aggregate of linear objects that are evenly/regularly spread within the hatched area especially when they are a checkered pattern then the results provided by SuperHatch command are unsatisfying. On fig. 4a and Fig. 4b the results of hatching using additionally defined hatch pattern (Fig. 4a) and by SuperHatch command (Fig. 4b) are shown.

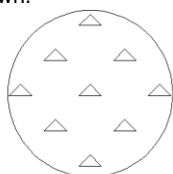


Fig. 4a.

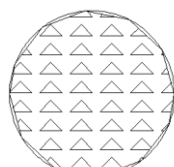


Fig. 4b.

The hatch pattern on Figure 4a stands for galena mineral (triangles with fixed dimensions spread in a checkered pattern). Such a result is impossible to be obtained by SuperHatch command. Furthermore, the SuperHatch command needs the hatching image to be created as a block before the command entering or the image should be uploaded from an external file.

The example above shows that no matter how easy the dialogue with SuperHatch is there are cases when manual creation of hatch patterns is necessary. This is valid especially in the cases when applications for other users have to be developed in AutoCAD. Description of pat-files can be found in (Creating custom hatch patterns, 2019).

Creation of supplementary commands. Programming languages for AutoCAD

The functionality of AutoCAD can be extended using several programme languages. Nowadays, supplementary commands are created mainly using AutoLisp/Visual Lisp, ObjectARX and .NET. Script files, action macros (automatically generated macros), menu macros and code using DIESEL language can hardly be applied to important applications due to the limited abilities of these means. The application of VBA (Visual Basic for Applications) was limited when .NET appeared. VBA was replaced by VB.NET.

AutoLisp and Visual Lisp are useful for creating commands with a simple graphical interface that do not have many arithmetic calculations, but the use of built-in AutoCAD commands or extraction of information from the graphical database prevails (Trifonova et al., 2015). These languages offer extremely powerful and flexible means for choosing graphic objects corresponding to fixed requirements. This is the function ssget (Trifonova, 2015). For example, to generate the selection set of all red circles and all green lines it should be typed in as follows:

```
(ssget "X"
(
(-4 . "<OR")
(-4 . "<AND") (0 . "LINE") (62 . 3) (-4 . "AND>")
(-4 . "<AND") (0 . "CIRCLE") (62 . 1) (-4 . "AND>")
(-4 . "OR>")
)
)
```

Geometric restrictions can be imposed on the selected objects as well, for example, in order to generate the selection set of all lines with starting point having the following coordinates x= 3, y> 10 and arbitrary z value the following should be typed in:

```
(ssget "X" '((0 . "LINE") (-4 . "=>,*") (10 3.0 10.0 0.0)))
```

To do the same task using ObjectARX or .NET would be a heavy procedure. It is not by chance that the number of AutoLisp/Visual Lisp files in "Express Tools" is over 78% out of the total number of the files in it.

The main disadvantage of AutoLisp/Visual Lisp in comparison with ObjectARX and .NET are the difficulties related to the creation of dialogue boxes due to the limited abilities of DCL (Dialog Control Language). In addition, ObjectARX and .NET are event-oriented and this type of programming has many advantages.

ObjectARX and .NET are more used nowadays due to the fact that in most universities procedural programming languages like C++ and C# are taught and functional programming languages like AutoLisp/Visual Lisp are rarely discussed.

The optimal option when plug-ins for AutoCAD are developed professionally in AutoCAD is creation of projects where files are generated using different languages so that it can be made use of the advantages of each one of them.

Conclusion

Optimisation of the work of the users of Autodesk products, especially when they work in a team, depends both on the suitable adjustment of the environment assignment and the presence of necessary new elements to be used.

Usage of contemporary programming languages can extend to a large degree the functionality of Autodesk products. A detailed knowledge on programming languages in Autodesk environment allows the process of creation of plug-ins to be optimised.

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USING SIMULATION MODELLING IN TEACHING THE GAME THEORY ELEMENTS

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ABSTRACT. The paper presents the author's attempt to use simulation modelling in the teaching of zero-sum matrix games. A matrix game with a 2x2 dimension is selected, which has a solution in mixed strategies. The conditions of the game are such that the solution obtained by applying the corresponding formulas seems paradoxical and questionable for the students. The correctness of the solution is confirmed by conducting a simulation experiment in the Microsoft Excel environment. At each stage of the teaching process, a survey is conducted. The statistical processing of survey data shows that the demonstration of simulation modelling results has the greatest impact on the learning of the curriculum.

Keywords: simulation modelling, game theory

ИЗПОЛЗВАНЕ НА СИМУЛАЦИОННО МОДЕЛИРАНЕ ПРИ ПРЕПОДАВАНЕ НА ЕЛЕМЕНТИ ОТ ТЕОРИЯТА НА ИГРИТЕ

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РЕЗЮМЕ. В настоящата работа е представен опит за използване на симулационно моделиране при преподаване на учебен материал от областта на матричните игри. Избрана е матрична игра с размерност 2x2, която може да се реши с прилагане на съответния аналитичен апарат, но полученият резултат предизвиква съмнение у студентите. Верността на решението се потвърждава с провеждане на симулационен експеримент в средата на Microsoft Excel. Оказва се, че експерименталното потвърждение на теорията оказва благотворно решаващо влияние върху усвояването на учебния материал.

Ключови думи: симулационно моделиране, теория на игрите

Introduction

Teaching is not just a transfer of information from the teacher to the learner. The memorisation of statements and facts is not enough. It is necessary to create conviction in their truth. Hence, the teaching material should be presented in such a way as to be credible. The attitude of the learner is very important. If his interest is awakened appropriately, teaching will achieve its goals.

The development of modern information technologies in the transition from the industrial to the information society (Georgiev, 2015) creates the opportunity to apply various innovative methods, which are capable of provoking a positive reaction of the learner belonging to the highly interactive generation (Atanasov, 2018; Atanasov, Ivanova, 2019). Unfortunately, however, the blackboard is still being applied, and the electronic materials are not being fully used (Kalev, 2019).

The above is also true for the teaching of mathematical disciplines. Computers are mostly used to present static training material (for example, as a Power Point presentation). They replace the classic blackboard without using their full potential. There is a positive experience with the use of software products that enable the rapid solution of classical problems, such as using Excel to solve the task of dynamic programming (Milkova, Yordanova, 2014). The authors use a computer to facilitate calculations for solving a deterministic

problem. However, it should be noted that this is not a new way of solving. Manual solving and computer solving use the same algorithm. This saves learning time. It is possible to solve more examples and to confirm the validity of the theory, but the theory is confirmed in the same way. The teaching pattern is from the theory (as a formal algorithm) to the practice (executing the formal algorithm with specific data). In the technical disciplines, for example, it is possible to conduct physical model experiment or 3D modelling with application software such as CAD/CAM (Kalev, 2011) to support the theoretical statements. This is a more difficult in abstract mathematical disciplines.

The acquisition knowledge process is a process of denying wrong ideas. Some of them are too persistent. Often the denial contradicts the 'common sense'. In such cases, the best way to achieve new knowledge is to present examples and analogies. The more diverse they are, the more plausible the new statement seems to be. Such are the views of Polya (1968). He describes patterns of reasoning in which the belief that a statement is true depends on how it is confirmed by its implications. If they are many and different, the statement is much more credible. Hence, the similar applications of the theory are not so credible.

Polya gives remarkable examples in the area where deterministic problems are dealt with. The task is more difficult in the area of stochastic problems. In this case, the best way is to conduct an experiment. Classical probability theory patterns

(drawing balls from an urn, coin flipping, etc.) require a time that limited curriculum does not allow. Also, these are boring repetitive actions and could repel the young people who are accustomed to dynamic modern life. To avoid this contradiction, suitable software and technical means may be used. They are now widely available. Thus, teaching can be even attractive (Shabanova et al., 2017). There are available tools that allow the creation of models to obtain new knowledge (Mihaylov, 2017).

Methods and Results

The hypothesis has been formulated that the presentation of an appropriate example or experiment is essential to persuade learners in the truth of theoretical statements that have a higher degree of abstraction.

To verify the hypothesis, an experiment was conducted with 12 students studying elements of game theory. The Microsoft Excel simulation modelling capabilities were used to represent the probability model. These capabilities are not developed enough, but are sufficient to achieve the goal.

The following knowledge presentation pattern has been designed:

1. Formulating a problem whose obvious solution is wrong.
2. Explanation of a theory statement which gives true solution, but this solution seems non-plausible.
3. Conducting a convincing experiment that confirms the theory.

An anonymous survey was conducted at each stage.

It should be noted that the announcement that an experiment and a multi-stage survey will be conducted during the classes and the dealing of the questionnaires caused excitement among the students.

The game called Odd or Even was presented to the student. The rules of the game are:

The players X и Y announce simultaneously and independently of each other one of the numbers 1 or 2. If the sum is even, then X pays to Y this sum. If the sum is odd, then Y pays to X this sum.

This game is classical Zero-Sum-Game. The payoff matrix is

$$H_{2 \times 2} = \begin{vmatrix} -2 & 3 \\ 3 & -4 \end{vmatrix}.$$

The first question from the questionnaire was if game rules gave advantage to one of the players. Possible answers and the number of students who have responded to each of them are:

- A) The first player has an advantage - one student.
- B) The second player has an advantage - three students.
- C) Neither of the two players has an advantage, the game is fair-play - eight students.

In the second stage it was shown how to solve the game. The optimal X strategy $P^* = (p_1^*, p_2^*)$, the optimal Y strategy $Q^* = (q_1^*, q_2^*)$ and expected game value V were calculated using formulas (Neumann and Morgenstern, 1953, pp. 172-173):

$$p_1^* = \frac{h_{22} - h_{21}}{h_{22} - h_{21} + h_{11} - h_{12}} =$$

$$= \frac{-4 - 3}{-4 - 3 - 2 - 3} = \frac{7}{12}$$

$$p_2^* = \frac{h_{11} - h_{12}}{h_{22} - h_{21} + h_{11} - h_{12}} =$$

$$= \frac{-2 - 3}{-4 - 3 - 2 - 3} = \frac{5}{12}$$

$$q_1^* = \frac{h_{22} - h_{12}}{h_{22} - h_{21} + h_{11} - h_{12}} =$$

$$= \frac{-4 - 3}{-4 - 3 - 2 - 3} = \frac{7}{12}$$

$$q_2^* = \frac{h_{11} - h_{21}}{h_{22} - h_{21} + h_{11} - h_{12}} =$$

$$= \frac{-2 - 3}{-4 - 3 - 2 - 3} = \frac{5}{12}$$

$$V = \frac{h_{11} \cdot h_{22} - h_{12} \cdot h_{21}}{h_{22} - h_{21} + h_{11} - h_{12}} =$$

$$= \frac{8 - 9}{-4 - 3 - 2 - 3} = \frac{1}{12}$$

The result shows that the game rules give advantage to the first player. The expected value is equal to 1/12.

The students were asked how they accepted this result. Possible answers and the number of respondents were:

- A) I totally reject the solution result because of distrust – two students.
- B) I rather reject the solution result because of distrust – one student.
- C) I am confused. This is contrary to the common sense – eight students.
- D) I rather accept the solution result with confidence – one student.
- E) I totally accept the solution result to be true – no one.

Multiple simulations of this game were demonstrated. The Microsoft Excel function RAND() was used. When the random value was less than 7/12 this meant the player chose his first strategy. In the opposite case the second strategy was chosen. Twenty sets of simulations (1000 simulations per set) were performed. The finite result was arithmetic mean of set's results. The example of simulations is shown on Figure. 1. The fact that the difference between theoretical result and simulation is less than 0.1 can be easily seen.

$$\frac{|V - \tilde{V}|}{V} = 0,0996.$$

	A	B	C	D	E	F	G	H	I	J	K	L	M
1					p1=	7/12							
2					p2=	5/12							
3	H=	-2	3		q1=	7/12							
4		3	-4		q2=	5/12	Set	Value					
5								1	0,18		V=	0,0833	(Theoretical)
6								2	0,059				
7		X		Y		V		3	0,234				
8	1	0,55	1	0,934	2	3		4	0,055		V̂=	0,0916	(Simulation)
9	2	0,47	1	0,065	1	-2		5	0,038				
10	3	0,27	1	0,119	1	-2		6	0,074				
11	4	0,63	1	0,325	1	3		7	0,153				
12	5	0,41	1	0,202	1	-2		8	-0,005				
13	6	0,14	1	0,139	1	-2		9	0,199				
14	7	0,56	1	0,454	1	-2		10	-0,069				
15	8	0,8	2	0,831	2	-4		11	0,07				
16	9	0,53	1	0,667	1	3		12	-0,009				
17	10	0,35	1	0,534	1	-2		13	0,113				
18	11	0,56	1	0,861	2	3		14	0,04				
19	12	0,08	1	0,531	1	-2		15	0,107				
20	13	0,86	2	0,686	1	-4		16	0,127				
21	14	0,84	2	0,317	1	3		17	0,201				
22	15	0,23	1	0,898	2	3		18	0,138				
23	16	0,33	1	0,414	1	-2		19	0,12				
24	17	0,29	1	0,035	1	-2		20	0,029				
25	18	0,79	2	0,845	2	-4							

Fig. 1. Matrix game simulations

It was explained to the students that in order to obtain closer to the theoretical result a large number of simulations must be performed. So, in the sets with only 1000 simulations, it is possible that the second player wins (as in set 8, 10 and 12 in Figure 1).

After simulations the students were asked again how they accepted the result. Now the distribution of respondents was:

- A) I totally reject the solution result because of distrust – one student.
- B) I rather reject the solution result because of distrust – no one.
- C) I am confused. This is contrary to the common sense – no one.
- D) I rather accept the solution result with confidence – six students.
- E) I totally accept the solution result to be true – five students.

Discussion

The purpose of the first question in the survey is to provoke students to appreciate the matrix game from the point of view of 'common sense', which in this case is misleading. The majority answer that the game is fair. Their logic is understandable – the sum of all payoffs is zero. It is subconsciously assumed that the choice of strategies is in equilibrium, which is not an optimal solution.

This provocation leads to the fact that only one student accepts the solution of the game, obtained with formulas, with confidence. Everyone else is confused or openly express their mistrust.

However, the simulation experiment has led to a sharp change. Neutral confusion has already disappeared. Only one student still does not believe in the solution. Everyone else accepts it with confidence (some of them 'rather accepts').

	Y_1	Y_2	
X_1	$a = 11$	$b = 1$	$a + b = 12$
X_2	$c = 1$	$d = 11$	$c + d = 12$
	$a + c = 12$	$b + d = 12$	$n = 24$

Fig. 2. Survey results

X_1 - result before the simulation;

X_2 - result after simulation;

Y_1 - students which reject the solution result or are confused;

Y_2 - students which rather accept the solution result with confidence or accept the solution result to be true.

The summarised results of the survey are shown in Figure 2.

Statistical analysis of the results should be done to assess the impact of simulations on the change in student's attitudes. Two hypotheses are formulated:

Null hypothesis H_0 – there is not a significant impact of the simulation on students' attitude and on teaching process.

Alternative hypothesis H_1 – there is a significant impact of the simulation on students' attitude and on teaching process.

The sample (number of students) is small, so the Fisher's Exact Test should be used (Fisher, 1954, 96-97).

Let $P(Y_1)$ и $P(Y_2)$ are the probabilities of events Y_1 и Y_2 and there is not an impact of conditions X_1 и X_2 on these events. Then the probability of obtaining the frequencies a, b, c, d (Fig. 2) is equal to

$$P = \frac{(a+b)!(c+d)!(a+c)!(b+d)!}{(a+b+c+d)!} \cdot \frac{1}{a!b!c!d!}.$$

The sums $(a+b)$, $(c+d)$, $(a+c)$ and $(b+d)$ should not be changed. It is possible to determine other frequencies whose departure is more extreme from independence. These are $a=12$, $b=0$, $c=0$, $d=12$ only. Finite probability that $P(Y_1)$ and $P(Y_2)$ are not dependent on X_1 and X_2 is the sum of the probability of observed frequencies (Fig. 2) and the probabilities of more extreme frequencies, i.e.:

$$P = \frac{12! \cdot 12! \cdot 12! \cdot 12!}{24!} \cdot \left[\frac{1}{11! \cdot 1! \cdot 1! \cdot 11!} + \frac{1}{12! \cdot 0! \cdot 0! \cdot 12!} \right] = \\ = \frac{145}{2704156} \approx 5,36 \cdot 10^{-5}$$

Hence the probability that $P(Y_1)$ and $P(Y_2)$ are independent from X_1 и X_2 is a small value. The null hypothesis is unlikely and is rejected in favour of the alternative hypothesis. There is significant impact of the simulation on students' attitude and on the teaching process.

Conclusions

This study shows that experiments could be used to teach disciplines traditionally considered to be theoretical. It turns out that in this way the interest of the audience can be provoked, which has a positive effect on the perception of the educational content. The computer equipment and software are available (to be read 'cheap') and this is a great advantage. In addition, computers should not be used only for presentations but for demonstrating models and solving problems in different areas.

The results of the survey and the statistical analysis of the obtained data show that the simulation experiment played an

important role in the perception of the study material in this class. Wider application of such methods would help to increase the learners' interest in the subjects taught and to acquire more stable knowledge.

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PERSONALISATION OF DISTANCE AND E-LEARNING FOR LEARNING CONTENT

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ABSTRACT. Personalisation of learning, i.e. adapting the learning content according to the specific preferences, needs, interests and learning styles of each learner, increases the efficiency of e-learning and distance learning. A large number of training courses on one and the same subject can be found on the Internet, presented in different ways, with varying degrees of multimedia use, of different duration and degree of complexity. The learner has the difficult task to choose from the wide variety of electronic courses the most appropriate one for his style of learning, basic competencies and skills. This is not always possible, and even when finally a course is chosen, the probability of achieving the initial goal (reaching a certain level of competence on a given issue) for a short time is quite small. The article discusses the individualisation of learning as a set of procedures, approaches and techniques to provide learners with the means to make progress in their own capacities and leisure, to choose the type and mode of delivery of teaching materials on the basis of their preferences.

Keywords: personalisation, adaptive approach, e-learning and distance learning

ПЕРСОНАЛИЗИРАНЕ НА ОБУЧЕНИЕТО ПРИ ЕЛЕКТРОННИ И ДИСТАНЦИОННИ ФОРМИ ЗА ПОЛУЧАВАНЕ НА УЧЕБНО СЪДЪРЖАНИЕ

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РЕЗЮМЕ. Персонализирането на обучението, т.е. адаптиране на учебното съдържание на базата на специфичните предпочитания, потребности, интереси и стил на учене на всеки обучаем повишава ефективността на електронното и дистанционно обучение. В Интернет пространството могат да се открият твърде много учебни курсове по една и съща тема, поднесени по различен начин, с различна степен на използване на мултимедия, с различно времетраене и степен на сложност. На обучаемия е поставена трудната задача сам да отсее от голямото разнообразие електронни курсове най-подходящия за неговия стил на учене, базисни компетенции и умения. Това не винаги е възможно, а дори и да се стигне до избор на учебен курс, вероятността да се постигне първоначалната цел (достигане до определено ниво на компетенции по даден проблем) за кратко време е твърде малка. Статията разглежда индивидуализацията на обучението като набор от процедури, подходи и техники за предоставяне на обучаемите средства, които да им позволяват да напредват според своите възможности и свободно време, да избират вида и начина на доставяне на учебните материали на базата на предпочитанията си.

Ключови думи: персонализиране, адаптивен подход, електронно и дистанционно обучение

Introduction

Over the past two decades, e-learning and distance learning have become a part of our lives as a way to quickly and comfortably acquire new knowledge and skills without having to break away from our usual work.

Through the Internet, different educational institutions offer a variety of courses on topics that are of interest to us, and the problem for each learner is to choose the most appropriate and effective one for them, which is not an easy task.

Even if the learner chooses the best course according to understanding, there's no guarantee that he/she will achieve his/her original aim – i.e. the necessary set of competencies and skills, because his/her basic knowledge and competences rarely match with the style and manner of presentation of the educational content. In order for the learner to achieve the set goals there is an increasing need for the so-called personalisation (individualisation) of the training offered through various electronic and distance forms.

Requirements for the individualisation of the e-learning

The individualisation of learning could be seen as a set of procedures, approaches and techniques to provide the learners with learning content, which will enable them to progress according to their capabilities and free time, to choose the type and mode of delivery of learning materials based on their basic competencies and preferences (Aleksieva-Petrova et al., 2017). In addition, learners want their e-learning to be as close as possible to their personal style and way of acquiring the learning content, i.e. to be able to adapt the learning content to their knowledge, which is very difficult to be achieved.

The individualisation or adaptation of the learning content to the learners' personal characteristics is a complex process that requires:

1. Initial data collection for each learner, which includes at least:
 - Information about his/her interests;

- The level of knowledge in the field;
 - The style of studying and learning.
2. Sustained storage of the received data, its maintenance and use in the search for and supply of appropriate teaching materials;
 3. Accumulation and storage of learner behavioural data when interacting with the eLearning system, which means that the system needs to monitor and remember:
 - The topics of learning materials which the learner was searching for;
 - How often a particular learning material has been used;
 - What keywords have been used most often in search of information in the system;
 - What results have been achieved in the knowledge control,
 - Has the learner used learning materials which do not reflect his style of learning, etc.?
 4. Analysis of collected data on learners' behaviour.

The results obtained after the behavioural analysis can be used by developers of learning materials (in most cases, these are teachers or authors of the courses) to obtain adequate information to what extent their training units are of interest to the learners, if they are tailored to their needs and preferences and are useful for improving the individualisation of learning.

Approaches to e-learning personalisation

Segmentation

The first attempts to personalise the e-learning and distance learning are based on the so-called segmentation of the content. According to this approach, the learning content is divided into modules, each module incorporating a certain level of knowledge and skills, starting from the lowest level (for beginners in the proposed subject matter) and moving on to the next, more advanced levels of knowledge (Ivanov, 2012).

This approach has been borrowed from the traditional training methods, as it is most used in language teaching. Both in the traditional and e-learning, this approach necessitates the learner to undertake a test in order to determine the level of knowledge and depending on the results (i.e. the gaps in his/her knowledge), the learner is advised which level is appropriate for him/her. The learner has to achieve the results expected at the respective level before moving on to the next one (Fig. 1).

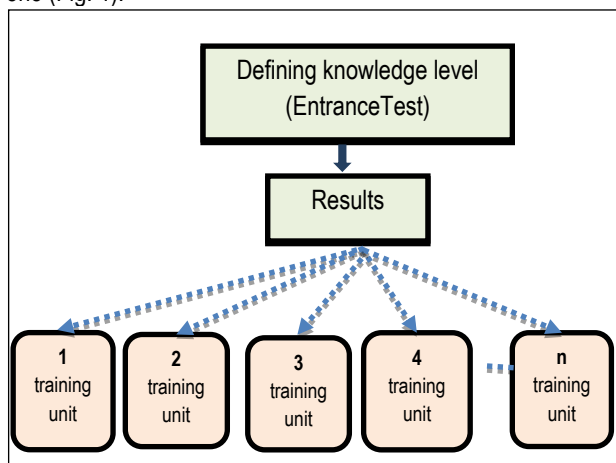


Fig. 1. Segmenting the learning content

The segmentation of the proposed content is not particularly appropriate for the personalisation of e-learning, as it only takes into account the level of knowledge of the learner, and not the style and manner of learning of each individual.

Personalisation (individualisation)

The most effective approach for personalising the learning is based on the dependence on the individual's learning style.

The learning style reflects the way the information is perceived and processed (Totkov, 2014). When a teacher knows the trainees' learning style, he can choose appropriate training methods to ensure learning efficiency (Yanev, Ivanov, 2016). It reflects the different ways in which people perceive, think, remember, and learn.

Each person gradually develops behaviour and specific approaches to learning, i.e. each individual has his/her own style of learning. This is related to three processes that are responsible for the differences in styles:

- Knowledge – the way of acquiring the knowledge;
- Rationalisation (conceptualisation) – each individual's ability to process the information;
- Motivation and emotions – decision-making process, values and emotional affiliations, which are strictly individual, hence this process is the most difficult to be summarised.

The approach used in modern distance and e-learning systems is to gather sufficient personal information in order to "recognise" the individual learning style of each learner. On the basis of this knowledge, the system could select appropriate learning content corresponding to the specific learning style.

The implementation of this approach is not an easy task, since in e-learning the teachers who provide the electronic content might have no direct contact with the learner, which makes it difficult to build a personal profile.

For this reason, in modern electronic and distance learning systems additional features are incorporated aimed at monitoring student's behaviour and storing characteristic information for each individual in the relevant database.

In order to comply with the relevant regulatory mechanisms on personal data protection and privacy of the information, prior to the training it is necessary each learner to be aware what kind of personal information the e-learning system collects and processes to customise the training. In case the learner does not agree to the processing of this type of information, he/she must be aware that it is impossible to get a customised training content and depending on the implementation of the e-learning system the learner can benefit only from the opportunity for segmentation or can access only specific modules.

The characteristic information collected by e-learning systems is organised generally in the so-called learner's profile, which is basically structured information in the relevant database, separated and describing the characteristics of each trainee. These characteristics most commonly include data about the learner's behaviour, abilities, habits, knowledge level, interests, etc. The characteristic information collected in the individual dossier of each learner is analysed and depending on the results, changes in the behaviour of the e-learning system are undertaken. These changes are usually called adaptation of the electronic and distance learning systems to the learner, and the accumulation of characteristic information about the learner – individualisation (personalisation).

Individualised e-learning takes the trainee out of the standard model of traditional learning. Using modern information technologies, the distance and e-learning systems and the modern communication systems provide the learner with an individual way of learning that includes:

- Individualisation of the provided learning content - in accordance with his/her knowledge and the type of information (text, graphics, audio, video, multimedia, etc.);
- Individual pace of learning;
- Maximum flexibility in terms of time, location and type of device (desktop computer, laptop, tablet, mobile phone) when acquiring the learning content;
- Possibility for individualisation of the current and end control.

To respond to these challenges, e-learning systems should be able to offer an individual learning environment tailored to the characteristics of each learner.

In order to implement this process in modern e-learning systems, training activities are designed to provide each learner with content adapted to his/her characteristics (Monova-Zheleva, Zhelev, 2007). The aim of this approach is to ensure maximum personalisation and the multiple use of adaptive learning activities. As a result, learners will interact with learning activities tailored to their style and specific characteristics.

In practice it is impossible to have e-learning systems with 100% personalised learning environments due to the differences in each individual. The purpose of the approach for customisation of training is to get closer as much as possible to the preferences of each learner (Fig. 2).

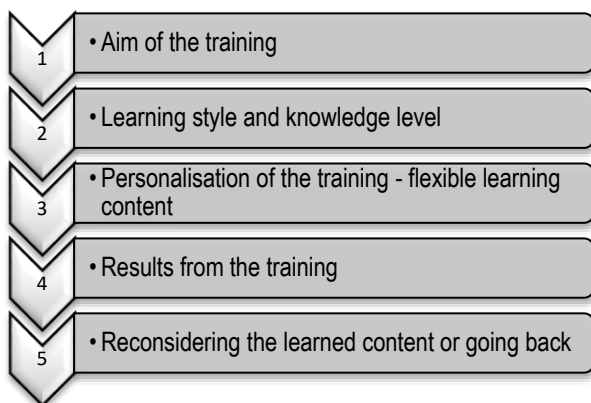


Fig. 2. Personalisation of the learning style according to the individual characteristics

To implement the personalisation, without breaching the requirements for personal data protection there is a need for standardisation and specifications of the systems, providing customised e-learning.

One of the consortia for e-learning – Instructional Management System Global Learning Consortium (IMS) – offers a set of certified products for creating e-learning content, providing this kind of specifications. The aim of the Consortium is for the design of the training units for electronic and distance learning to be more formalised and suitable for interpretation by computer systems.

The process of individualisation can be implemented both by building complex and to a large extent closed systems, and

by using multiple Web-based services. The architecture of e-learning systems offers a clustering of Web services at different levels, including:

- Agents providing the interface between the learners and the educational services. They combine user applications and programme agents to ensure the maintenance of essential elements in terms of the standards for e-learning systems. The agents guarantee the copyright of the educational content, manage the training and provide access to the training;
- Educational services that are a collection of data models and patterns of behaviour. The components constituting this level are characterised by functions that implement a particular behavioural pattern. Each service is identifiable, discoverable, platform independent and included in a grouped logical set. It also disposes of built-in tools to manage access and data protection rights.

Adaptive e-learning

The best results in personalisation of e-learning are provided by using adaptive learning. This is an educational method that uses sophisticated computer algorithms to organise the interaction of the e-learning system (respectively the teacher) with the trainee and to provide personalised resources and learning activities corresponding to his/her unique needs.

E-learning systems using this method, adapt (enable the system to modify) the provision or the presentation of learning content according to the specific needs of each learner as a function of the information about him/her (Ivanov, Zabunov, 2005). The information about a particular learner is obtained through monitoring, analysis and assessment of the achievements and results in the implementation of successfully passed tests, activities and tasks assigned to him/her and the experience gained.

The technology, which enables the implementation of adaptive e-learning systems, covers aspects resulting from the different areas of study, including information technology, using artificial intelligence, psychometry, education, psychology and brain science.

The IMS Simple Sequencing Specification (IMS SS) defines the method for presenting the planned behaviour, so that each training system to arrange consistently the discrete learning units. It defines the required functionalities and behaviours and includes rules, which describe the branch or the so-called flow of training according to the results from the interactions of the learner with the content. Sharable Content Object Reference Standard Model (SCORM) defines a specific way to build learning management systems (LMS). The various versions of SCORM manage basically two things in the e-learning systems: packing (separating appropriate units of study) of the proposed training content and continuous exchange of data during training.

The combination of the IMS SS specification and the SCORM standard allows the adaptive learning strategy to be transformed into sets of rules and operations that manage the sequence of learning activities. These rules are based on the learner's progress achieved in the learning process while simultaneously controlling the learner's access to the learning content.

On the basis of consistency rules for the content offered, the e-learning system registers each activity performed by the trainee. Its progress is monitored by determining the values of a set of characteristics used to record his/her achievements. The results of the analysis of these characteristics and the application of the rules set out in the system determine the further course of the training, i.e. they adapt the learning content according to the knowledge already acquired (Fig. 3).

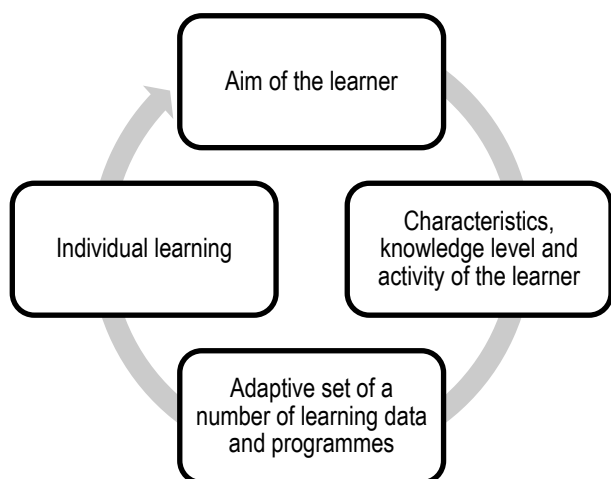


Fig. 3. General scheme of adaptive e-learning systems

Conclusion

The personalisation of learning in electronic and distance learning forms includes all three approaches – segmentation, individualisation and adaptation.

The learning content is divided into separate learning units (groups of topics) that are logically interrelated. The learner fills in a specialised set of e-content questions (so-called entry test) that determines the knowledge level (learning unit) from which the training process begins.

In the learning process, on the basis of an analysis of the information collected by the e-learning system on the style and the method for acquiring the learning content by the particular learner and the results displayed, the system selects the sequence, volume and type of materials to be used by the learner in order to reach a certain level of competence.

Depending on the results displayed by the learner in learning process, the e-learning system may adapt the learning

content for each individual, which is carried out through specific sets of rules and procedures.

The main advantages of personalisation and adaptability in the distance and e-learning systems are:

- Possibility to personalise the learning in a heterogeneous learners' group (learners with different levels of knowledge and learning styles);
- Creating a personal learning flow (individualised learning content delivery);
- Providing an approach which is as close as possible to the learner's style of learning;
- Focusing on filling in the knowledge gaps of each learner (offering additional learning content);
- More efficient use of training time.

According to statistics, the supply of learning content on the Internet has grown by 23% on average per year over the last five years. The large number of courses offered increase the learners' requirements, thus pre-supposing the demand for e-learning systems, which offer individual and adaptive approach to the utilisation of knowledge and competencies.

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APPLICATION FOR TRACKING THE WORKLOAD OF LECTURERS AND STUDENTS AT UNIVERSITIES

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ABSTRACT. This article presents modules developed for tracking the student workload, forming groups for tutorials and streams for lectures, as well as accounting the workload of lecturers from the University of Mining and Geology. These modules have been integrated in a comprehensive information system developed by a team of students and lecturers from the Department of Informatics. The modules provide a wide range of inquiry options for the different user categories. The focus lies on the interface and the interaction with the user and the options for mistake finding in the process of filling out the database.

Keywords: information system, database, object-oriented programming

ПРИЛОЖЕНИЕ ЗА ПРОСЛЕДЯВАНЕ НА УЧЕБНАТА ЗАЕТОСТ НА ПРЕПОДАВАТЕЛИ И СТУДЕНТИ ВЪВ ВУЗ

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РЕЗЮМЕ. Настоящата статия представя разработените и интегрирани към обща информационна система модули за проследяване на учебната заетост на студенти, формирането на подгрупи за упражнения и потоци за лекции, както и отчитане на натоварването на преподавателите от Минно-геоложкия университет. Предвиден е богат набор от справки за отделните категории потребители на системата, която се разработва от екип студенти и преподаватели от катедра „Информатика“. Акцентира се върху интерфейса и диалога с потребителя и възможностите за откриване на грешки в процеса на попълване на базата данни.

Ключови думи: информационна система, бази данни, обектно-ориентирано програмиране

Introduction

Most universities in Bulgaria have integrated and are using an information system (IS) for tracking and reporting of educational workload. Such a system has not been introduced to the work of UMG yet. As a first attempt in this direction an IS has been developed in 2018 as a part of the thesis of Milen Kiryakov. In it, modules have been introduced, whose main purpose is the automated generation of reports about planned and realised classes of UMG lecturers according to the regulations of the University. The system was developed in Visual Studio .NET in the language C#. The database was built up using MS Access and contains 10 tables. In the current year the work in this direction has been continued with two further master theses of CTE students under the guidance of Assoc. Prof. Yanev and Assoc. Prof. Trifonova. Thus, the first version of the IS has been developed in two directions:

1. Migrating of the database to MySQL Server. This has a number of advantages. As Yanev (2013) points out, the server provides the functions for creating and processing the database, keeps its comprehensiveness, offers back-ups of the database, and more. Furthermore, it provides restructuring the data from a relational to a hierarchical format – e.g. XML (Yanev, 2011).

2. Extending the functionality of the system. This is the topic of the current article.

Database Structure

The database of the application contains 20 tables (Fig. 1). It is in the third normal form. Some of the tables, in which the main data is contained, are as follows:

- Lecturers – first and last name, e-mail address, academic title, contract type, department;
- Course – code, full and abbreviated name according to the curriculum, timetable of lectures and tutorials, pursued degree;
- Stream – class type (lectures/tutorials), education form (regular/distance), automatically generated field for naming the stream showing the subject and the course of studies forming the stream, as well as an external key to the subject;
- Curriculum – subject number, course of studies number, semester number, number of weeks, course type, examination form, credit points.

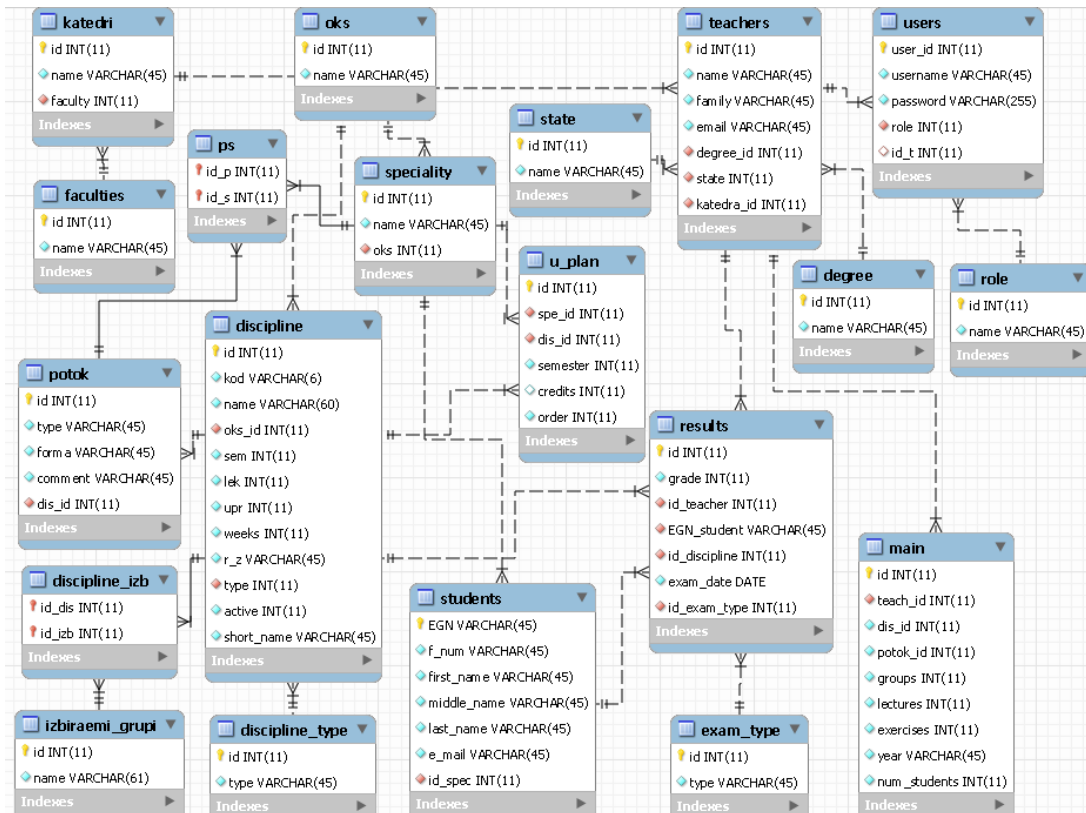


Fig. 1. Scheme of database

Potential of C# for database processing

To access database .NET Framework uses ADO.NET - set of libraries for database processing. ADO.NET is ADO-ActiveX Data Objects successor and offers a programming model for data processing. This model corresponds to both models for access to the data - linked and not linked (Nakov et al., 2005).

Main data providers in ADO.NET are as follows:

- **SqlClient** – meant for access to MS SQL Server (version 7.0 or later). This data provider is optimised for work with SQL Server;
- **OleDb** – this provider is applied for access to databases maintaining OLE DB standard. Most of the known servers aimed at databases processing (for instance, Oracle, DB2, SQL Server, MySQL, Interbase, PostgreSQL and others) have OleDb drivers and can be used through a OleDb provider;
- **Odbc** – is applied for access to databases corresponding to the ODBC standard. All better known database servers are maintained. OLE DB and ODBC are in general competing standards but OLE DB is the more contemporary one and should be preferred to ODBC because it provides more flexibility and has better maintenance.
- **Oracle** – aimed at access to Oracle sources of data.

Besides the standard data providers that are incorporated in ADO.NET, there are also providers for direct link with other RDBMS that are offered by third developers. Such exist for IBM DB2, MySQL, PostgreSQL, Borland Interbase and others.

As Nakov recommends (Nakov et al., 2005) for accessing databases that are not supported according to the standard by .NET Framework, it is desirable to use the .NET Data

Providers, which is specific for them, instead of OLE DB or ODBC as far as this reduces the productivity and limits the accessible functionality that is specific for the relevant database. That is why, for the purpose of the developed system the driver MySQL Connector/.NET has been installed in advance. This driver allows .NET applications to work with MySQL.

MySQL Connector/.NET comprises several classes that are used to connect to the database, execute queries and statements, and manage query results. The following are the major classes of Connector/.NET (*MySQL Connector*, 2019):

- **MySqlConnection**: Represents an open connection to a MySQL database.
- **MySqlConnectionStringBuilder**: Aids in the creation of a connection string by exposing the connection options as properties.
- **MySQLCommand**: Represents an SQL statement to execute against a MySQL database.
- **MySQLCommandBuilder**: Automatically generates single-table commands used to reconcile changes made to a DataSet with the associated MySQL database.
- **MySqlDataAdapter**: Represents a set of data commands and a database connection that are used to fill a data set and update a MySQL database.
- **MySqlDataReader**: Provides a means of reading a forward-only stream of rows from a MySQL database.
- **MySQLException**: The exception that is thrown when MySQL returns an error.
- **MySQLHelper**: Helper class that makes it easier to work with the provider.
- **MySQLTransaction**: Represents an SQL transaction to be made in a MySQL database.

Application interface

On Figure 2 a generalised scheme of application interface is shown

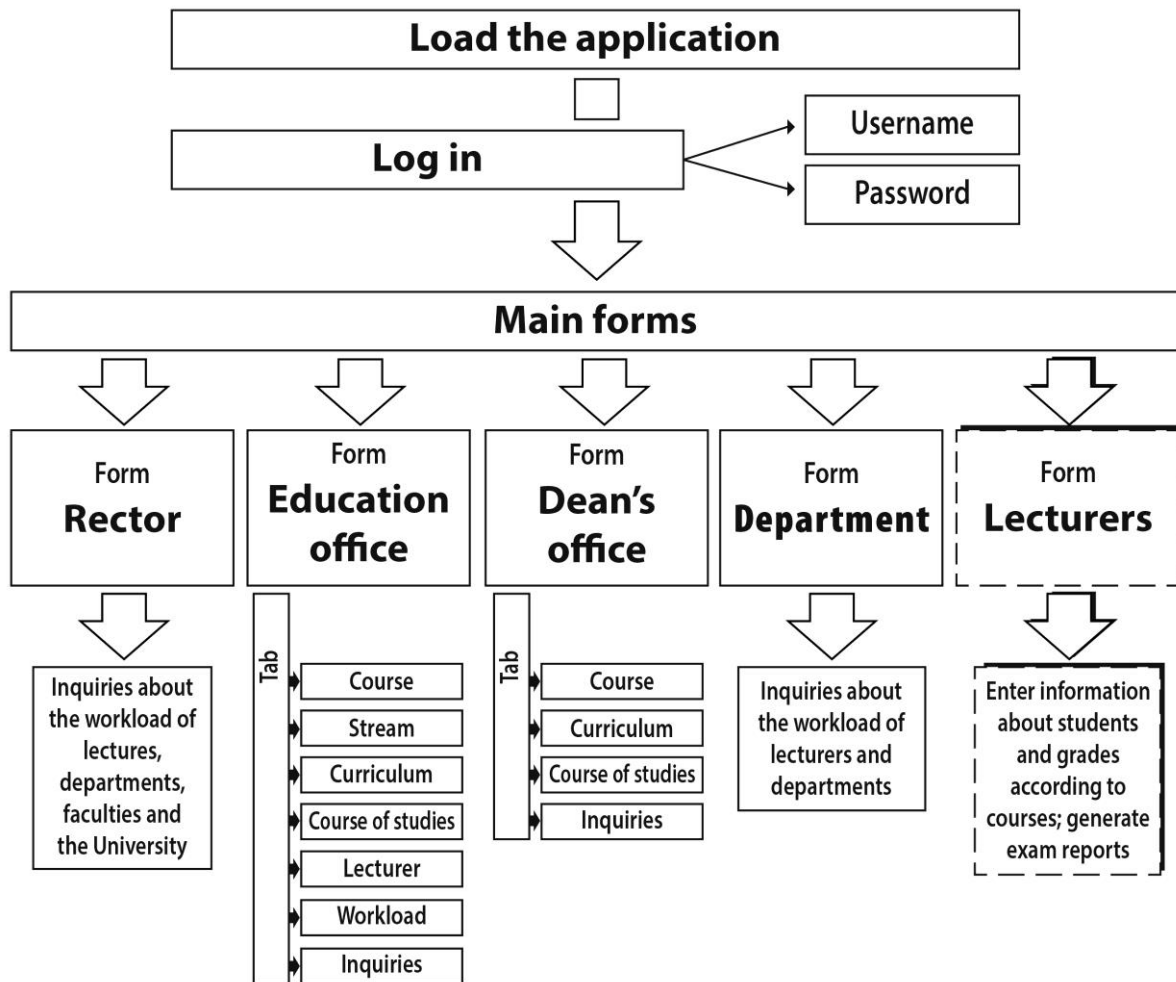


Fig. 2. Generalised scheme of the application

At the system start, the user must type in valid name and password. Currently, besides a system administrator the following five categories of users ("roles") are envisaged: rector, education office, Dean's office (in this case 3: the Faculty of Mining Technology (MTF), the Faculty of Mining Electromechanics (MEMF) and the Faculty of Geology and Exploration (GPF), lecturer (each of the lecturers in the University who will rate the students on a given subject), department (each one of the departments in the University).

Upon the successful login in the system, depending on the user's category, access to a given part of the database and given functions of IS is allowed. Each user can change his password.

User "Education Office"

This user is allowed to enter and edit as follows:

- Course. For each course, its code, full and abbreviated name (the abbreviated name is applied at streams forming), number of classes for lectures and exercises and pursued degree must be typed in. The course's code must not be used as an identifier because a course may be found in a number of various courses of studies under the same name and code but with different workload. That is

why, in the table of the courses a course (for instance, Introduction to the Computer Technologies) can be found six times with six different workloads but under the same code. On Figure 3 the dialogue for introducing of courses is shown. Tabular information in the main part of the window shows the entered courses into the database up to the moment. The user (in this case Education Office, but it can be some of the Dean's offices) can introduce and edit a new course using the controls in the right part of the form.

- Courses of studies.
- Curricula for courses of studies. The system can be used even if more than one curriculum for a course of studies is active at a moment. If so, the curriculum should be entered for the concrete academic year only. For example, the course of studies CTE, Bachelor's degree is typed in 4 curricula – for the first, second, third and fourth year, respectively. Thus, the system supports at a moment only one curriculum for each course of studies and course and it's the one in power at that moment. This makes easy for the changes in the curricula to be made and it is possible all four courses of a given course of studies to be taught according to different curricula.

Код	Наименование	ОКС	Л	у	Съкратено име
371102	Въведение в компютърните технологии	Бакалавър	2	3	ВКТ
371104	Основи на програмирането	Бакалавър	2	3	ОП
371152	Теоретични основи на информатиката	Бакалавър	2	2	ТОИ
371106	Обектно ориентирано програмиране	Бакалавър	2	2	ООП
371153	Компютърни мрежи и комуникации I	Бакалавър	2	2	КМК1
371109	Визуално програмиране	Бакалавър	2	4	ВП
371164	Основи на C#	Бакалавър	2	3	C#
371154	Компютърни мрежи и комуникации II	Бакалавър	2	2	КМК2
371110	Операционни системи	Бакалавър	2	2	ОС
371111	Системи за управление на бази данни	Бакалавър	2	4	СУБД
371155	Web дизайн	Бакалавър	1	3	WEB
371112	Разработване на приложен софтуер	Бакалавър	1	2	РПС
371108	Структури от данни и алгоритми	Бакалавър	2	3	СПА

Fig. 3. Form for introduction, editing and deleting of courses in the database

- Lecturers;
- Classes streams. "Stream" means a group of students (it can be a part of the students of a course of studies, but it can be, as well, students of a number of different courses of studies) who attend classes (lectures or exercises) in a group. Notion "stream" is used not only for lectures but also for seminars. The reason is that sometimes several courses of studies are combined in a subgroup (for example, for the elective courses). The user chooses the course, fixes the classes type (lectures/seminars), the form of education (regular/distance) and marks the courses of studies forming the stream. To make the dialogue for defining the workload easier, the system generates automatically a short name for the stream on the basis of the abbreviated names of the course and the courses of studies included in it. On Figure 4 is shown the dialogue for introducing of streams. The tabular information in the main part of the window shows the streams that have been entered in the database up to the moment. Using the controls in the right part of the form the user can edit, delete or introduce a new stream.
- Workload - fixes the lecturer for each concrete stream. While the information about courses, courses of studies, lecturers, curricula and streams is relatively constant and is to be corrected fairly rarely, the workload (or the lecturer for a concrete stream) is to be typed in each and every semester and it corresponds to the agenda. According to the University requirements related to the information about the lectures and seminars led by the lecturers and on the base of the workload that have already been entered MS Excel tables can be generated.

At the Education Office's disposal is a set of information about the workload of a concrete lecturer, department, faculty or the University as whole.

User "Dean's Office"

As a matter of fact there is no user "Dean's Office" in the system generally speaking. There are concrete Dean's offices, in this case MEMF, MTF and GPF. This user's functions and rights are part of the Education Office's functions, namely introduction and editing of course, curriculum and course of studies as well as reports about the workload of a concrete lecturer, a department or a faculty as a whole. The main difference between the Dean's office and the Education office as users is that the concrete Dean's office has access to the information about courses, courses of studies and departments of its own faculty, while the Education Office processes this information for the whole university. A concrete Dean's office has no access to the information about the courses of studies and the departments of a different faculty. The introduction in the database of the Department of Foreign Languages and Sports as an user in the Dean's office category is forthcoming.

Users "Rector" and "Department"

These users are only allowed to access information. The rector can get information about a concrete lecturer's workload, a department, a faculty or the University as whole. "Workload" means only the teaching activity of the lecturers. The user "Department" is allowed to get information about one or more lecturers in the respective department only. When completed, the module for tracking the teaching process and the students' grades is going to provide the users "Rector" and "Department" with information about the average grade of a given student, course of studies or a faculty.

№	Дисциплина	Специалност	Л/У	Р/З
1	Въведение в компютърните технологии	КТИД 1	Л	редовно
2	Въведение в компютърните технологии	КТИД 1	У	редовно
3	Основи на програмирането	КТИД 1	Л	редовно
4	Основи на програмирането	КТИД 1	У	редовно
5	Теоретични основи на информатиката	КТИД 1	Л	редовно
6	Теоретични основи на информатиката	КТИД 1	У	редовно
7	Обектно ориентирано програмиране	КТИД 1	Л	редовно
8	Обектно ориентирано програмиране	КТИД 1	У	редовно
9	Компютърни мрежи и комуникации I	КТИД 2	Л	редовно
10	Компютърни мрежи и комуникации I	КТИД 2	У	редовно
11	Визуално програмиране	КТИД 2	Л	редовно
12	Визуално програмиране	КТИД 2	У	редовно
17	Основи на C#	КТИД 2	Л	редовно

Fig. 4. Form for introduction, editing and deleting of streams in the database

User "Lecturer"

Currently, this module is under construction. Its purpose is to allow lecturers responsible for the grading to insert course marks. Additionally, the module tracks each student's performance. Based on the average grades, this module is going to provide information about different kinds of suitable scholarships. Further functions of this module are the introducing of new students or deleting students. The programme also generates exam reports and automatically moves students to the next course year at the end of each academic year.

Conclusion

Governing the teaching process in a university has a lot of individual features, specific for a given university. Therefore, it is difficult to develop a universal information system which can be applied at all universities. Thus, such a system created specifically for the needs of a specific university is necessary. Thus, reflecting the dynamics of the teaching process is made easier. The IS introduced in this article is the first attempt at creating such a system for the needs of UMG "St. Ivan Rilski".

Currently, around 5% of the database of the system is filled in with actual data. After completion of the database with real information about courses, lecturers and curricula, the maintenance of the system is going to be much easier, and the system itself is going to simplify the work of the respective experts.

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GOOD PRACTICES IN LANGUAGE TRAINING AT THE TECHNICAL UNIVERSITY OF GABROVO

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ABSTRACT. With the development of new technologies, the role of information and knowledge at all levels and in all spheres of social development is increasing. Foreign language proficiency is a prerequisite for young people's success and professionalism and allows them to employ and explore the information available in the global community, to communicate with colleagues from different countries. The objective of this paper is to share some best practices applied in language training at the Technical University of Gabrovo related to: student mobility under the Erasmus + Programme, language support and training of students according to the requirements of modern society, preparatory courses for foreign students and language training for ethnic Bulgarians living abroad.

Keywords: foreign language training, foreign language proficiency, good practices

ДОБРИ ПРАКТИКИ ЗА ЧУЖДЕЗИКОВО ОБУЧЕНИЕ В ТЕХНИЧЕСКИ УНИВЕРСИТЕТ ГАБРОВО

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РЕЗЮМЕ. С развитието на новите технологии нараства ролята на информацията и знанията на всички нива и във всички сфери на социалното развитие. Владенето на чужди езици е предпоставка за успеха и професионализма на младите хора и им позволява да използват и проучват информацията, с която разполагат в глобалната общност, да общуват с колеги по професия от различни страни. Целта на доклада е да сподели някои най-добри практики, прилагани в езиковото обучение в Технически университет в Габрово, свързани с: студентската мобилност по програма Еразъм +, езикова квалификация и обучение на студентите според изискванията на съвременното общество, подготвителни курсове за чуждестранни студенти в български университети и езиково обучение за етнически българи, живеещи в чужбина.

Ключови думи: чуждоезиково обучение, владене на чужди езици, добри практики

Introduction

In modern pedagogical literature, one of the most discussed issues is the implementation of the *competence-based approach* promoted by the *Bologna Process*. Concepts such as *competency* and *competence* are increasingly debated. Different groups of key competencies, which also include *communicative competence*, have been suggested. Yet, the successful practical application of this approach implies an adequate support based on the psychological and pedagogical theory fundamentals. The formation of the specialist's *professional competency* has been studied from the position of the activity-based learning approach – a unity of personality, consciousness and activity, interconnection of processes related to activities and communication.

A particular role here has the *foreign language proficiency*, which is a must attribute of the successful professional in today's world. The integration processes in various fields of politics, economy and culture raise the problem of intercultural communication and mutual understanding of participants belonging to different cultures. This requires a proper selection of the content and teaching methods of foreign language professional training of students, including a situational range of thematic areas and respective language and speech material reflecting the specifics of their future professional

activity. Along with the *development of new technologies*, the role of information and knowledge at all levels and in all spheres of social development is increasing. Foreign language proficiency is a prerequisite for success of prospective professionals and allows them to work with the information available to the global community and to communicate with colleagues in profession from different countries. This is a reason why UNESCO characterised XXIst century as the *century of polyglots*.

Recent problems with foreign language proficiency of students

Foreign language is a compulsory but not a leading subject in non-language universities. On the one hand, language training has to be an *instrument for acquiring professional knowledge*, and on the other – to contribute to the realisation of the modern purpose of education – formation of specialist professionals capable to operatively solve professional tasks by using the potential of the global information space. The course in foreign language is not just a university subject - it is a sphere of personal and professional development of future specialists, which forms their communicative competence (D. Hymes, N. Chomsky), (Izvorska, 2016).

At present, significant experience has been gathered in the area of foreign language training, but in some cases, students lack skills for fluent language communication; a poor command of professional vocabulary and a fragmentary knowledge of the socio-cultural context of language use are also observed. All this does not meet the requirements of modern education and precludes the active participation in the Bologna process. There is a necessity to *intensify the language training* with regard to *establishing new training standards* and *updating the methodology of teaching*. These two lines have been actively developed in didactics. The transition to new standards of training has been initiated by the process of European integration in education and is based on the *competence approach* - from knowledge to competencies (J. Delors, J. Raven, N. Chomsky, W. Hutmacher, I. Zimnyaya, C. Baydenko, etc.), (Izvorska, 2015). The regulations of the *Council of the European Union* direct the focus of education to *developing communicative competence*. In the scope of foreign language teaching, this concept is consistent with categories such as: *foreign language competence* (D. Hymes, etc.) and *intercultural communicative competence* (C. Safonov, E. Tarasov, etc.), (Izvorska, 2017). From a didactic point of view, more adequate is the concept of *foreign language communicative competence* (O. Iskandarova, S. Savington, etc.) (Izvorska, 2017), which has become a standard for language training. The second methodological line for intensification of language training supports the competency line and represents the logics of transition from lingua-centric learning model to lingua-sociocultural and further to communicative learning model (Chantov, 2014). In addition, university carrier centres can also be beneficial in language support of students (Hristova, 2008).

Foreign language skills and international student exchange. Statistical data

The Technical University of Gabrovo provides high-quality professional training, including language training, in conformity with the needs of the labour market for modern broad-profile Bachelor's degree courses, as well as modern Master's and Doctoral degree programmes in the field of engineering and technologies, business and social sciences. The language training is conducted by the Department for Language and Specialised Training, which comprises 14 members of academic staff. Using some of the latest interactive forms and methods of teaching, rich material resources and facilities, the lecturers provide excellent conditions for learning and personal development of 4,000 students.

The University actively participates in European educational and research programmes and has effective cooperation with more than 150 universities and research organisations in Bulgaria and the European Community. In terms of the ERASMUS+ Programme for exchange of scholars and students, the Technical University of Gabrovo has bilateral agreements and strong cooperation relations with 74 partner universities. The success of TU-Gabrovo in the international academic and student exchange under the Erasmus + Programme is variable in the years. The statistical data provided below cover the last 5 years and reflect mobilities realised only within the Erasmus+ Programme. For better visualisation, the data are presented in graphical form.

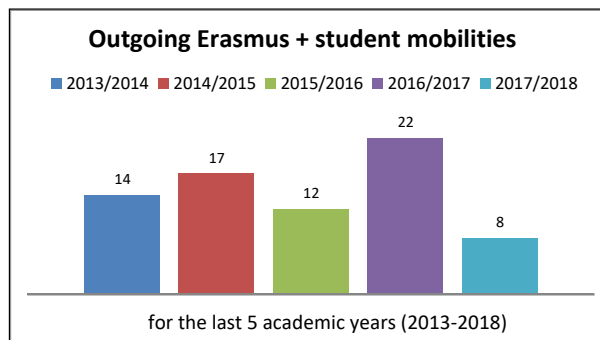


Fig. 1. Realised Erasmus+ student mobilities for the period 2013-2018

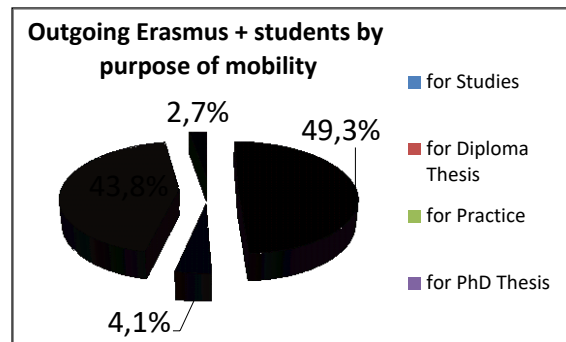


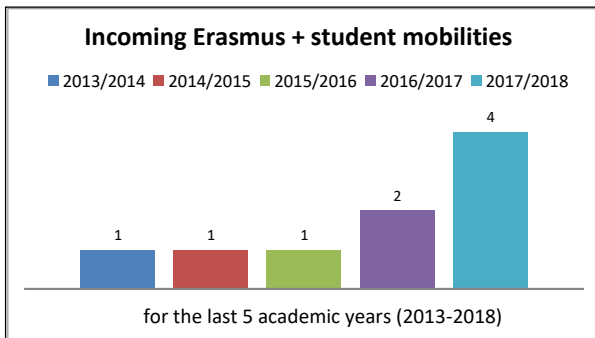
Fig. 2. Statistical data on the purpose of mobility of outgoing students within the Erasmus+ Programme for the period 2013-2018

The most preferred Erasmus+ mobility host countries for the period 2012-2018 are as follows: Germany – 24 students, Great Britain - 16 students, the Czech Republic – 12 students, Latvia – 11 students, Lithuania – 4 students, Austria – 3 students, Poland – 2 students, Romania – 2 students, Spain – 2 students, Greece – 2 students, Turkey – 2 students and Switzerland – 1 student.

The following conclusions could be made with regard to Figures 1 and 2:

- Most of the outgoing Erasmus+ students prefer to perform mobility for studies and practice, and a negligible number of students prepare in foreign universities their Diploma or PhD theses.
- The most economically developed countries in the EU are the most desirable countries by students to conduct their Erasmus+ mobility, i.e. Germany, Great Britain, the Czech Republic, etc.
- The number of outgoing students in the years varies and there is a slight decrease in the last academic year;
- The demographic problems in Europe are a partial reason for the decrease in the number of students in universities in general and it is an indirect reason for decreasing the number of outgoing mobilities;
- Students do not have enough motivation to participate in the international exchange. An additional reason for demotivation is the insufficient foreign language proficiency;

Over the last 5 academic years, the number of incoming foreign students within the Erasmus+ Programme is comparatively low. As seen from Figure 3, foreign students that have preferred TU-Gabrovo as a host university come mostly from nearby, neighbouring or culturally similar countries – Latvia, Romania, the Republic of Turkey, etc.



Erasmus + incoming students by their country of origin		
Latvia	3	students
Romania	2	students
Republic of Turkey	2	students
Germany	1	students
Austria	1	students

Fig. 3. Incoming Erasmus+ foreign students for the period 2013-2018 and their country of origin

TU-Gabrovo has made a lot of efforts in the last years in order to be attractive for the international Erasmus students. Most of these activities have been related to:

- Active collaboration between TU-Gabrovo and the partner universities;
- Active policy for establishing new collaborations and partnerships with foreign universities under the Erasmus+ Programme.

As a result, the number of incoming student mobilities during the last two years showed a slight increase.

Nowadays, the process of globalisation is characterised by the tendencies of intercultural mixing and student exchange. The number of mobile students (not only under the Erasmus+ Programme) is growing year by year. They subsequently face the problem of a language barrier in their host country and university environment. The language barrier seems to be the main problem that the outgoing and incoming Erasmus students generally have.

In Europe, the most popular languages that students use for mobility are English and German. Russian is typically used by incoming international students coming from Russian speaking countries.

The main issues related to the language proficiency of the outgoing students are as follows:

- Insufficient foreign language training of newly enrolled students. Exceptions are the students who have graduated from language high schools;
- Fear and low self-confidence on the part of students when communicating in a foreign language (written and spoken proficiency)

The incoming foreign students prefer English, German and Russian language. Their difficulties in communicating in public places are associated with the fact that the elder population in Bulgaria does not have a good proficiency in English and German. Moreover, it is very important to note that all incoming

foreign students are interested in studying Bulgarian language during their stay at the University.

Good practices of language training in the Technical University of Gabrovo.

Incoming foreign students

Bulgarian language training for incoming Erasmus+ students is available with a workload of 60 academic hours per semester. Finally, the language course ends with an examination in which students receive a numerical score of their result and the course "Bulgarian Language" is recorded in their academic transcript as an optional subject with the appropriate credits awarded according to the curriculum of their degree course.

Along with studying Bulgarian language, the foreign students acquire knowledge about the Bulgarian culture, history, traditions and customs. The University organises educational trips to historical and geographical landmarks in the country. The location of the town of Gabrovo, adjacent to the geographical centre of Bulgaria, in a region near the old capital Veliko Tarnovo, the architectural and historical reserve "Bozhentsi", Tryavna – a town with rich and unique cultural-historic heritage and last but not least the peak of "Shipka" favours their organisation and diversity.

The good practices in language training are of key importance for better results in the international student exchange.

Foreign language training of outgoing students

The University has a strategy for improving the language skills and competencies of students according to the needs of the modern society. For this purpose during the last several years an example of good practice is the implemented *facultative foreign language training* of students, which is conducted by the Department for Language and Specialised Training (DLST). As stipulated in the curricula, all students pursuing Bachelor's degree courses study a foreign language for a period of 6 semesters. In the first two of them the language training in English, German or Russian (eligible by students) is compulsory. It is strongly associated with their scientific major. In the next four semesters (second and third year of study) the training is conducted in the form of a specialised foreign language course, which improves students' language proficiency and extends their language competences in the respective professional field.

At the end of their first year of study, students apply for facultative language training, which is optional. It is conducted from 3-rd to 6-th semester and is not mandatory, but by choosing this option students get the chance to improve their foreign language skills and proficiency free of charge. At the beginning of the academic year, students applying for facultative language training are divided into groups with regard to their foreign language progress after passing an entry level exam (Beginners, Intermediate, Advanced levels).

At the end of each academic year of facultative training, students pass a language examination and the University awards them a certificate for the respective Common European Framework of Reference for Languages (CEFR)

language level (A1 (Beginner); A2 (Elementary); B1 (Intermediate); B2 (Upper-Intermediate); C1 (Advanced); C2 (Proficiency)). The CEFR Language Certificates are internationally valid and students may use them when applying for Erasmus+ mobility or after graduation when applying for a job in the country or abroad.

Language training of foreign prospective students applying for studies in Bulgarian universities

Foreign prospective students who wish to study at Bulgarian universities, according to the state regulations of the Ministry of Education and Science (MES) need to pass preparatory language training in a licensed Bulgarian university. This training lasts nine months (2 semesters) and comprises 1000 academic hours of workload. DLST at TU-Gabrovo conducts such preparatory training for foreign prospective students applying for engineering or economics degree courses in accordance with an adopted by the Academic Council (AC) curriculum. The workload of 1000 academic hours is distributed as follows: language training (including language for special purposes) – 650 hours; mathematics (covering the curriculum of Bulgarian high schools) – 200 hours; elective course (Physics, Computer Science, Economics) – 150 hours.

The training is finalised by passing of three exams in the respective language of training and for the respective courses. After passing the three exams, foreign prospective students are awarded a certificate, which they can use in every Bulgarian university (state or private) that offers engineering or economic studies. There is an option for the foreign prospective students who wish to independently prepare for these three exams to directly pass the exams and obtain a Certificate of preparatory training.

Another example of good practices is related to the established by the MES net of Sunday schools in the Bulgarian diasporas in Ukraine, Moldova, Serbia and Macedonia. There, prospective students with Bulgarian origin can study their mother tongue and prepare for application in Bulgarian universities. Each year, Bulgarian universities in conjunction with the Government, offer 400 places for full-time Bachelor's, Master's and Doctoral degree courses intended for ethnic Bulgarians. The list of degree courses and universities is published by the Ministry of Education and Science on annual basis. The ethnic Bulgarian students enrolled at TU-Gabrovo

attend a course in Bulgarian language with workload of 60 academic hours per year in their first and second year of study.

Conclusions

Language training is of key importance for obtaining good results in students' mobility and is a prerequisite for their successful professional realisation.

The good practices presented in this paper are applicable, if they are adapted to the cultural, historical and legislative specifics of the country.

Local language training in host universities is a good way for the international students to feel the spirit of the host country – to acquaint with its culture, history, traditions, people's mentality.

The additional language support and training of the outgoing students is a prerequisite for successful mobilities. The related benefits of an effective additional language training are as follows: students become more fluent in the foreign language usage in host universities; better communication with the host academic staff; improved success at the exams held in host universities; motivation for further mobilities in the same or other foreign university or company.

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TECHNOLOGY OF BUILDING TESTING QUESTIONS AND TASKS IN THE VOCATIONAL TRAINING EDUCATION

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ABSTRACT. This material addresses a significant and current issue related to the construction of test questions and tasks. The essence of basic concepts directly related to the topic of the material are clarified, namely: question, task, test task and others. Some essential requirements for the test questions and tasks, task types, their advantages and disadvantages are considered as well as how they are developed and in which cases they are appropriate to be used. Emphasis is placed on the structured response questions and tasks (closed type). The practice in testology shows that they are of higher quality as compared to the other main group - open-ended response questions (open type).

The material also presents the basic rules for building high quality test questions and selective answer tasks, because these types of questions and tasks are difficult to build, but they are objective, reliable and valid. Specific examples are presented for more clarity and completeness on the application of the different types of test questions and tasks.

Different types of questions and tasks are used in the tests, they are created by specialists in the relevant scientific (subject) field, but their design must be aligned with the current standards in this area in order the measurement and evaluation of specific knowledge, skills and competencies to be objective and reliable.

Keywords: test question, test task

ТЕХНОЛОГИЯ ЗА КОНСТРУИРАНЕ НА ТЕСТОВИ ВЪПРОСИ И ЗАДАЧИ В ОБУЧЕНИЕТО ПО ПРОФЕСИОНАЛНА ПОДГОТОВКА

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РЕЗЮМЕ. В настоящия материал се разглежда един значим и актуален проблем, свързан с технологията на конструиране на тестови въпроси и задачи. В тази връзка се изяснява същността на основни понятия, пряко свързани с темата на разработката, а именно: въпрос, задача, тестова задача и други. Разглеждат се основни изисквания към тестовите въпроси и задачи, видове, техните предимства и недостатъци, как се разработват и при какви случаи са подходящи. Акцентира се върху въпросите и задачите със структуриран отговор (закрит тип). Практиката в тестологията показва, че те са с по-високо качество в сравнение с другата основна група - със свободен отговор (открит тип). В материала са представени и основните правила за високо качество на тестови въпроси и задачи с изборен отговор, защото този тип въпроси и задачи се конструират трудно, но са обективни, надеждни и валидни. Представени са и конкретни примери за по-голяма яснота и пълнота относно приложението на отделните видове тестови въпроси и задачи.

В тестовите се използват различни видове въпроси и задачи, които се конструират от специалисти в съответната научна (предметна) област, но тяхното конструиране трябва да е съобразено с действащите стандарти в тази област, с оглед измерването и оценяването на конкретни знания, умения и компетентности да е обективно и надеждно.

Ключови думи: тестов въпрос, тестова задача

Introduction

The paper aims to show the technology of constructing testing questions and tasks in theoretical and practical aspect.

My practical experience with vocational education teachers for more than thirty years has shown that at present the teachers do not have the necessary theoretical and practical knowledge on the method for construction of test questions and tasks. Nowadays, this issue is very topical, because all the teachers in Bulgaria use tests during the training process, and they prepare tests themselves, which do not correspond to any standards.

Presentation

Each didactical test consists of a series of questions and/or tasks, which are used to check the level of the accumulated knowledge and skills from dedicated training contents

corresponding to the requirements in the educational plans. The questions and the tasks are the basic fundamental element of the didactic tests. The proper selection and definition for the particular test is of great importance for its quality in general (in terms of quality measuring instrument).

1. Basic questions

The paragraph defines the basic questions, which are used while constructing test questions and tasks.

Question: query which requires response (Burov, 1994).

Task: question, a response where is requested by means of mathematical calculations or by cogitation (mathematical task, logical task, etc.); given task or goal, which must be fulfilled (for instance – preparation of a model of a single fundament (Burov, 1994).

Test question – correct, clear, which requires unambiguous response or execution of a certain algorithm of actions.

Distractor – the word originates from English “distract” (confuse, disturb, quell, distract the anger, disorient) (Stoyanova, 1996).

2. Requirements for the test questions and tasks

The selection of questions and tasks doesn't mean that this is a test. It is necessary to fulfil certain requirements in order these questions to be considered as a testing inquiry as follows: to be applied in a system; to be based on concrete goals of the educational process; to match in form and content the age and psychological and physiological specifics of the person tested; to be different in form, structure and language presentation; to fulfil each element from the content point of view of different levels of the educational plan, which will be examined; the definition must be perfect from linguistic, stylistic, content and aesthetic point of view; more than 50% of questions and tasks compared to the planned volume should be defined, because after approbation not all of them will have the quality required and will be dropped or will need to be redefined (Bizhkov, 1992).

3. Classifications of questions and tasks

There is no uniform classification of test questions and tasks, because of various division groups:

- from the point view of their content, they may be divided into questions/tasks on: mathematics, biology, physics, chemistry etc.

- if a cognitive processes must be taken into account – questions and/or tasks on the level of: knowledge, comprehension, application, analysis, synthesis and evaluation.

- c) depending on the level of objectivity (means of evaluation of responses given) of the evaluation – the question or/and tasks are divided into: objective; subjective (Stoyanova, 1996).

One of the most frequently used classifications is related to the way the tested person gives his/her response. The test questions and tasks are divided into two big groups: questions and tasks with open responses (open type); questions and tasks with predefined responses (selection) (closed type) (Bizhkov, 1992).

3.1. Questions and tasks with open response (open type)

The teachers use them more frequently into their pedagogical practice that is why they will be presented first. In this type of questions the tested person constructs the response by himself, which may be presented in various ways: verbally, graphically, etc.

Advantages: quick and easy construction; allow measurement of complex skills and level of development of creative skills.

Disadvantages: difficult evaluation of the performance: the quantitative processing and evaluation of the results is difficult, but in spite of that the qualitative estimation is easier; there is a possibility for subjective evaluation when testing (Stoyanova, 1996).

3.1.1. Types

In testology there are various kinds of questions and tasks of open type. Depending on restrictions to the response of the tested persons, they are of two basic kinds: questions and

tasks with a short response; questions and tasks with an expanded response (Stoyanova, 1996).

3.1.1.1. Questions and tasks with a short response

This type of questions and tasks has a response limited to one or several words, expressions, digits or symbols.

Examples of tasks with a short response:

- Which is the chemical formula of water?
- Bulgaria is a member of EU from (date, month, year).
- When was the Bulgarian state founded?
- Which is Christo Botev's birthplace (as town name)?

They are frequently used and their measurement can be characterised as reliable and valid.

3.1.1.2. Questions and tasks with an expanded response

This group includes: freely made compositions, retelling, essays, etc. The strengths of this type of questions and tasks are that the tested person has the possibility to present his/her own knowledge and skills by himself/herself, to show creativity, to reach more aspects, freely and with arguments to express his/her own opinion, to show ingenuity. The weaknesses can be generally found in the difficulties of the tested persons to express independently with arguments their own thoughts and answers (Bizhkov, 1992).

It is worthy to note the other point of view of F. Stoyanova. She classifies the tasks of the “essay” type into tasks with open expanded response, and also includes tasks for evaluation of the performance skills (musical, artistic, sporting, cooking, technical, etc.). As shortcomings of the tasks with open expanded response compared to these with predefined choice response, the author presents the lower reliability and validity of the measurement. For instance, if the person tested has adopted 50% of all the tasks from the educational plan and he/she by hazard selects a question for which he/she expects good evaluation or the opposite case – expects lower evaluation; in both cases the evaluation doesn't match adequately the total personal knowledge acquired. With the same duration the tested person can resolve a test form, which instead of two questions with open response will contain questions with a selective choice response, covering the whole material of the educational plan (Stoyanova, 1996).

Because of the shortcomings of the questions of open type, their usage should be restricted.

When is it necessary to use questions and tasks with expanded response (open type)?

When:

- there isn't enough time for preparation of tasks with choice response;
- the teacher feels that he/she doesn't have enough knowledge and skills to define other kind of tasks;
- the purpose is to check the capabilities of the person tested to express himself/herself;
- when performance skills or creative capabilities are evaluated;
- the number of tested persons is small and the test is performed for a single use (Stoyanova, 1996).

However they can be used if the following requirements are met: maximum concretisation of the questions and tasks; inclusion of more questions with shorter responses.

The practice shows that the main problem with the questions and tasks with open response is that the evaluation is not objective.

3.2. Questions and tasks with structured, choice response (closed type)

Some questions and tasks have predefined selected number of responses, and the tested persons are requested to show (by means of enclosure, underlying, etc.) the response they think is correct. It is recommended that the correct answer is unique, while the other responses that are given to be the so called distractors (not correct responses). This type of questions and tasks are usually preferable, because they guarantee higher degree of objectivity (Bizhkov, 1992). They allow to be evaluated by specialists, whose area of competency is different from the subject of the test. In various researches it is shown that this type of tasks have higher reliability compared to other types. But it is necessary to know that they are more complex to build, harder to be defined, especially with regard to the distractors. The practice in testing shows that the most effective distractors are built by the tested persons themselves; they are one reliable source of ideas for this type of tasks (Aleksieva, 1994).

With regard to the scope of the higher levels of competence sometimes it is practically impossible to build questions with choice response of higher levels such as: synthesis and evaluation (Stoyanova, 1996).

3.2.1. Structure

That kind of questions and tasks have two main structural elements as follows: condition of the task; list of possible responses.

Considering the higher objectivity of the evaluation it is recommended that all tasks (questions) should contain equal number of distractors and only one correct response (Stoyanova, 1996).

3.2.2. Types

- Identification questions and tasks;
- questions and tasks with alternative response;
- questions and tasks with multiple choice responses;
- questions and tasks for compliance.

3.2.2.1. Identification questions and tasks

T. Ruter shows the following possible cases:

- simple identification (one of the elements of the task is redundant; the tested person is required to cross off, underline, enclose, etc.);
- tasks with multiple identification (for instance, the tested person is required to underly each adjective in a given text);
- tasks for consecutive identification, also called "Labyrinth" (the tested person is required to pass the labyrinth, to reach a given place and to solve the problem in that way).

Tasks which contain a diagram for identification are included into the group of the identification tasks. Typical of them is that they include a diagram, a figure, and the elements, which the tested person must numerate according to the instruction given. There are possible different options for solving the task:

- To present a diagram where all the elements are numerated and the appropriate requirements to the elements of the diagram are given. The tested person is required to point

out the appropriate number from the elements of the diagram before each word in the list.

- A diagram is given whose elements are not numerated, also a list of names of elements with a given number. The tested person is required to numerate the elements of the given diagram.

- A crossing out of improper elements is required, drawing missing elements, connecting of elements according to the instruction given, etc.

3.2.2.2. Questions and tasks with alternative response (from the type "true"/"false"/"yes"/"no")

This type of tasks (questions) represents a list of statements and the person tested is required to define if they are true or false. Each statement has two alternative responses given, one of which is true. The tested person selects one of the two possible responses (Stoyanova, 1996). Questions/tasks of this kind are short, they are created quickly and can cover the greater part of the educational material. Because of that they have wide application when controlling the learning of new educational material.

Advantages:

They are mainly related to the application and the possibilities of this type of tasks (questions):

- they can be used for evaluating knowledge on each cognitive levels;
- they are suitable to distinguish facts among opinions; logical conclusions and ratiocinations; discovering of cause and effect relationships; comprehension and argumentation;
- easy to build;
- the greater quantity of questions and tasks allows to cover better the related educational content, which leads to improvement of the evaluation's validity;
- the direct connection between the test length and its reliability, *ceteris paribus*, the questions and tasks with alternative response permit higher reliability (Stoyanova, 1996).

Disadvantages:

- The possibility of guessing by chance the correct response is usually greater than 50% (it may be compensated with bigger number of tasks (Stoyanova, 1996).
- Triviality of measured knowledge (usually their author is oriented to trivial facts, etc.).

Recommendations for building questions and tasks with alternate response:

- to be constructed in such a way, so that it is clear what is true and what is false, without additional consideration and preconditions (Andreev, 1995)
- the false statements to be more than the true statements;
- key words to be avoided;
- complicated statements to be avoided;
- in false statements to avoid such words as "always", "never"; they may be replaced with "sometime", "usually", "frequently";
- in the true statements "sometimes", "usually", "frequently" must not be used (Stoyanova, 1996).

3.2.2.3. Questions and tasks with multiple choice responses

They are some of the most common in didactical testing in the normative, as well in criteria tests. Each task or question of this type consists of the following structural elements:

- base (a task itself or a question);
- possible responses of a given question (task) (multiple responses, of which only one is true, correct and proper, the others are distractors). Most often the person tested is required to enclose, scratch or underlining the correct response according to his own opinion. It is allowed the task or question to have more than one correct response, but test practice shows that in only one correct response the knowledge and/or the skills are evaluated more properly and objectively.

3.2.3. Basic rules for high quality of questions and tasks with choice response

- To use such a format of the task (question) which has only 1 correct (proper and full) response.
- Short formulation of tasks (questions).
- To be independent from one another.
- To avoid negative phrases and negative conclusions.
- To use a question form (direct question) and not to use unfinished sentences.
- To avoid trivial tasks (questions).
- The responses to follow logical consequence (chronological order of the events).
- The responses to be of the same length (homogeneity).
- The position of the correct response to follow the random principle;
- Key words must be avoided.
- To use attractive distractors (for instance – typical errors of students, scientific terminology).
- Do not use distractors such as “none”, “all cited”, etc., which are not effective.
- To be elaborated in such a visual way, which is easily perceived and readable (Bizhkov, 1994), (Stoyanova, 1996).

All of the above-mentioned rules can be broken only if there are enough reasons for that.

The positive sides of the questions and tasks with multiple structured response are more as compared to the negative ones, namely:

- knowledge at almost all levels is evaluated;
- they are independent of external factors such as: orthography, handwriting, psychological condition, etc.;
- the check is fast and may be performed by unqualified persons, also automatically;
- the evaluation is maximally objective;
- it may fully cover the educational content and achieve the objectives of the evaluation.

The negative sides/difficulties when building questions/tasks with multiple structured responses are as follows:

- they need relevant level of knowledge and training of the teacher for the construction of tasks (questions);
- more time is needed for their creation;
- there is some risk of guessing by hazard the correct answer, but this may be reduced by using more attractive and effective distractors.

For instance:

Enclose the right answer of the statement:

Ottawa is a capital of: a) USA; b) Japan; c) Canada; d) China.

3.3. Questions and tasks for compliance

This type of questions and tasks is another form of the group with choice response and because of that they will be defined in a dedicated paragraph. The basic rules of that group (Bizhkov, 1992).

The main thing is that the preliminary information (the base) of the question and/or the task is presented in at least two columns. The person tested is required to relate the elements of one column to the elements of the other (Bizhkov, 1992).

3.3.1. Structure

Each task or question contains a condition and two columns (in most cases) with words, digits, symbols, statements. For each element from the first column, the tested person is required to define the corresponding element from the second column. It is not recommended to include items (existing standalone) in one column that do not have match items from the other column. The list of multitudes between which compliance can be established is infinite, but most often the following are used: events-dates; concepts – definitions; terms – indications; tools-application; persons – products of the activity; words (idioms) – translation; actions – results; elements – functions; principles – examples. (Stoyanova, 1996).

3.3.2. Quality requirements for questions and tasks for compliance

When building tasks or compliance questions, it is necessary to comply with rules specific to this type, which ensure their high quality to a great extent.

- The content of each column to be homogeneous (it is aimed at a higher discriminatory force, i.e. to distinguish strong from weak pupils).
- The elements in the columns to be arranged in optimal order (alphabetical, descending, ascending, etc.)
- It is recommended that the two columns have different lengths (as in the example; left column has more elements than the right column) (Stoyanova, 1996).

Positive sides

- They allow relatively quick and easy check of the level of learning of a large amount of factual information.
- The assessment is objective and does not depend on the person who makes the verification.
- The verification may be carried out by an unqualified person or automatically.
- Stimulate the testing persons to integrate (summarise) the knowledge and skills (Bizhkov, 1992).

Negative sides/difficulties

- It takes considerable time to construct this type of questions and tasks.
- A longer list of possible answers makes it difficult for the tested persons to perceive them.
- Higher cognitive levels cannot be checked such as: analysis, synthesis, assessment (Bizhkov, 1992).

Task 1. Join with arrows the elements of the left column which correspond to these of the right column:

Building	
Pen	
Monkey	Animal
Horse	Construction
Pencil	Notebook

Task 2. Join with arrows the elements of the left column which correspond to these of the right column:

Action	Result
36/6	7
10/2	4
20/5	6
45/5	5
56/8	9

Table 1 presents the main advantages and disadvantages of tasks of open and closed type.

Table 1. Advantages and disadvantages of the questions and tasks from the two main groups (open and closed type)

N	Preliminary conditions	Tasks with a choice response	Tasks with an open response
1	Time for defining a task	More time (-)	Less time (+)
2	Time for checking the test	Less time (+)	More time (-)
3	Time for checking the results	Less time (+)	More time (-)
4	Objectivity of the evaluation	Higher (+)	Lower (-)
5	Reliability of evaluation	Higher (+)	Lower (-)
6	Degree of professionalism	Higher (+)	Lower (-)
7	Possibility of random selecting the correct answer	Higher (-)	Lower (+)

It should be noted that none of the different types of tasks should be absolutized. Everything depends on the specific situation, the conditions, circumstances, objectives, educational content, degree of professionalism, etc.

3.4. Half-opened Questions and Tasks

There is another group of questions and tasks, which also has its application as elements of didactical test. They are called half-opened questions and tasks and the following two

types of questions/tasks will be presented: for addition; for replacing.

3.4.1. Questions/tasks for Addition

This is one of the oldest forms and its advantage is primarily that the random selection of the response is reduced to the minimum. However, this is also a shortcoming. On one hand, the positive side is that the tested person can present the knowledge learned by himself. But there is a difficulty in quantitative estimation. There is need to point out the fact that for resolving such kind of tasks/responses more time for deliberating is needed. Because of the subjectivity of the task/question formulation, it is not possible to guarantee higher degree of objectivity of the results.

- The question/task consists of missing words, digits, figures, etc.
- The tested person is required to fill in what has been omitted.

3.4.2. Questions/tasks for replacement

Wrong information is given in them and the tested person is required to replace it with the correct one (e.g.: find out the wrongly included digit, sign, etc.; chemical compound, formula for naming, etc. and replace it with the correct one) (Bizhkov, 1992).

Conclusion

In the construction of questions and tasks for the verification of given knowledge and skills by means of test, various types can be used, as the specialists who develop them must comply with the acting standards for their construction.

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SOME ASPECTS IN THE DESIGN AND DEVELOPMENT OF LEARNING APPLICATIONS FOR ENGINEERING SPECIALTIES

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ABSTRACT. The impact of information and communication technologies has permanently reformed many of the traditional training methods. The changes imposed by the Fourth Industrial Revolution, define new standards and approaches for a high-quality training of engineers. These changes require a transition from technologically-supported to technology-based teaching in lecture rooms and laboratories. The selection of engineers to work with sophisticated automated systems and CNC machines requires relevant competencies for a given specialty. The paper presents some aspects of training students of engineering specialties based on information and communication technologies. The new highly-interactive generation has imposed the creation of a new didactic tool for the purposes of the learning process. One possible solution to this problem is the development of WEB-based teaching application which supports the visual thinking of the new learner generation.

Keywords: education, engineering teaching, curriculum, ICT approaches

НЯКОИ АСПЕКТИ ПРИ ПРОЕКТИРАНЕТО И РАЗРАБОТКАТА НА ОБУЧАВАЩИ ПРИЛОЖЕНИЯ ЗА ОБУЧЕНИЕТО ПО ИНЖЕНЕРНИ СПЕЦИАЛНОСТИ

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РЕЗЮМЕ. Въздействието на информационните и комуникационни технологии трайно преформатира много от похватите на традиционното обучение. Промените наложени от Четвъртата индустриална революция, дефинирали нови стандарти и подходи, целящи качествена подготовка на инженерни кадри, налагат преход от технологично подкрепено към технологично базирано преподаване в лекционните зали и лабораториите. Подборът на инженерен състав за работа със сложните автоматизирани системи и машини с програмно управление поставя условието те да притежават съответните компетенции за дадена специалност. В настоящия доклад се разглеждат някои аспекти на обучението на студенти от инженерните специалности, основаващи се на информационните и комуникационни технологии. Формираното високоинтерактивно поколение налага създаването на нов дидактически инструментариум при изграждането на учебен процес. Един от вариантите за решение на този проблем е разработеното УЕБ-базирано обучаващо приложение, съобразено с визуалното мислене на новото поколение обучаеми.

Ключови думи: обучение, инженерно обучение, учебна програма, ИТ приложения

Introduction

The Fourth Industrial Revolution imposes new standards and approaches aimed at the preparation of engineering specialists (Bedolla, 2017) at a level which ensures adequate and competitive production. The ultra-high degree of systems integration and automation in the modern design and manufacturing stages, as part of the life cycle of new products, requires the selection of engineers with relevant competences for automated design (Panayotov, 2016) and work with complex computer controlled machines. Therefore, students' preparation in the field of technical disciplines should respond to the new trends in the manufacturing sphere in order to achieve a higher degree of balance between market needs and the quality of engineering specialties (Kalev, 2019). This balance could be achieved by focusing on the transformation (building) of methods, forms and didactic tools in the training. The paper discusses some aspects in the process of the design, development, and deployment of WEB-based learning applications for learning purposes.

Accepted terms

For reasons of technological accuracy, the following terms will be adopted and used in this paper:

- *digital*, rather than electronic, which is used in other publications;
- *basic types* of data which are a particular primary digital type of data having common generic properties, specific to that type, that can be used in learning content and could be visual, aural, textual, and user defined;
- *learning content* is any logically structured content that can be used for learning or training and is digitally represented by the *basic types* of data;
- *learning resource* is an object through which access to learning content is provided and which can be identified by a unified resource identifier (URI) and localised under a unified resource locator (URL);
- *interactivity* is a set of interactions based on provided programming functionality between the user and the learning application during the learning process;
- *efficiency* is seen as the process of application of learning tools and methods to achieving certain goal;

• effectiveness is the ratio of the set goals and the goals achieved by using learning tools and methods.

Prerequisites

The dynamic impact of information and communication technologies on a vast number of human activities has formed a new model of perception of the world around us. The so called digital generation has been replaced by a Highly Interactive Generation (HIG), which exists in high-tech environment and transforms its nature into a virtual one. This HIG accomplishes the predominant part of its needs through various types of technological devices and rightly raises questions about the approaches and didactic tools in the learning process in which it is a participant. On the other hand, there is a learning process in which a wide range of information tools is applied (Mihaylov, 2010a; Mohamad, 2015), but this process lacks attributes and teaching tools adequate to the perception model of learners and could not lead to increased quality in teaching. It is necessary to take into account that the lack of motivation in HIG learners has a negative impact on the learning process results (Mihaylov, 2010a).

Aspects of web-based applications

The main aspects in the development of WEB-based learning applications can be divided into two main groups:

- technological (hardware and software);
- pedagogical.

The leading prerequisite for the development of the application is the pedagogical goal, and the technological tools and approaches should ensure the achievement of the stated goal. The integral unity of these aspects defines the framework of the development process. There are models developed for research purposes which are relevant to the subject matter of the discipline (Mihaylov, 2016). However, the major difference, between the regular non-educational software and the software product with the characteristics of a learning application, is defined by the following aspects:

- pedagogical goals;
- didactic model;
- implementing high interactivity.

In the process of developing the application, there are constant factors that have a significant impact on the end product and which determine its application in the learning process. These factors establish a direct dependence of the application and operation of the product on the pedagogical goals, the didactic model and the functional high interactivity.

The use of the learning application should lead to the achievement of set pedagogical goals with measurable results. The developed learning application should provide considerable freedom of interaction between the application users and the learning resource. This is a key aspect and it is defined by the characteristics of the Highly Interactive Generation of learners, which means that one of the criteria for the effectiveness of a learning application should be the high degree of measurable interactivity of the learning content (Atanasov, 2019).

In this paper, a set of conditional average interactivity of a total high-tech environment I_{avrg} is allowed and a formalisation of a learning application model is presented:

$$(G \cap D) \cap I \Rightarrow E, \tag{1}$$

where:

- G – pedagogical goals;
- D – didactic model of the learner;
- I – application interactivity;
- E – efficacy of the learning process.

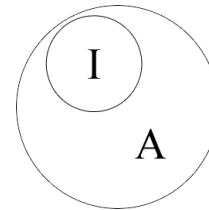


Fig. 1. The structured relation of the subset of interactivity I and the set of all pedagogical interactions A

In the presented model (GAD) is the pedagogical component and I is the technological component. The structured relation of the subset of interactivity I and the set of all pedagogical interactions A are outlined (Fig. 1).

This means that any interactivity of a given learning application should be pedagogically coherent with the teacher's interactions. In order for the learning application to be effective, the following conditions are required:

$$I \neq \emptyset \tag{2}$$

$$I \subseteq I_{avrg} \tag{3}$$

$$f(E) \Rightarrow \sum_{i=1}^{I_{avrg}} I_i \tag{4}$$

There are several conclusions from (4):

- higher interactivity determines higher efficiency;
- the interactivity of a given learning application should be no less than the conditional average interactivity of a total high-tech environment of a learner.

The aspects which follow are presented in the context of the learning process of the main phases of development of the learning application.

Analysis of the requirements

From a software perspective, WEB based learning applications are software products developed on a programming language in a specific integrated development environment to achieve certain pedagogical goals, following a didactic model.

These requirements can be divided into the following three groups:

- functional requirements - requirements to the software system;
- non-functional requirements - emotions, motivation, etc.;
- pedagogical requirements - pedagogical goals and didactical model.

The formulation of the requirements is based on the perspective of hypermedia learning systems. A Web based learning app in an optimal case should:

- 1) have functionality based on a didactical model (content-logical and methodological structure),

- providing a programming mechanism for realisation of the main pedagogical processes;
- 2) integrate a learner model;
 - 3) provide access to the application and resources through authentication;
 - 4) provide an adequate in form and scope mechanism for content visualisation;
 - 5) provide opportunities for learning resources with rich interactive content;
 - 6) offer access to additional learning resources, directly or indirectly related to the specific subject matter;
 - 7) offer support and compatibility with widespread platforms;
 - 8) include handbooks, manuals, and instructions;
 - 9) provide a mechanism for monitoring the results by the teacher;
 - 10) be built on a client/server model;
 - 11) have a built-in database;
 - 12) provide a mechanism for dynamic management of the learning content by the teacher;
 - 13) provide a mechanism for managing user registrations of the application by the teacher;
 - 14) contain a user panel;
 - 15) contain an administrative panel;
 - 16) provide options for settings related to various display device resolutions;
 - 17) provide deployment capabilities to a local machine.

Choice of technologies

In developing the learning application and in view of the limited resources, the team chose to build a prototype application model by applying the iterative approach (Sommerville, 2011). The choice of the prototype approach is justified by a clearer review of the partial functionalities built to date and their compliance with the set requirements in the initial development phase for short time intervals. These activities are part of a step-by-step verification of the core system behaviour whose set of functionalities are subject to procedures described in an accepted verification methodology that is beyond the scope of this paper. The development of the learning application ends up after the achievement of the requirements which have been targeted and reaches the last phase – its implementation. Based on the engineering aspect of the application, key criteria such as visual perception, multitasking and hypermedia (Mynbayeva, 2017) are formed. The choice of technology for development of the learning application is based on research related to the processing of perceived information from certain brain regions, which determines that in the engineering disciplines the domain of the concepts and the domain of the processes predetermine the information to be visualised (Huang, 2013) including parallel visualisation of each of its text parts.

Programming tools

These tools are an important element in the system development process, and their choice is based on the provided functionalities, possible product implementation fields, a set of development tools, operational file compatibility, and other indicators that directly affect the system development process. The accepted methodology for the design and development of WEB based learning application, predetermine

the environment and means for the development of: user part; administrative part; database.

The key reasons for the choice are the following prerequisites for the visual perception and thinking of the students in the engineering disciplines:

- ability to create and edit 2D images;
- interoperable file compatibility;
- creating visual effects and animation, editing the sound environment, processing data streams and minimising the set of external applications to create visual or audio accessories;
- opportunities to create own components;
- real-time testing capabilities;
- a wide range of error detection capabilities in the code base;
- overall perspective of software development, graphic and sound layout;
- multiplatform independence;
- extensive documentation, handbooks, manuals and instructions;
- the presence of a wide community of developers in Internet forums.

In order to meet the requirements, it is necessary to ensure: high degree of interactivity; Web base; extensive support by client agents (browsers); accessibility at any time and from anywhere; multimodality to perceptions.

The development team has created its toolbox in two directions – design and development. Designing a tool for system modelling using UML layouts and graphics and animation tools has been selected and focused on the programming language JavaScript and HTML5 and CSS3 structured WEB content.

Design and development

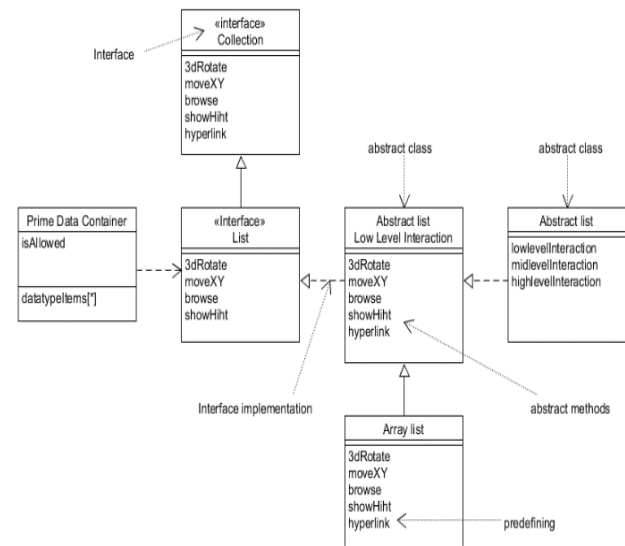


Fig. 2. Interface and abstract class of low-level interactivity

The development process is based on the synthesis of models and their implementation. According to the principles of object-oriented modelling, a system model should be synthesised representing the types of objects and their static relationships. The functional model of the application provides information about the logical procedural determination of its components from a user perspective.

Fig.2 presents the interface and abstract class of low-level interactivity of the data type object via UML class diagrams.

After the system has been modelled, the steps of code writing, testing procedures, verification and deployment have to be done. The development team of the WEB based learning app for the specific engineering specialty, taking into consideration the described in this article aspects, has achieved the desired functionality. In the steps that follow the developed learning app is to be tested in real educational environment, i.e., in the real process of learning.

Conclusion

The development of learning applications is a complex set of interrelated activities, actions and steps that are subordinate to the objectives that find their adequate reflection in the requirements analysis. As noted above, the development process has its specific features closely related to a target group with certain social and psychological characteristics – the Highly Interactive Generation. On the other hand, the developed software product should be based on certain principles that would define it as a learning tool in the hands of the teacher – a pedagogical aim, didactic model and student model. The aspects discussed above should be taken into account in a development of a learning application, which in turn would increase the efficiency of the learning process, the motivation and the interest of the learners in class.

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SIMILARITIES AND DIFFERENCES IN TEACHING ENGLISH FOR SPECIFIC PURPOSES TO ENGINEERING STUDENTS AT THE UNIVERSITY OF MINING AND GEOLOGY “ST. IVAN RILSKI”, SOFIA, AND AT THE TECHNICAL UNIVERSITY BERGAKADEMIE FREIBERG

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ABSTRACT. Teaching English for Special Purposes (ESP) to engineering students is a challenge that is concerned with very particular purposes, tasks and requirements. One crucial point represents the need for specific curricula, as well as good understanding of general English. This knowledge is the basis for students' improvement and successful and easy acquirement of terminology in the foreign language. Another important point is the methodology – how terminology is taught to the engineering students. The paper explores the similarities and differences in teaching ESP to engineering students in two universities - the University of Mining and Geology “St. Ivan Rilski”, Sofia, and Technical University Bergakademie, Freiberg. The comparison and contrast data was collected during a teaching mobility activity to Germany under the Erasmus+ programme and the author's own experience as a foreign language lecturer. The paper presents and adapts useful methods of teaching and learning terminology so that university lecturers find the best and most convenient, practical and functional way in which they can increase and improve engineering students' skills and knowledge.

Keywords: ESP, Foreign Language Teaching, engineering students, methodology, terminology

СРАВНИТЕЛЕН АНАЛИЗ НА ИЗУЧАВАНЕТО НА АНГЛИЙСКИ ЕЗИК ЗА СПЕЦИФИЧНИ ЦЕЛИ В МИННО-ГЕОЛОЖКИЯ УНИВЕРСИТЕТ “СВ. ИВАН РИЛСКИ”, СОФИЯ, И В ТЕХНИЧЕСКИЯ УНИВЕРСИТЕТ МИННА АКАДЕМИЯ, ФРАЙБЕРГ

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РЕЗЮМЕ. Преподаването на чужд (английски) език за специфични цели на студенти от инженерните специалности е предизвикателство, което е свързано с особени цели, задачи и изисквания. Важен момент представлява нуждата от специфична учебна програма, както и добро владение на общоговорим чужд (английски) език. Тези знания са основата, с която студентите да могат по-успешно и по-лесно да усвояват терминологията на чужд език. Друг важен момент е методиката – как терминологията бива преподавана на студентите от инженерните специалности. Настоящият доклад представя прилики и разлики в начина на преподаване на чужд език за специфични цели в два университета – в Минно-геоложкия университет “Св. Иван Рилски”, София, и в Техническия университет Минна академия Фрайберг. Направеното сравнение е възможно благодарение на информация, получена по време на обмен за преподавателска мобилност с цел обучение по програма Еразъм+, както и от личния опит на автора като преподавател по чужд език. Докладът представя полезни методи за преподаване и учене на терминология, които да дадат насоки на преподавателите да открият най-удобния, практичен и функционален начин, който да им помогне да подобрят знанията и уменията на студентите от инженерните специалности.

Ключови думи: английски (чужд) език за специфични цели, чуждоезиково обучение, инженерни специалности, методология, терминология

Introduction

Teaching English for Specific Purposes (ESP) is a very special task that university lecturers have to deal with. This is a different level of teaching English and it concerns all aspects of the teaching itself: it affects methodology, the students, the course units, the language and the syllabus (Tahir, 2008).

The experience over the past years has led to the present research in order to find the best and most effective ways to teach a (foreign) special language to engineering students. A related institution from the mining industry – the Technical University (TU) Bergakademie Freiberg is used as a benchmark for this research. The comparison and contrast data was collected during a visit to Germany under the Erasmus+ programme – Staff Mobility for training.

In the beginning, it is necessary to define what ESP is. In a world where business demands more and good qualified

specialists and English language is the basis for professional communication, it is inevitable for universities to follow this trend by providing the best education for their students. The English language is the *lingua franca*¹ for the academic education (Terzieva, Kolarski, 2014). The use of a special language is required in all fields of science: medicine, technology, and engineering. The special language is professionally oriented and aims to deliver students with the appropriate vocabulary in the selected area of work (Hutchinson, Waters, 1987). “The necessity for European citizens to master more than one foreign language is a prerequisite for development of linguistics and a serious challenge for foreign language teachers and scholars in relevant specialties.” (Veselinov, 2014).

¹Lingua franca is a language used for communication between groups of people who speak different languages (Cambridge Dictionary).

The English classes at the TU Bergakademie Freiberg

The comparison was done during the visit at the TU Bergakademie Freiberg, where Technical German and English classes were attended. The present article focuses on teaching ESP. As far as terminology is concerned, the English classes are specific for each course of studies at the TU Bergakademie, Freiberg. This means, students from only one specialty would attend the class, which is held once a week during all 4 semesters, and it is not streamed. Two of the semesters are compulsory, and two are optional. However, all students continue attending the English classes even when they are optional. This form of arrangement has proven itself as the most appropriate for the students at the TU Bergakademie, Freiberg.

The English classes in the 1st year of studies

The English course "Einführung Englisch. Geotechnik und Bergbau" / "Introduction English. Geotechnics and Mining" is taught to the students at the TU Bergakademie Freiberg in their 1st and 2nd semester. A textbook on ESP (Geosciences) with texts and exercises on the specific topics and terminology that come up is used during the classes. The lecturer also prepares handouts especially for the class. An important part of the English classes is the use of multimedia. This is a fine way to show students authentic material – videos, discussions and interviews, which are related to their professional area and will be useful for their professional development. Discussions are organised in class where groups of two or more students are asked to present or debate on certain issues.

Terminology is quite important in the first year of English studies. The lecturer Karin Löttsch presents different strategies when working with text (reading and listening comprehension) and this is done only in English. The aim is to give the students the knowledge they need in order to attend and actively participate in foreign language lectures. They should be able to take notes as they hear the English language. Another significant part of their work during the first two semesters of language studies is to practice writing abstracts. After listening to or reading a text, students are assigned to summarise the information in only a few sentences, *not using the same words as those given in the text*. This is a good way to practice vocabulary, as they have to search for synonyms and use terminology.

The language course is completed by an exam and the students receive a certificate of performance.

The English classes in the 2nd year of studies

The second year of studies (3rd and 4th semesters) builds upon the English course the students attend in their 1st and 2nd semesters. In semesters 1 and 2, the students' terminological vocabulary is developed and tested, whereas semesters 3 and 4 are dedicated more to communication and this is also the basis for the exam. They have to pass a listening exam during the semester, their final exam is on writing and speaking.

The second English class that was attended is dedicated to "Geoökologie" / "Geoecology". Dr. Mark Jacob usually begins with a warmup – a topic that was discussed in the previous class and leads to the new topic. According to the lecturer, it is important for the students to do things that they are familiar with from secondary school. In secondary school, they do not do much translation, so they do not do that much at university

either. This is why the presentation is a good method to practice communication. The lecturer explained that working on presentations is important, as this is part of the life-long learning experience. Hence, the topic of the discussion in class was "how to give a good talk" (Alon, 2009).

Students use the OPAL² platform to register for the presentations. Then, when it is time to prepare for the presentation itself, the students choose a chairperson and a timekeeper for the presentation session, which is organised as a conference. The lecturer sits in the back and discusses their presentations at the end of the class.

In addition, the lecturer makes videos and interviews with foreigners about their life in Freiberg (podcasts) and the students have access to these materials – to listen to and watch. Thus, they have the opportunity to hear different accents and pronunciations. When completing the course in the 4th semester, the students receive a UNICert³ certificate. The English course aims to get students to the C1 level.

The English classes at the University of Mining and Geology "St. Ivan Rilski", Sofia

The foreign language classes are obligatory at the University of Mining and Geology "St. Ivan Rilski", Sofia. Students from two specialties ("Geology and Geoinformatics", and "Computer Technologies in Engineering") study only English language during all 8 semesters of their Bachelor studies. The students from all other specialties can choose one of the following languages and attend classes in a stream: English, German, French, Spanish or Russian. The classes are held once a week during all 3 semesters.

The English classes in a stream during the 1st and 2nd semester of studies

At the beginning of the course, the students take a placement test in English. Thus, lecturers divide students from each faculty in three levels – A2-B1, B1-B2 and B2-C1. Different parts of the textbook *Technical English* (2011) are used for each level. The English course in the first year of studies aims to develop students' communicative skills, as well as build up on grammar and enrich the vocabulary they use. This textbook gives a selection of commonly used lexical units with high frequency of use in technical context. Many topics are standard for some specialties, which is good in the case of a streamed group of students from all courses of studies in one faculty. Lecturers use a practical task-based approach and encourage students to develop their knowledge in the foreign language in order to be able to solve different vocational tasks. They work on description of every day activities, professions, processes, installation and equipment, technical support. This helps students integrate new knowledge with prior knowledge during the class.

They are tested at the end of each semester on different aspects of language competence – each lecturer prepares their own tests for the students at the end of the course.

² OPAL is an online platform for academic teaching and learning that offers access to tasks, tests, video content and interactive virtual space.

³ UNICERT (United Certification Services Limited) provides certification with the widest scopes of certification, including quality, environmental, health and safety, information technology, and information security management systems and other popular standards.

The English classes in a stream during the third semester

In the last semester, students discuss terminology, read and translate specialised texts related to the major disciplines taught at the respective faculty. This is a good chance for them to get to know terminology from other areas and not only from their special one. Attending the foreign language classes in a stream provides students with concepts, many of which are common in all specialties. They also are acquainted with more specific terms that are used in different professional fields. The duration of each class gives the opportunity for broadening students' knowledge in terminology.

Lecturers use materials such as scientific articles, textbooks and manuals. The classes include reading and translation of specialised texts, after which students are required to write abstracts on the selected text. They work with dictionaries, additional sources of information, use multimedia and prepare presentations. The lecturers from the Foreign Language Department at the University of Mining and Geology "St. Ivan Rilski" constantly expand the materials and exercises in ESP teaching, e.g. new learning materials were developed and approved several years ago (Purvanova et al., 2014). As the experience of our colleagues at the TU Bergakademie Freiberg also shows, presentations are an effective way to motivate students to do their own research and work with scientific texts. This increases their ability to compare different types of problems and even improves their computer skills when working with PowerPoint/MS Office.

The topics discussed in the English classes cover all specialties represented in the three faculties. Some of the topics of the scientific texts are related to, respectively: for the Faculty of Geology and Exploration: "Mineralogy", "Petrology", "Engineering Geology", and "Hydrogeology"; for the Faculty of Mining Technology: "Minerals", "Open Pit Mining", "Underground Mining", "Geodesy"; for the Faculty of Mining Electromechanics: "Mechanics", "Hydraulic and Pneumatic Equipment", "Mining Equipment", "Electricity Supply and Electrical Equipment".

In addition to that, the lecturers use selected units from the *Oxford English for Electrical and Mechanical Engineering* (Glendinning, Glendinning, 1995) for the engineering students from the Faculty of Mining Technology and the Faculty of Mining Electromechanics. Another textbook that is used is *English for Students of Mining and Geology* (Alexiev, 1985). The students from the Faculty of Geology and Exploration also use some of the topics included in *English for Oil and Gas* (Frendo, Bonamy, 2008).

The exam at the end of the third semester is different from the previous two. Students are expected to be able to read and translate scientific texts, write abstracts and have a good command of the appropriate terminology.

Conclusion

This article aims to give an insight in our colleagues' work at the TU Bergakademie Freiberg. The first part of the research is dedicated to teaching ESP to engineering students, whereas the comparison of FLT in the German classes at the TU Bergakademie Freiberg and the University of Mining and Geology "St. Ivan Rilski" will be discussed in another paper. Comparing the foreign language teaching methodology at the University of Mining and Geology "St. Ivan Rilski" to that at the TU Bergakademie Freiberg gives the opportunity to adapt some useful approaches. The observations show three

methods that are commonly used in the foreign language classes at the TU Bergakademie Freiberg: the direct method of teaching, the audiolingual method, and the communicative approach (Shopov, 2008). Their methods are interesting and it is to be ascertained whether they could be appropriate for the students at the University of Mining and Geology "St. Ivan Rilski", Sofia, where the grammar-translation method and the direct method (Shopov, 2008) are mostly applied. This would involve a more interactive course design, where students are more actively engaged in the teaching process (work in groups, preparation of posters and presentations). Since they already work with multimedia and presentations, the presentation experience could be expanded and the students could be placed in different environments. They do so at the TU Bergakademie Freiberg and it seems reasonable to make the presentation session look like a conference. Thus, students would get familiar with the spoken language, feel free to talk to their partner, and be ready to answer questions at any time. This is highly important in a job interview or later on, at the work place with foreign coworkers.

Students also work on translation and writing abstracts. This could be done in groups. That way, the competition element between the groups will encourage teamwork and motivate the groups for scoring the best results. Different teams write abstracts, use terminology, look for synonyms, then compare, find the best abstract and give reasons why it is the best one. This process involves many aspects: writing, making a list of pros/cons and naming the elements that make a good abstract.

Lecturers aim to provide the students with the best ways and methods to acquire technical knowledge in a foreign language so that they can be better prepared for working in the area of their academic discipline and compete with colleagues from foreign universities and companies.

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COMPUTER MATHEMATICS SYSTEMS IN HIGHER MATHEMATICS TRAINING OF STUDENTS AT TECHNICAL UNIVERSITIES

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ABSTRACT. The subject of this paper is related to some applications of computer mathematics systems (CMS) in higher mathematics teaching. The mathematical preparation of students at the technical universities is characterised by its practical orientation. It is formed on the basis of interdisciplinary integration, which is based on general scientific principles and methods, one of them being the *modelling method* combining the mathematical subjects with the natural scientific and vocational training of students at technical universities. The paper presents a diagram of the process of solving engineering problems using ICT. The role and place of CMS in this process is explored. The levels of command of CMS – low, intermediate and high – are analysed. A system of mathematical problems which can be solved with appropriate CMS (Maple, MathCad, Excel and Mathematica) is proposed.

Keywords: computer mathematics systems (CMS), higher mathematics teaching, students at technical universities

СИСТЕМИТЕ НА КОМПЮТЪРНАТА МАТЕМАТИКА В ОБУЧЕНИЕТО ПО ВИСША МАТЕМАТИКА НА СТУДЕНТИТЕ ОТ ТЕХНИЧЕСКИ ВУЗ

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РЕЗЮМЕ. Предмет на настоящата работа са някои приложения на системите на компютърната математика (СКМ) в обучението по висша математика. Математическата подготовка на студентите в технически ВУЗ се характеризира със своята практическа насоченост. Тя се формира на базата на интердисциплинарната интеграция, която се основава на общонаучни принципи и методи, един от които е *методът на моделирането*, обединяващ математическите дисциплини с естественонаучната и професионална подготовка на студентите от технически ВУЗ. В работата е представена схема на процеса на решаване на инженерни задачи с помощта на ИКТ. Разгледана е ролята и мястото на СКМ в този процес. Направена е характеристика на нивата на овладяване на СКМ от студентите – ниско, средно и високо. Предложена е система от математически задачи, чието решение е с подходящи СКМ (Maple, MathCad, Excel и Mathematica).

Ключови думи: системи на компютърна математика (СКМ), обучение по висша математика, студенти от технически ВУЗ

Introduction

Modern social development is characterised by global informatisation. The rapid development and improvement of ICT leads to an increase in the information density of the public and professional activity of people. The skills to work with information, to create and study mathematical models, to perform mathematical calculations using mathematical packages and applied computer programmes, as well as the good command of the means of information and communication technologies are important components in the structure of the professional readiness and ability of the future graduates from a technical university.

Integration of training is based on general scientific principles and methods, one of which is the *modelling method* combining mathematical disciplines with the natural and vocational training of students at technical universities and thus, substantially enhancing fundamentality of technical higher education. The development of computer technologies is of particular importance in the training of the future engineers as it helps in the modelling of technological processes. This is due first to the increased amount of information that students obtain and it leads to the need of

qualitative changes in the training content; secondly, to the integration of sciences requiring the ability to consistently apply knowledge from different university disciplines.

Exposition

The use of programming tools and ICT precedes the construction of mathematical models, so the students at the technical universities are obliged to study mathematics. It is necessary for them to learn to study mathematical models because this is required for their future professional activity.

The process of solving engineering problems with the implementation of modern ICT is presented in Figure 1 (Shishakov, Trohova, 2005).

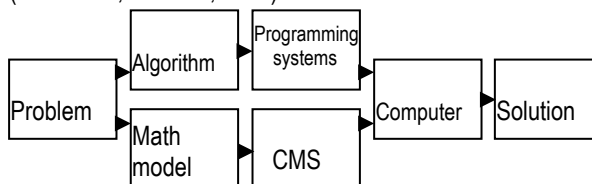


Fig. 1. Structure of the process of solving engineering problem with ICT

As can be seen from Figure 1, the solution can be obtained in two ways: the first one – by creating a programme in a relevant programming language; the second one – by using ready-made programming tools and ICT without direct programming. The rapid development of ICT with a convenient graphical interface makes it possible to significantly increase the number of engineering problems solved with them. The right choice of software tools and ICT used in the training of students at technical universities enhances their professional preparation and allows for the effective formation of mathematical culture and literacy based on the integration of mathematics and informatics.

The integrative link between mathematics and informatics is based on the content of their subject areas. In the process of learning mathematics, logical and algorithmic thinking of students is formed, the ability to compile mathematical models of phenomena and processes, skills for estimating results, prognosis of results, etc. are developed. The training in informatics provides a basis for understanding of the information character of the phenomena studied, enables the formulation and solution of problems in an effective visual form.

The idea of using computer mathematics systems (CMS) as a tool for integrating the students' learning-mathematical activities is in line with the basic principles of the competence approach. The training for working with modern CMS develops skills for creating and solving mathematical models of practical tasks. Using computers as means of learning and organising research creates new opportunities for interaction between students and teachers in the learning process as well as among students themselves; allows each student to increase their intellectual potential.

The new educational paradigm which is based on the integration of education on the basis of the fundamentalisation and introduction of key competences implies new educational goals, new principles for training content selection and systematisation, not so much for broadening of the scope of general scientific and professional knowledge, but rather for defining the interrelationship between them and other ways of their formation. In the near future, CMS will start to determine the new characteristics of mathematical activity and "the command of CMS will become a special key competence that will be directed towards preparing of students in the context of the new information technologies. In addition, we can talk about the skills for applying CMS as key competencies of mathematical activity (both practical and theoretical), reflecting contemporary integrative tendencies in conducting mathematical research and extending the scope of application of mathematical methods (Ivanyuk, 2008).

Taking into account the structure and the general principles of activity in CMS integrative environment, the following levels of (Table 1) command and application of CMS in the learning-mathematical activity of students at technical universities can be distinguished.

Table 1. Characterisation of levels of command of CMS by students at technical universities

Level of PC	Characterisation of level
Low	The activity at this level is characterised by mastering of general skills for working with CMS (starting, inputting of data and outputting of results, their saving, etc.) and the ability to apply internal built-in functions of selected system packages when solving standard mathematical tasks, use of their reference materials.
Intermediate	The activity implies an experience in using internal functions for solving standard tasks, skills to apply built-in functions at the stage of searching for ideas for solving non-standard tasks, i.e. in performing learning-mathematical activity in modified and unknown situations. Autonomous creation of external functions for solving standard mathematical problems.
High	In addition to the previous level, the activity is characterised by the existence of experience for autonomous creation of external functions when performing learning-mathematical activity in modified and unknown situations.

We will look at the possibilities of modern CMS and how they can be applied in higher mathematics training of students at technical universities.

Let us illustrate two applications of *Maple* in analytical geometry training – for canonisation of curves of the second degree and for rotational surfaces.

Problem 1. Find the canonical equation of the following centre curve:

$$F(x, y) = a_{11}x^2 + a_{22}y^2 + 2a_{12}xy + 2a_{13}x + 2a_{23}y + a_{33} = 0.$$

Draw the curve.

It is known how laborious the process of canonisation of a second degree curve is in the classical way, whereas with the help of *Maple* it is achieved with only a few commands, which is evident from the proposed solution:

$$F := a_{11}x^2 + a_{22}y^2 + 2a_{12}xy + 2a_{13}x + 2a_{23}y + a_{33};$$

$$a_{11} := 5; a_{22} := 2; a_{12} := 2; a_{13} := -12; a_{23} := -6; a_{33} := 18; \quad a_{11} := 5, \quad a_{22} := 2, \quad a_{12} := 2, \quad a_{13} := -12, \quad a_{33} := 18$$

$$s1 := \text{simplify}(1/2*a_{11} + 1/2*a_{22} + 1/2*(a_{11}^2 - 2*a_{11}*a_{22} + a_{22}^2 + 4*a_{12}^2)^{(1/2)}); \quad s1 := 6$$

$$s2 := \text{simplify}(1/2*a_{11} + 1/2*a_{22} - 1/2*(a_{11}^2 - 2*a_{11}*a_{22} + a_{22}^2 + 4*a_{12}^2)^{(1/2)}); \quad s2 := 1$$

$$p1 := \text{simplify}(2/(8*a_{12}^2 + 2*a_{11}^2 - 4*a_{11}*a_{22} - 2*a_{11}*(a_{11}^2 - 2*a_{11}*a_{22} + a_{22}^2 + 4*a_{12}^2)^{(1/2)} + 2*a_{22}^2 + 2*a_{22}*(a_{11}^2 - 2*a_{11}*a_{22} + a_{22}^2 + 4*a_{12}^2)^{(1/2)})^{(1/2)}*a_{12});$$

$$p1 := \frac{2\sqrt{5}}{5}$$

$$p2 := \text{simplify}(-2*(1/2*a_{11} - 1/2*a_{22} - 1/2*(a_{11}^2 - 2*a_{11}*a_{22} + a_{22}^2 + 4*a_{12}^2)^{(1/2)})/(8*a_{12}^2 + 2*a_{11}^2 - 4*a_{11}*a_{22} - 2*a_{11}*(a_{11}^2 - 2*a_{11}*a_{22} + a_{22}^2 + 4*a_{12}^2)^{(1/2)} + 2*a_{22}^2 + 2*a_{22}*(a_{11}^2 - 2*a_{11}*a_{22} + a_{22}^2 + 4*a_{12}^2)^{(1/2)})^{(1/2)});$$

$$p2 := \frac{\sqrt{5}}{5}$$

The coordinates of the centre are:

$$y0 := -(a_{11}*a_{23} + a_{12}*a_{13})/(-a_{11}*a_{22} + a_{12}^2); x0 := -(a_{12}*a_{23} - a_{13}*a_{22})/(-a_{11}*a_{22} + a_{12}^2);$$

$$y0 := 1, x0 := 2$$

We find $k:=\text{eval}(F,[x=x0,y=y0]);$ $k := -12$
 The translation is $x=x0+x1;y=y0+y1;$
 $x = 2 + x1, y = 1 + y1$

To draw, we use the programme:
 with(plots):
 t1:=textplot([-0.1,-0.2,O],align={LEFT,DOWN},colour=red):
 t2:=textplot([x0-0.2,y0+0.2,M0],align={LEFT},colour=green,thickness=3):
 t3:=plot([t,0,t=-1..4.5],thickness=1):
 t4:=plot([0,t,t=-1..4],thickness=1):
 t5:=plot([x0+t,y0,t=-1..4],thickness=2,color=green):
 t6:=plot([x0,y0+t,t=-1..3],colour=green,thickness=2):
 t7:=plot([x0+p1*t,y0+p2*t,t=-2..4],colour=blue,thickness=2):
 t8:=plot([x0-p2*t,y0+p1*t,t=-4..4.5],colour=blue,thickness=2):
 t9:=implicitplot(F=0,x=-1..4,y=-4..4.5,colour=red,thickness=2):
 t10:=textplot([4+0.2,-0.1,x],align={DOWN},colour=red):
 t11:=textplot([-0.2,3.8,y],colour=red,align={DOWN}):
 t12:=textplot([x0+1+1.5,y0-0.1,x1],colour=green,align={DOWN}):
 t13:=textplot([x0-0.2,y0+1+2,y1],colour=green,align={DOWN}):
 t14:=textplot([x0+p1+1.5,y0+p2+0.5,X],colour=blue,align={DOWN}):
 t15:=textplot([x0-p2-0.9,y0+p1+2.5,Y],colour=blue,align={DOWN}):
 display([t1,t2,t3,t4,t5,t6,t7,t8,t9,t10,t11,t12,t13,t14,t15]);
 The rotation is:
 $x1:=\text{simplify}(p1*X-p2*Y);y1:=\text{simplify}(p2*X+p1*Y);$

$$x1 := \frac{2\sqrt{5}X}{5} - \frac{\sqrt{5}Y}{5}, y1 := \frac{\sqrt{5}X}{5} + \frac{2\sqrt{5}Y}{5}$$

The canonical equation is (Fig. 2):
 $K:=s1*X^2+s2*Y^2+\text{eval}(F,[x=x0,y=y0])=0;$
 $K := 6X^2 + Y^2 - 12 = 0$

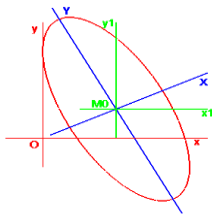


Fig. 2.

Let us take, for example, the course of mathematical analysis containing concepts such as limits, derivatives, integrals of different types, ranks and rows, differential equations. A large number of rules for finding limits, derivatives, calculating integrals, etc. have to be learned, the tables of the derivatives of the basic elementary functions and the main integrals have to be remembered and this is a huge amount of information. This information is very quickly forgotten and it is necessary to use reference books later on. Such calculations in real activity are not the main purpose of engineers. Their purpose is to solve a practical problem and the calculations are only an intermediate step on the way to this solution. By using CMS, much time can be saved and many calculations errors can be avoided (Izvorska, 2017).

Examples of this are the following problems.

Problem 2. Draw and animate the graph of the following function for large values of x. Use the graph to find the limit of the function at x tending to infinity (Fig. 3). Calculate this limit.

with(plots): plot(exp(-x/100)* cos(x), x=0..500 ,numpoints=100);
 animate(plot,[exp(-x/100)* cos(x), x=0..t], t=0..500, frames=50);

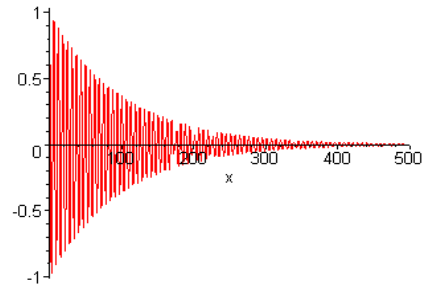


Fig. 3.

We will demonstrate the applications of Maple when studying integrals.
 Problem 3. Solve

> int(exp(sin(x)),x);

$$\int e^{\sin(x)} dx$$

It can be seen that this integral cannot be expressed through functions known to Maple. We will graphically present some approximation of the integral. Through the Maple-function $\text{taylor}(f(x), x = a, n)$ we obtain a Taylor row for the function $f(x)$ around the point a with precision to the n -th member.

> taylor(%,x=0,8);

$$\% \text{ is a system variable that remembers the last result}$$

$$x + \frac{1}{2}x^2 + \frac{1}{6}x^3 - \frac{1}{40}x^5 - \frac{1}{90}x^6 - \frac{1}{1680}x^7 + \frac{1}{720}x^8 + O(x^9)$$

We will convert the row into a polynomial (no residual member):

> convert(%,polynom);

$$x + \frac{1}{2}x^2 + \frac{1}{6}x^3 - \frac{1}{40}x^5 - \frac{1}{90}x^6 - \frac{1}{1680}x^7 + \frac{1}{720}x^8$$

Let us draw the graph of this polynomial (Fig. 4):

> plot(%,x=-4..4);

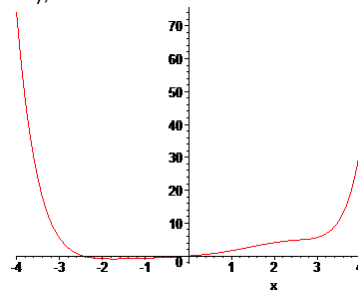


Fig. 4.

Problem 4. 3-D graphs. Let us consider the function f, whose graph is the „mountain” in Figure 5. After differentiating and integrating the function with x, we get the graphs in Figures 6 and 7, respectively.

$f:=\text{exp}(-\text{abs}(x-\text{sin}(y)))*(1+0.2*\text{cos}(x/2))*(1+0.4/(0.3+y^2));$
 $\text{plot3d}(f,x=-6..6,y=-6..6);$

$$f := e^{-(|x-\sin(y)|)} \left(1 + 0.2 \cos\left(\frac{x}{2}\right) \right) \left(1 + \frac{0.4}{0.3 + y^2} \right)$$

plot3d(diff(f,x),x=-6..6,y=-6..6); plot3d(int(f,x),x=-6..6,y=-6..6);

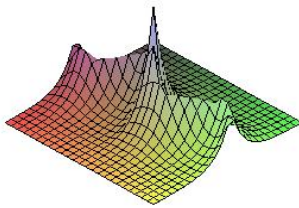


Fig. 5.

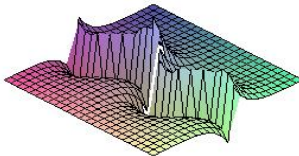


Fig. 6.

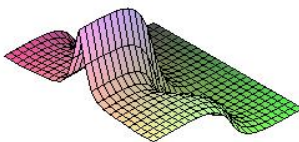


Fig. 7.

Applying Maple in higher mathematics training makes it possible to improve the quality and the efficiency of students' mathematical preparation, to apply a differentiated approach to learning taking into account their individual characteristics. In addition, the interaction between student and teacher in a dialogue regime facilitates the process of information exchange.

Combination methods are the basis of many problems from the probability theory, mathematical statistics and their applications. There are different methods of solution of combinatorial problems – the method of exhaustion of the possible variants; methods based on the application of the rules of addition and multiplication of probabilities by which basic combinatorial ideas are acquired, and the method of finding the number of compounds with or without repeats (variations, permutations and combinations) using formulae.

We will illustrate these methods with problems that can be solved using CMS.

Problem 5. From 10 red and 8 white roses a bouquet has to be made so that there are 2 red and 3 white roses in it. In how many ways can this be done?

Let's first choose 2 red roses out of the 10. This can be done in C_{10}^2 ways. Regardless of the choice of the red roses, from the 8 white roses 3 can be chosen in C_8^3 ways. Using the multiplication rule, 2 red and 3 white roses can be chosen in

$$C_{10}^2 \cdot C_8^3 = \frac{10 \cdot 9}{1 \cdot 2} \cdot \frac{8 \cdot 7 \cdot 6}{1 \cdot 2 \cdot 3} = 2520 \text{ ways.}$$

In *MathCad*, the combinations are obtained as follows:

n:=10	n:=8
m:=2	m:=2
C:=combin(n,m)	C:=combin(n,m)
C = 45	C = 56

Problem 6. There are employees of different ages in a computer manufacturing company. The young employees are 24, middle-aged ones – 82 and the people of retirement age – 16. The probability of sending a young employee to a qualification course is 0.52; a middle-aged one – 0.54; and a person of retirement age – 0.36. What is the likelihood of a randomly selected employee to be sent to a qualification course?

Let the event A be "An employee is sent to a qualification course". All employees are $24 + 82 + 16 = 122$. The young employees are 24 and if the event B1 is "a young employee has been chosen", then $P(B1) = 24/122 = 0.2$ (in *Excel* we have QUOTE PB1=24/122). The middle-aged employees are 82 and if the event B2 is "a middle-aged employee has been chosen", $P(B2) = 82/122 = 0.67$ (in *Excel* we have QUOTE PB2 =82/122). The employees of retirement age are 16 and if B3 is the event „an employee of retirement age has been chosen", then $P(B3) = 16/122 = 0,13$ (in *Excel* we have QUOTE PB3=16/122). The probability a young employee to be sent to a qualification course is $P(A|B_1)=0.52$ (in *Excel* we have QUOTE P(A|B1)=0.52); the likelihood a middle-aged employee to be sent is $P(A|B_2)=0.54$ (in *Excel* we have QUOTE P(A|B2)=0.54); the probability a person of retirement age to be sent is $P(A|B_3)=0.36$ (in *Excel* we have QUOTE P(A|B3)=0.36). Using the full probability formula, we get

$$P(A) = P(A|B_1)P(B_1) + P(A|B_2)P(B_2) + P(A|B_3)P(B_3) = 0.51$$

	A	B	C	D	E	F	G	H
1	B1=24			P_B1(A)=0,52			P(B1)=0,20	
2	B2=82			P_B2(A)=0,54			P(B2)=0,67	
3	B3=16			P_B3(A)=0,36			P(B3)=0,13	
4	N=122							
5				P(A)=0,51				

Problem 7. A manufacturer claims that the likelihood of a buyer's negative attitude towards a new good is not great. How many people should be interviewed so that with a probability of not less than 0.9 it can be argued that the relative frequency of the negative attitude towards a new commodity differs from the one stated by the manufacturer not more than 0.01.

The solution to the problem will be presented by using the system *Mathematica*.

We use the package *Statistics'NormalDistribution'*

In[1]: =<< *Statistics'NormalDistribution'*

Let us find the value of n , where the inequality is met

$$P \left\{ \left| \frac{\xi}{n} - p \right| \leq \varepsilon \right\} \geq \beta, \quad \beta = 0.9, \quad \varepsilon = 0.01$$

In[2]: = $\beta = 0.09$; $\varepsilon = 0.01$

The sought value of n is found in the inequality

$$n \geq \frac{1}{4} \frac{x_\beta^2}{\varepsilon^2}$$

where x_β is a quantum of $(1 + \beta) / 2$ of the standard normal distribution

In[3]:= `ndist = NormalDistribution[0,1];`

In[4]:= `xβ = Quantile[ndist, $\frac{1+\beta}{2}$]`

Out[4]:= 1.64485

Let us find n .

In[5]:= `$\frac{1}{4} \frac{x_\beta^2}{\varepsilon^2}$`

Out[5]:= 6763.86

Therefore $n = 6763.86$

In[6]:= `Clear[ndist, xβ, ε]`

The examples presented do not deplete the enormous possibilities of applying CMS in higher mathematics teaching. They only illustrate some of their applications.

The study of mathematical disciplines with CMS requires preliminary preparation including consecutive arrangement of lectures, seminars and laboratory classes in the weekly schedule of students on the one hand, and, on the other hand, the lecturer must prepare in advance a mathematical package of illustrations of basic concepts, discovering regularities when studying theorems, substitution of deductive evidence with geometric interpretations, suitable for visualization of counterexamples for concepts and theorems.

Conclusions

Summing up the studied problem, we can draw the following conclusions:

1. The knowledge acquired with the help of CMS has a universal character leading to the formation of special key competences – “command of CMS”. The motivation and interest in studying mathematics increase; there is a need for reflection and self-control; the learning results improve.

2. With the application of CMS, the traditional forms of organising higher mathematics training should not be radically changed. Application and adaptation of CMS in the existing lectures and practical seminars is needed.

3. Without acquiring skills for work with CMS, it is impossible to solve tasks with their help, as it is impossible to

consciously use CMS without knowledge of the fundamentals of mathematics. Therefore, the productivity and effectiveness of the interactive dialogue between the learner and the computer is determined by: level of formation of general habits for work with CMS; the content and level of development of the learner for mathematical activity. Only lasting and deep mathematical knowledge allows the use of ICT in solving mathematical problems of applied character.

4. Training in mathematics of students at technical universities with the use of CMS should be implemented employing appropriate sets of mathematical problems. The methodology of such training implies: the proposed tasks should reflect the characteristics of the mathematical activity in the “man-computer” system, i. e. it should be computer-oriented; the need to use CMS must “ripen” during the training and become a conscious need of the student; this need should be “increased” through gradual creation by the teacher of situations, necessary for this learning, which arise in the process of solving tasks.

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FORMATION OF PROFESSIONAL COMPETENCE IN TECHNICAL UNIVERSITY STUDENTS DURING THEIR HIGHER MATHEMATICS STUDIES

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ABSTRACT. This paper is focused on the specific features that characterise mathematical studies of students enrolled in technical institutes of higher education. The four constituent components of academic preparation in mathematics – motivational, cognitive, activity-oriented and reflexive have been defined. Likewise, the basic mathematical competencies of every individual student who follow their degree courses in technical colleges or universities have been identified. Also, a point of special consideration has been the construction of a system of mathematical problems which aim at generating mathematical competencies during higher mathematics studies. A system of mathematical problems is proposed, that enhance the formation of basic mathematical competencies. Special emphasis is laid on the practical aspect of higher mathematics studies in technical universities as a basis for formation of professional competence in students; as well as on the role of mathematical modelling and the selection of contemporary interactive forms and methods of training, which involve application of ICT and suitable systems of computer mathematics.

Keywords: mathematical preparation, mathematical competencies, professional competence

ФОРМИРАНЕ НА ПРОФЕСИОНАЛНА КОМПЕТЕНТНОСТ В СТУДЕНТИТЕ ОТ ТЕХНИЧЕСКИ ВУЗ ПРИ ИЗУЧАВАНЕТО НА ВИСША МАТЕМАТИКА

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РЕЗЮМЕ. Предмет на настоящата работа са специфичните особености на математическата подготовка на студентите в технически ВУЗ. Дефинирани са нейните компоненти – мотивационен, когнитивен, дейностен и рефлексивен. Идентифицирани са основните математически компетенции на студента от технически ВУЗ. Разгледани са изискванията за конструиране на система от математически задачи, ориентирани към формирането на математически компетенции по време на обучението по висша математика. Предложена е система от математически задачи, формирани основни математически компетенции. Специално място е отделено на практическата насоченост на обучението по висша математика в технически ВУЗ като база за формиране на професионална компетентност в студентите; ролята на математическото моделиране и избора на съвременни интерактивни форми и методи на обучение, включващи прилагането на ИКТ и подходящи системи на компютърна математика.

Ключови думи: математическа подготовка, математически компетенции, професионална компетентност

Introduction

A crucial determinant of innovative transformation of our education system at all levels is the application of competence approach. It is clear that the implementation of this approach means a significant reorientation of educational process. The main purpose of this reorientation is towards the personality of the trainee. This is undoubtedly related to new opportunities for professional training of future specialists, which will ensure their career development and success in the professional sphere.

Let us briefly consider the question of the necessity and effectiveness of the transition of Bulgarian education to the principles of the competence approach. We can distinguish between the following features of the competence approach: First of all, this approach takes into account the individual interests and abilities of the students. Secondly, orientation of the final result of education towards expansion of the educational space beyond the boundaries of formal education in the parallel structures of continuous education system. Thirdly, a process of informatisation of education implying use

of information technology, methods and means of information science for implementing the ideas of development education. Fourth, intensifying the learning process at all levels and increasing its efficiency and quality.

Exposition

Undoubtedly, quality engineering education is based primarily on mathematics. The problems of mathematical education in pedagogical, classical and technical universities have been discussed in the works of renowned mathematicians, pedagogues, psychologists, philosophers and methodologists (M. Eraut, G. V. Dorofeev). There are many works of scientists and researchers devoted to the professional orientation of teaching mathematics in technical universities.

Within the competence approach, a technical university cannot provide its graduates with a corresponding level of competitiveness on the labour market, if it does not form the ability to adopt the achievements of fundamental sciences and their application in the corresponding engineering activity.

Therefore, it is essential to increase the students' desire to thoroughly master fundamental sciences, including mathematics, during their first year of study at a technical university.

The European Parliament and the European Council recommend a structure with 8 core competences:

- 1). Communicating in the native language;
- 2). Communicating in foreign languages;
- 3). Mathematical abilities and core competences in the field of science and technology;
- 4). Information competence;
- 5). Skills for learning;
- 6). Interpersonal, intercultural and social competences, civic competence;
- 7). Entrepreneurship;
- 8). Cultural self-expression.

Mathematical abilities and core competences in science and technology are listed under number three in the list of core competences. Mathematical abilities are related to availability of knowledge about basic mathematical concepts and categories, abilities to formulate mathematical statements, to understand mathematical proofs, to reason mathematically, to communicate in mathematical language, to use mathematical methods and ways for creating and solving mathematical models of real phenomena and processes.

Modern social development is characterised by global informatisation. The rapid improvements in ICT result in an increase in the information saturation of the public and professional activity of the individual. Skills to work with information, to create and study mathematical models, to perform mathematical calculations using mathematical packages and computer applications, as well as knowledge of ICT are core components in the structure of professional readiness and ability of the future specialists graduating from a technical university. This is a topical issue related to the formation of their professional-mathematical training. The development of systems of fundamental mathematical knowledge and skills, as well as the possibility of their application in the context of constantly developing information technologies, is one of the conditions for preparation of highly qualified specialists. The main idea of the competence approach in teaching is the coordination of the idea of *integration* of mathematics and informatics with professional-mathematical activity of students.

On account of the above analysis, it can be said that *mathematical preparation* of students from technical universities determines the ability and readiness of future engineers to solve problems arising in the sphere of engineering and technical activities. It is based on fundamental mathematical knowledge, practical skills and habits for mathematical modelling using mathematical packages and computer application software. It comprises the following components:

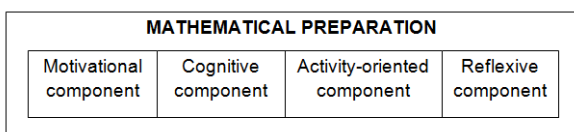


Fig. 1 Structure and content of mathematical preparation

The motivational component characterises the presence of value orientation, motives and interests aimed at professional-mathematical preparation and awareness of its importance for the future profession; interest on the part of the learners towards different activities in math classes.

The cognitive component of mathematical preparation determines the presence of theoretical and practical knowledge formed in the process of professional-mathematical training and self-training, facilitating the students to orient in the information space and to use mathematical packages for solving practical problems;

The activity-oriented component is a complex of activities aimed at self-regulation and skills to make decisions; elements of professional creativity, communicative competence and adequate self-assessment.

The reflexive component of mathematical preparation is aimed at reaching an informed solution to a given problem; to evaluate the process and outcome of self-acquired knowledge and to apply the experience gained from the training; to adequately evaluate their abilities; to form a sense of responsibility for their successes and failures in the learning process and professional activity, which is expressed in: self-assessment of the preparation for application of mathematical knowledge, skills, habits and competences in professional activity (Izvorska, 2017, 128-129).

As has already become clear, the competence approach does not deny the necessity to form a knowledge base and a set of skills and habits, but it is about achieving an integrated outcome – the formation of competence. So, let's take a brief look at the concepts "competency" and "competence".

The concept of "competency" is a successful combination and a set of skills, knowledge, attitudes and behaviour of employees to achieve results in a given professional sphere. Competencies in this meaning should be understood as *ability to self-organise*. By "*competencies*" we shall understand a *set of skills, knowledge, attitudes that are used to perform a successful, professional activity*.

The concept of "competence" is a *personal quality (a set of qualities) that is necessary to perform concrete activities in a particular subject area*. Competence is the ability of the person to perform a particular type of activity successfully, effectively and efficiently; to act skilfully in competitive situations; to make proper choices; to assess his abilities and resources adequately in order to make the right decisions. Competence includes all-round knowledge, skills, habits and behaviour in any field of activity that are necessary for obtaining quality and efficiency. It characterises the outcome, the quality of the professional training and includes both professional preparation (above all, information and technical preparation) and a system of nonprofessional knowledge that every specialist should possess.

In short, *Professional competence* of a specialist is a set of abilities and personal qualities, as well as knowledge and experience necessary for successful professional activity in one or another sphere. (Eraut, 1994).

Bearing in mind the objectives of education, the following mathematical competencies are identified that students enrolled in technical institutes of higher education should possess:

- 1) ability to use the analogy method;
- 2) ability to analyse – ability to see the new sides of a given mathematical object;

3) ability to synthesise – ability to find the common in different mathematical objects;

4) reversibility of the thinking process – ability to switch from direct to reverse thought; this ability is the link between ability to analyse and ability to synthesise;

5) generalisation – ability to summarise the mathematical material; to separate the important from the unimportant; to divert the attention from the insignificant; to see the common in the different and the different in the common;

6) systematisation skills – ability to translate a problem or a way to solve it into an algorithm for its further solution or analysis;

7) ability to translate the problem into the “language of mathematics” – ability to isolate the mathematical problem from the real problem and to rephrase it into a mathematical problem;

8) mathematical intuition – ability to quickly find the right solution and to orient in different situations in order to predict the course of events.

Since the mathematical problem is an essential tool for forming mathematical competencies in students, mainly during their practical math classes, the following *functions* can be defined:

- mathematical problems are an essential tool for developing students' reasoning in the process of math training;
- the problem is an essential means of achieving learning objectives; a means of activating, managing and individualising learning;

- the use of a system of problems designed in accordance with certain levels of knowledge acquisition (algorithmic, recognition, generalisation, creativity) allows the process of mathematical competency formation in students to be manageable;

The following *basic requirements* for construction of a system of mathematical problems oriented towards mathematical competency formation during mathematics studies are set:

- hierarchy (the levels of adoption of the basic components of mathematical knowledge: algorithm, recognition, synthesis, creativity should be the basis for constructing the system of problems);

- adequacy of activity management (the number of problems should be such that the students should move from more rigorous activity management to less severe, taking into account the difficulty limit);

- alternativeness of activity management (the system of problems should be such that the students can compare different approaches to solving mathematical problems in order to be able to assess their effectiveness and relevance);

- error provocation (the system of problems should contain problems developed on the basis of common misconceptions and common mistakes of students);

- procedural (the problem presented to the students should be defined so that they can control not only the outcome of their activity but their progress as well);

Formation of *mathematical competencies at algorithmic level* includes: mastering the algorithm which consists in developing the mathematical processes and their sequence; the application of the algorithm – its development in familiar and unfamiliar situations. As consecutive operations in the prescriptions of the algorithmic type of problems, such problems should be proposed, the solution of which requires

the student to be able to overcome tolerable difficulties. For example elementary operations from algorithmic prescriptions can be proposed in higher mathematics studies along with problems requiring the use of definitions, theorems, formulae, as well as previously solved mathematical problems. Thus, the students receive a task with absolutely precise instructions for all steps that have to be accomplished in order to solve the problem. Such tasks can help to develop the ability for clear and consistent accomplishment of all stages of an activity and to facilitate the accomplishment of activities that prove to be difficult for the students.

Problem 1. Find the vertical asymptotes for the function graph

$$y = \frac{x^4}{(x+1)^3}$$

The sequence of operations is as follows:

1) Find the definition area (DA) of the function.

2) Find the limits of the function at the ends of DA.

3) Draw conclusions and write down the vertical asymptote equations.

Problems at *algorithmic level of training* may only contain a general notion of the method of action. Instructions for performing such tasks may be suggested in view of the difficulties likely to be faced by students when solving the respective problems. This type of activity determines a higher level of formation of mathematical competencies in students. Problems of this type may be the following: problems with indication of the theorem to be used for solving them; proof-oriented problems with use of well-known facts or requiring additional drawing tasks; problems with indication of method(s) of solution; problems for which an instruction is given to use the method of solution for an already solved problem (Yagova, Zubkov, 2013).

In mathematical training it is essential that students are able to recognise concepts, to apply theorems, to use different mathematical methods to solve problems in specific circumstances or contexts and to be able to explain their choices. The problems for forming mathematical competencies at a *recognition level* should be selected taking into account the basic concepts and theorems learned in mathematical classes, which the students have mastered and can distinguish (recognise) among others.

When most of the topic “Differential calculation of function of one variable” has already been studied, the students should be able to select from many examples those in which the application of logarithmic differentiation is first necessary, and secondly rational.

Problem 2. Choose from the following functions those for which the derivative can be found:

1) only by logarithmic differentiation;

2) logarithmic differentiation is the most rational way to find the derivative;

a) $y = \ln(x^2 + 2x) - 3$ б) $y = \frac{x^2 \cdot 3^x}{\cos x \cdot \ln x}$

b) $y = 3 \arcsin(5 - 2x)$ г) $y = (\sin x)^{2x}$

c) $y = \frac{\lg(3x - 2) \cdot \arctg x}{\cos x}$ e) $y = (8x - 3)^{13} (x + 11)^{23}$

Find the derivatives of the selected functions applying logarithmic differentiation. Find derivatives of the same

functions without using logarithmic differentiation. Compare solutions and results.

The problems aimed at forming mathematical competencies at a *generalisation level* imply the need to emphasise the properties of the object, to analyse their relationship, to generalise typical examples, to reconstruct the mathematical learning material. Such tasks are as follows: to retrieve the condition of the problem through the result; to change the dependences in the result resulting from the change in the condition of the problem. On the basis of several typical examples, it is suggested to find the patterns of the solution and to obtain general formulae or rules for the solution.

For the problems requiring *retrieving the condition of the problem through the result*, the end result of the solution is given in the form of a mathematical expression. The students are supposed to retrieve the original expression and to describe the process of obtaining the result. These tasks are intended to enhance the students' ability to make transformations leading to the end result. As an example of a problem requiring retrieving the condition of the problem starting from the end result obtained, the following is suggested:

Problem 3. By calculating the limit of the function in **a** we have the following:

$$\lim_{x \rightarrow a} \frac{2x^3 - 2x^2}{5x^3 - 4x^2} = \frac{1}{2} \text{ Find } a.$$

$$\text{Solution: } \lim_{x \rightarrow a} \frac{2x^3 - 2x^2}{5x^3 - 4x^2} = \lim_{x \rightarrow a} \frac{x^2(2x - 2)}{x^2(5x - 4)} = \frac{1}{2}$$

$$\frac{2x - 2}{5x - 4} \rightarrow \frac{1}{2} \text{ with } x \rightarrow 0 \Rightarrow a = 0$$

Through problems requiring change of the dependences in the end result arising from changes in the condition of the problem students are supposed to learn to establish causative links. A specific change in the condition results in a corresponding change in the end result. Such tasks aim to enable students to master the ability to solve prognostic problems.

$$\text{Problem 4. Solve the inequality } \int_0^a (2 - 4x + 3x^2) dx \leq a,$$

$$a > 0.$$

Despite the fact that this inequality seems to be unusual (contains an integral) and is perceived as an inequality with a given parameter, it is not difficult for first-year students to use the Newton-Leibnitz formula. The inequality is reduced to a simple algebraic inequality and the following result is obtained: $a = 1$.

Students are then asked the following questions:

1. How does the function $f(x)$ change, so that the solution of this inequality is the interval $[5; +\infty)$?
2. Suggest your own inequality, like the one you have, the solution of which is $a = 3$
3. Suggest a solution to an inequality in general, if $f(x)$ is a square function, by considering all parabola positions.

By answering the above questions the students learn to construct, to put hypotheses, to summarise the obtained results. All these actions are a step towards formation of mathematical competencies.

The choice of problems to form mathematical competencies, whose *solution requires a creative approach*, must be based on the possibility for students to develop such qualities of the mind as depth, flexibility, stability, awareness of their thinking process and autonomy in acquiring and using new knowledge.

Problem 5. Is the function $y = 3^{-x^2} + x \cdot \sin x$ even?

Those students who have not developed the ability to deviate from the stereotypes will check the equation $y(-x) = y(x)$.

Those students who possess such qualities of the mind as intellectual agility and can rely on past experiences will consider the function as a sum of two functions: $y_1 = 3^{-x^2}$

and $y_2 = x \cdot \sin x$, and prove that these are even functions.

Then according to the well-known theorem, it is concluded that the sum of two even functions is even.

In the process of performing such creative tasks students will discover other important aspects of the learning material. Opportunities are being created for the students to use effectively and efficiently their mathematical abilities to master the learning material and to apply it creatively in concrete situations.

We can state that students from technical universities should:

- be aware of the role of mathematics in both their professional activity and in mastering the basic professional knowledge and skills;
- be familiar with basic mathematical methods used to solve applied problems from their professional field;
- to be familiar with basic concepts and methods from branches of higher mathematics, such as mathematical analysis, discrete mathematics, linear algebra, analytical geometry, complex number theory, probability theory and mathematical statistics;
- to be familiar with theoretical basis of differential and integral calculus;
- to be able to solve standardised math problems and applied problems in the field of their professional activity;

The special characteristics of mathematical preparation of students following degree courses in technical colleges or universities set a number of requirements to the organisation of the training in mathematical subjects, content, means and methods of training.

Training in higher mathematics in technical universities has a practical focus which includes:

- revealing the significance and importance of mathematical knowledge as a prerequisite for formation of professionals with higher technical education who will be capable of working in contemporary market economy conditions;
- application of the principle of interdisciplinary integration. This is particularly important when developing curricula in the respective degree courses;
- use of basic mathematical methods that are applied in solving practical problems. This implies focusing the attention on the methods and ways of creating mathematical models that adequately meet the demands of modern manufacturing;
- use of modern interactive forms and methods (study groups and group discussions, interactive seminars, business and role games, etc.) to present the learning material, including an electronic version;

- choosing between several modern forms and methods used in mathematical training in the system of higher technical education;

- application of ICT (computer and software use, internet, multimedia) and appropriate computer mathematics systems, such as MathLab, MathCad, Maple, etc.

The effectiveness of mathematical preparation depends on the *pedagogical conditions*. We can determine the following pedagogical conditions: forming a sustainable motivation to study mathematics; application of personality development methods; designing the content of the discipline.

Conclusion

Summing it all up, the following *conclusions* with regard to the issues pointed out in the research paper can be made:

1. Professional competence (PC) of a specialist graduating from a technical university is multifaceted and integrated concept.

2. Mathematical preparation is an integral part of PC of students enrolled in technical institutes of higher learning.

3. The task of forming PC is closely related to the formation of common competencies that are responsible for the development of such important needs and abilities of future professionals as conscientious work, creativity, self-development - these are all qualities for which mathematical training plays an important role.

4. Training in mathematics in technical universities through creation and analysis of mathematical models of applied mathematical problems has a significant potential for formation of PC in future engineers.

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INTRODUCING ACADEMIC AND INSTITUTIONAL TERMINOLOGY AND ANALYSIS OF STUDENTS' SKILLS TO RECOGNISE AND TRANSLATE SPECIFIC TERMS IN THEIR WORK WITH SCIENTIFIC FOREIGN LANGUAGE TEXTS AT THE UNIVERSITY OF MINING AND GEOLOGY "ST. IVAN RILSKI"

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ABSTRACT. The project of the Department of Foreign Languages is aimed at the practical side of the educational process at the University of Mining and Geology "St. Ivan Rilski", Sofia in the module in foreign languages for special purpose. The aim is to actively recognise terms in training texts with scientific orientation in the respective foreign language included in the curriculum of the students at the University of Mining and Geology. At present, the assignments to the students participating in the project have included: preparatory work with a glossary and a dictionary of terms; individual work on a text describing the organisation of the educational activities at our university and the graduates' occupational fulfilment; introduction/acquisition of general academic terminology; working in an Internet environment for introducing/acquiring the institutional terminology of the University of Mining and Geology; introduction/acquisition of basic mining and geological terminology. Since all students work on an identical text, the analysis of the lecturers in the respective language and at the specific level gives an idea of the peculiarities of the students' cognitive activity during the acquisition and translation of terms. The achievements and difficulties in working with a special purpose text on the morphological, syntactic, semantic, and stylistic levels are analysed. The expected results are: improved skills to identify academic and institutional terms in a foreign language; selecting the appropriate/equivalent meanings in Bulgarian; improved cognitive skills of learners; laying solid foundations for work with scientific literature and specialised materials; determining the current trends and the degree of influence of the foreign language on the Bulgarian terms. The benefits for students with regards to their involvement in the project are discussed.

Keywords: foreign language teaching (FLT), terminology, terms

ВЪВЕЖДАНЕ НА АКАДЕМИЧНА И ИНСТИТУЦИОНАЛНА ТЕРМИНОЛОГИЯ И АНАЛИЗ НА УМЕНИЯТА НА СТУДЕНТИТЕ ЗА РАЗПОЗНАВАНЕ И ПРЕВЕЖДАНЕ НА СПЕЦИФИЧНИ ТЕРМИНИ ПРИ РАБОТА С НАУЧНИ ТЕКСТОВЕ НА ЧУЖД ЕЗИК В МГУ "СВ. ИВАН РИЛСКИ"

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РЕЗЮМЕ. Проектът на катедра „Чужди езици“ е насочен към практическа страна в процеса на обучение на студенти в МГУ "Св. Иван Рилски", гр. София в модула по специализиран чужд език. Цели активното разпознаване на термини в учебен текст с научна насоченост на съответния чужд език, включен в учебния план на студентите от специалностите в МГУ. Към момента задачите към студентите-участници в проекта включват: подготвителна работа с терминологичен речник; самостоятелна работа по текст, описващ организацията на учебната дейност в университета ни и реализацията на завършилите; въвеждане/възприемане на общоакадемична терминология; работа в среда Интернет за въвеждане/възприемане на институционална терминология на МГУ; въвеждане/възприемане на основна минно-геоложка терминология. Тъй като всички студенти работят върху идентичен текст, анализът на преподавателите по съответния език и в конкретното ниво дава представа за особеностите на познавателната активност на студентите при усвояването и превода на терминологична лексика. Анализират се постиженията и затрудненията при работа със специализиран текст на морфологично, синтактично, семантично и стилистично ниво. Очакваните резултати са: подобрени умения за идентифициране на академична и институционална терминология на чужд език; намиране на подходящите/еквивалентни значения на български език; подобрени когнитивни умения на обучаемите; полагане на стабилни основи за работа с техническа литература и със специализирани материали; определяне на актуалните тенденции и степента на влияние на чуждия език върху българската терминология. Обсъждат се ползите за студентите от работата им по проекта.

Ключови думи: чуждоезиково обучение (ЧЕО), терминология, термини

Introduction

The project of the Department of Foreign Languages is in the scientific field of Philology, in the area of the Humanitarian Sciences, and more specifically within the Foreign Language Teaching (FLT) methodology related to foreign language for specific purposes. Its implementation began at the end of March 2019, as soon as the proposal for its funding was approved.

The project continues previous research of the teamed participants. Currently, all the lecturers in the department are involved in this project. Our previous scientific activities (Purvanova et al., 2010) have already imposed a successful algorithm of work and there is a continuity with the methods of our previous research activity. We actively involved students in retrieving terms from original scientific texts in the relevant foreign language from the fields in which they are trained – mining, computer technology, geology, ecology, electrical

engineering, etc. (Purvanova et al., 2017). The current project is in two directions: first, towards the practical side of the process of training students at the University of Mining and Geology "St. Ivan Rilski" (UMG) within the module in foreign languages for special purposes – through the introduction of general academic and specific institutional terminology; secondly, towards the methodological aspect of teaching – through the analysis of the cognitive skills of students to recognise and translate specific terms in working with scientific texts in foreign languages.

Current issues addressed by the project

Students at the UMG in the full-time courses of the Bachelor's degree, as well as in some of the part-time courses study a foreign language. Most of the curricula offer a choice between English, German, French or Spanish, and Russian languages. Only the curricula for the courses of study in *Computer technologies in Engineering and Geology and Geoinformatics* provide training only in English. The syllabi for all courses of study include the study of technical terminology as part of the overall FLT. The importance of technical terminology is crucial as the materials that students use during their university education and further during their professional careers, contain a high percentage of terms. Therefore, the terminology is the major means of transmitting facts and knowledge. Recognising and using the right terms increases the precision of speech and eliminates ambiguity. The quality of the terminology used determines the quality of communication of specialists operating in various engineering spheres.

Hence, the importance of providing information to students at the UMG. Acquiring knowledge of concepts in foreign languages within the course of study is particularly important in view to student education. Moreover, acquiring knowledge of terminological concepts in foreign languages within the courses of study offered at the UMG, as well as the extension of students' cognitive skills to recognise and use such concepts, are of paramount significance for the subsequent training and occupational development of the Bachelor and Master degree students, as well as of those taking a PhD.

Factors in the effectiveness of academic education are not only teaching skills and strategies but also cognitive components (knowledge and experience in the cognitive activity, emotional and social, motivational and contextual, etc.) (Terzieva et al., 2014). In methodological literature (Izvorska, 2016), cognition is defined as that element of students' information competence, which "reflects the processes of information processing through...the use of new information and its interaction with available knowledge bases, ... [through] an ability to apply the knowledge gained in the professional activity, an ability to determine the possible sources of information and the strategy for searching, receiving, and transmitting information, an ability to analyse the received information and to assess it, an ability to store and generate information in the form of knowledge of its use in occupational activities".

The *object of our study* are the students from all courses of study at the UMG and broadening their cognitive capacities when working with terms from original scientific texts in the respective language. The reason for our interest is that working

with special knowledge and information is necessarily associated with the recognition and the use of terminological units. The ability to handle information, especially in a foreign-language environment, is bound to terminology, and the focus is on terms when transferring knowledge in a foreign language.

Terms are a special group of words that have some specific features: they are less common words, limited in a particular area where they appear relatively often, with an explicit connection to other terms in this area. Despite these criteria, the distinction between the terminological and non-terminological meaning of words is not always clear. It is often context-dependent. The project is aimed at broadening the cognitive abilities of the students at the UMG so that they can be even more actively involved in the extraction of terms from scientific texts in the respective language and in the identification of the exact Bulgarian terminological equivalent both within a general scientific context and in varied specific fields of exploration and mining.

Objectives

The objectives of the project are as follows:

- The students should recognise terms in a training scientific text which contains general academic terminology and terminological items specific for the three faculties at the UMG;
- Students should individually find the exact Bulgarian equivalent to the extracted terms in accordance with the particulars of the scientific text presented;
- Guided by the lecturer, students should try to change the extracted terms - by adding prefixes/suffixes or compression (abbreviation, acronym);
- By working independently with a dictionary, students should render the extracted terms and terminological phrases systematic by thematically arranging them;
- On the basis of the students' work, the lecturers in the respective languages should analyse the difficulties in working with special-purpose texts. The analysis should be on the phonetic, morphological, syntactical, and semantic level.
- Based on this analysis, a comparative language study should be carried out of the difficulties which students encounter in recognising and working with the terms of a scientific text;
- Students' cognitive skills to recognise specific terms should be compared and practices should be offered to enhance these skills.

Implemented activities

A single training text entitled "The Interview" was developed in Bulgarian, in conformity with the average level of the students in the foreign language groups. The main criteria for selecting the information were: topicality of the material and the difficulty level of the included terminological units.

The lecturers who participate in the project translated the uniform text into the respective foreign language they teach (English, German, French, Spanish, and Russian). The text thus prepared was offered to the students participating in the project for making a forward translation, i.e. from a foreign

language into Bulgarian.

The active work with students has been implemented both in the combined (or "streamed" as they are referred to) groups in the three faculties of UMG (since the middle of April 2019) and in the "off-stream" education for the courses of study in *Computer Technologies in Engineering* (for the 1st, 2nd, 3rd, and 4th year students).

During the summer semester of the 2018/2019 academic year, a total of 98 students were involved in the project from:

A: the "streamed" groups – 48 full-time students:

- the **English** language groups, **II level** – 9 students, three from each faculty (from the Faculty of Mining Technology – 2 students from the course of study in *Development of Minerals* and 1 student from *Management of Resources and Production Systems*; from the Faculty of Geo-Exploration – 1 student from each of the courses of study in *Ecology and Environmental Protection*, in *Biotechnology*, and in *Geology and Exploration of Mineral and Energy Resources*; from the Faculty of Mining and Electrical Mechanics – 2 students from the course of study in *Gassy, Combustion, and Purifying Equipment and Technologies* and 1 student from *Automation, Information, and Controlling Equipment*); **III level** – 8 students (from the Faculty of Mining Technology – 6 students from the courses of study in *Management of Resources and Production Systems*, in *Development of Minerals*, and in *Underground Construction*; from the Faculty of Geo-Exploration – 2 students from the courses of study in *Biotechnology* and in *Geology and Exploration of Mineral and Energy Resources*); and from **IV level** – 12 students (from the Faculty of Mining Technology – 5 students; from the Faculty of Mining and Electrical Mechanics – 3 students; and from the Faculty of Geo-Exploration – 4 students);

- the **German** language groups – 7 students (from the Faculty of Mining Technology – 4 students from the course of study in *Mine Surveying and Geodesy* and 2 students from *Management of Resources and Production Systems*; from the Faculty of Mining and Electrical Mechanics – 1 student from the course of study in *Electrical Power Engineering and Electrical Equipment*);

- the **French** language groups – 3 students (from the Faculty of Mining Technology – 1 student from the course of study in *Mine Surveying and Geodesy*; from the Faculty of Mining and Electrical Mechanics – 2 students from the courses of study in *Electrical Power Engineering and Electrical Equipment* and in *Automation, Information, and Controlling Equipment*);

- the **Spanish** language groups – 2 students (from the Faculty of Geo-Exploration – 2 students from courses of study in *Ecology and Environmental Protection* and in *Hydrogeology and Engineering Geology*)

- the **Russian** language groups – 7 students (from the Faculty of Mining Technology – 3 students from the course of study in *Development of Minerals* and 2 students from *Management of Resources and Production Systems*; from the Faculty of Mining and Electrical Mechanics – 1 student from the course of study in *Electrical Power Engineering and Electrical Equipment*; from the Faculty of Geo-Exploration – 1 student from the course of study in *Ecology and Environmental Protection*);

B: the "off-stream" groups – 50 students studying **English** language:

- from the Faculty of Mining and Electrical Mechanics – 45 full-time students from the course of study in *Computer Technologies in Engineering* taking a Bachelor's degree, distributed as follows: **1st year** – 11 students (5 from the low level group and 6 from the high level group); **2nd year** – 17 students (9 from the lower level group and 8 from the higher level group); **3rd year** – 9 students (3 from the lower level group and 6 from the group with a high level of English language proficiency); **4th year** – 8 students;

- from the Faculty of Geo-Exploration - 2 part-time students from the from course of study in *Drilling, Extraction, and Transport of Oil and Gas* taking a Bachelor's degree in their **1st year**;

C: a **control group** - 3 students: 1 student taking a Master's degree in the course of study in *Computer Technologies in Engineering* at the Faculty of Mining and Electrical Mechanics, **2nd year**; 2 students taking a PhD at the Faculty of Mining and Electrical Mechanics).

Due to the heterogeneous character of the students in the groups, a text was proposed whereby the terms were consistent with their level of acquisition of general scientific and general academic terminology and with the degree of awareness of the students about academic life. For all students, however, the translation assignment was on an unfamiliar text from the foreign language being studied into Bulgarian. The genre of the training text is a scientific interview. It makes it possible to analyse the translation skills of students in the field of general and specific terminology. Academic terms are also included. Concurrently, it is possible to trace different grammar units/structures that are included in the syllabus in the respective foreign language and which the lecturer expects students to have acquired and mastered by the time of performing the activity "student translation for training purposes". We proceeded from the point of view of: what amount of knowledge on the structure and functioning of the higher educational establishment the students had acquired in the respective year (first-year students in the majority of the cases in the "streamed" groups); what amount of engineering knowledge the students were expected to have in the special course units at this stage of their education. The text was compiled according to the following criteria: complexity - medium; number of terms – 51 general academic and 75 specific for the UMG; volume – 2 print pages.

Students had to recognise terms of medium complexity (often due to their belonging to the international lexis, as a result of which such terms are regarded as borrowings/foreignisms in the Bulgarian language) in an adapted text, the information whereby was selected in accordance with the level of the narrow specialisation of students' scientific knowledge as of the moment. They had to find the exact Bulgarian equivalent to the respective term according to the context of the scientific text and to include it in correct syntactic units in Bulgarian. Eventually, the translation into the host language also had to be surveyed for stylistic matches.

The format for the presentation of students' translation scripts was specified: either handwritten during a period, or electronically submitted.

Herewith, we present the text in English:

TRAINING TEXT FOR TRANSLATION FROM ENGLISH INTO BULGARIAN

INTERVIEW

Hello, dear readers of our monthly edition!

It is time for applying for a university and the choice of job is important.

We present to you an interview that we have recently taken from Assoc. Prof. Ivancheva, Deputy Rector at the prestigious University of Mining and Geology "St. Ivan Rilski" in Sofia in connection with the upcoming Open Days:

INTERVIEWER: Good afternoon, Mrs. Deputy Rector.

ASSOC. PROF. IVANCHEVA: Good afternoon.

INTERVIEWER: Please tell us about the structure of your higher school.

ASSOC. PROF. IVANCHEVA: The University of Mining and Geology "St. Ivan Rilski" has five major units: three faculties (the Faculty of Geo-Exploration, the Faculty of Mining Technology, and the Faculty of Mining and Electromechanics) one branch (the Kardzhali Branch), and one department (the Department of Foreign Languages and Sports).

INTERVIEWER: What training do you offer?

ASSOC. PROF. IVANCHEVA: We train full-time and part-time students taking bachelors' and masters' degrees, as well as PhD students.

INTERVIEWER: Could you tell us which the best of the faculties is?

ASSOC. PROF. IVANCHEVA: They are all at a very high level.

INTERVIEWER: What branches of science are taught at your university?

ASSOC. PROF. IVANCHEVA: Earth sciences, the study of rocks and minerals - of their composition, origin, mode of formation, distribution, properties. They are subject to General Geology. Mineralogy studies minerals that are natural inorganic substances. It studies the physical and chemical properties of all minerals. The five branches of mineralogy study various factors associated with the minerals, namely: general mineralogy, determinative mineralogy, mineral genesis, descriptive mineralogy, and economic mineralogy.

INTERVIEWER: This knowledge is acquired in the Faculty of Geo-Exploration, isn't it?

ASSOC. PROF. IVANCHEVA: Basically there, but through some common course units it is also offered at the Faculty of Mining Technology and to the students at the Faculty of Mining and Electromechanics.

INTERVIEWER: Can you be more specific?

ASSOC. PROF. IVANCHEVA: The knowledge of rocks and minerals is the foundation on which the mining and geological activity is based, so it is offered in all courses of studies at our higher educational institution.

INTERVIEWER: I suppose that the focus at the Faculty of Mining Technology is the extraction of minerals. Is that right?

ASSOC. PROF. IVANCHEVA: Absolutely. Quarrying on the surface of the earth is called opencast mining. Underground mining is the one that takes place below the surface, in the land itself. Opencast and underground mining require the use of explosives. The existence of appropriate mine ventilation plays an important part in the successful opencast and underground mining. It supplies the air necessary for the team of people and the facilities.

INTERVIEWER: Which are the important branches of science that provide the proper understanding of the earth, the rocks and the operation under such working conditions?

ASSOC. PROF. IVANCHEVA: Mechanics, for example. It is a branch of physics that studies and analyses the movement and evolution of bodies under the influence of forces. In exploration and in the mining of minerals, forces act on the rock mass and they must be studied, known and controlled. We are helped here by classical mechanics, by theoretical mechanics and other branches that are related to the rock massif, to the construction below and above the rock, to the structures supporting the rocks, and last but not least to the constructions that guarantee the safe operation of miners and engineers.

INTERVIEWER: Is the extraction the only field where the knowledge acquired at the Faculty of Mining Technology is applied?

ASSOC. PROF. IVANCHEVA: Not at all. I suppose that few readers are aware of the fact that our mining engineers are building the metro diameters of the Sofia underground railway.

INTERVIEWER: This is a novelty!

ASSOC. PROF. IVANCHEVA: We are extremely proud because our graduates from the course of studies in *Underground Construction* have been building the underground. The initial stages date back to some 40 years ago with the tunnel below the Dragan Tsankov Blvd.

INTERVIEWER: Congratulations on this very successful work!

ASSOC. PROF. IVANCHEVA: Thank you!

INTERVIEWER: What scope of knowledge is offered to students at the Faculty of Mining and Electromechanics?

ASSOC. PROF. IVANCHEVA: Some of the basic knowledge obtained at the Faculty of Mining and Electromechanics is related to the provision of the area of mining with mine machinery, geological equipment, exploration and electrical facilities and electronics.

INTERVIEWER: And they are directly related to the knowledge of the environment in which they will be installed, aren't they?

ASSOC. PROF. IVANCHEVA: Yes, but also to the specific tasks that will be solved through such machines. Electrification and mining mechanisation provide the technical side of mining. Automation ensures the smooth operation of machines, and computerisation of machines and processes leads to safe processes, to efficiency and control at every stage of the functioning of mining enterprises.

INTERVIEWER: In other words, machines and equipment are the visible part of mining ...

ASSOC. PROF. IVANCHEVA: ... yes, along with the quarries, the rock blocks, the stone ballasting for the roads, and many others. The invisible part is much larger and comprises industrial management, risk reduction, environmental cleanliness, safe substances and materials for the industry and metallurgy.

INTERVIEWER: It is obvious that the holders of a degree from the University of Mining and Geology can find occupational fulfilment in a variety of fields.

ASSOC. PROF. IVANCHEVA: Yes, as engineers, geologists, prospectors, ecologists, information experts.

INTERVIEWER: In this country or abroad?

ASSOC. PROF. IVANCHEVA: Everywhere. I do claim, with a great deal of pride, that there is no other university able to train staff for the full cycle of activities related to the study, extraction, and use of raw materials that are generously offered to us by the Bulgarian land. The quality of our graduates is on a world level and, therefore, they are also successfully employed in foreign companies in this country and abroad.

INTERVIEWER: I suppose this is facilitated by the foreign language teaching of your students.

ASSOC. PROF. IVANCHEVA: Definitely. And that, accordingly, is at a very high level. It is offered in all courses of studies in the length of at least three terms, whereas for some courses of studies - during all eight semesters in the Bachelor's degree.

INTERVIEWER: Thank you for the time spared, Assoc. Prof. Ivancheva. I hope that our young

readers will be intrigued by your description of this unique Bulgarian university. ASSOC. PROF. IVANCHEVA: May they choose to study and work in their homeland, because it needs them.

INTERVIEWER: I wish the University of Mining and Geology a successful new academic year with many enthusiastic and hard-working young people in their first year at university next year!

ASSOC. PROF. IVANCHEVA: Thank you very much, indeed!

Dear readers, this was an interview taken and prepared for you, the people who are interested in good opportunities for training and secure employment following your graduation. These are offered to you by the University of Mining and Geology "St. Ivan Rilski". Take a wise decision and think about your secure fulfilment.

Some of the students preferred to fulfill the assignment during the seminar classes, while others completed the task at home. All students were able to cope with the task and on very short terms, at that. Students worked on their own using dictionaries of terms and general dictionaries in the foreign language (as a paper body or in an electronic version), electronic sources, and a library. To produce the correct translation of the majority of the academic terminology, students had to work in the Internet environment - the focus was on the website of the UGM "St. Ivan Rilski", particularly on the section about the structure of the higher school (faculties and departments) and about the courses of study (in the part concerning the occupational fulfilment of graduates).

So far, the assignments to the students participating in the project have included:

- preparatory work with a terminological dictionary - prior to assigning the translation task, a seminar class was carried out with students to introduce the rules for working with a bilingual technical dictionary, the use of which is a prerequisite for the effective execution of the translation assignment;
- individual work on a training text describing the organisation of the educational activity at our university and the occupational fulfilment of the graduates; the text has been compiled in accordance with the specifics of our higher school and its faculties;
- introduction/acquisition of general academic terminology;
- work in the Internet environment for the introduction/acquisition of UMG institutional terminology;
- introduction/acquisition of basic mining and geological terminology.

Analysis of the results of the participating students' work

It is worth noting the large number of students from the different language groups who are taking a Bachelor's degree (95) and have willingly participated in the project. In performing the tasks, most have shown diligence and eagerness.

The analysis of the performance in the respective foreign language and on the particular level gives an idea of the peculiarities of students' cognitive activity in the acquisition and translation of terminological units. The achievements and the difficulties in working with special-purpose texts are analysed on the morphological, lexical, syntactic, general-grammar, and stylistic levels.

On the *morphological level* (in terms of word composition - e.g. prefixes, endings, auxiliary verbs), students' knowledge of words as parts of the speech, their forms, their formation, composition, and functioning are examined. Students recognise and correctly translate words as parts of speech, the

verb forms in constructions in the Active and the Passive Voice, etc. This is attributed to the fact that, in accordance with the syllabi, the topics from the general foreign language that are necessary for the morphological perception of units in the respective language have currently been discussed, practiced, and mastered in all groups “in the stream”, as well as with the first-year students in the groups “off-stream”. Only occasionally are such inaccuracies noticed in the translation of some students as the ending *-ics* rendering the meaning of [+science] (e.g. “Mechanics”/“механика”) which has been confused with [+the Plural meaning of the Agent noun] (“mechanics”/“механици”); similarly, in places, “physics” has been improperly translated as the Plural form of [+“physicists”] instead of implying the correct meaning of [+“the science of Physics”].

On the **lexical level**, the cognitive abilities of the participants are analysed along the following directions:

A: general academic terminology;

B: specific mining and geological terminology.

Along the first direction, students are expected to recognise academic concepts (like “higher educational institution”, “higher education”, “higher school”, “university”, “faculty”, “alumni”), administrative positions (like “Deputy Rector”), academic positions (such as “Associate Professor”), curricula terms (like “course of study”, “course unit”, “academic year”, “semester/term”, “year of study”, “graduation”, “Bachelor’s degree”, “Master’s degree”), verbs and verb phrases (like “train”/“offer education”, “study” as distinguished from “learn/acquire knowledge/acquire education”, “graduate”, and many others). Almost all students have experienced certain difficulties with academic terminology (for example, in their Bulgarian versions they have used the equivalent to “Assistant Professor”/“асистент” or “Professor”/“професор” instead of the correct translation of “Associate Professor”/“доцент”). There are also inconsistencies with the name of the university itself: “University of Mining and Geology” is sometimes erroneously rendered as “University of Mining Activities and Geology”/“Университет по минно дело и геология”. In all translations, at places, the names of UMG faculties have been mistranslated – e.g. “Faculty of Geo-Exploration” appears in Bulgarian as the equivalent to “Faculty of Geological Surveys”/“Факултет по геоложки проучвания” or “Faculty of Geosurveys”/“Факултет по геопроучвания”. In addition, this terminology is inconsistent throughout the text – in the beginning, the names were translated correctly, but variants appear later in the text. This shows that not all of the students have checked the correct names of the administrative units in the university structure with the correct ones on the UMG website.

Along the second direction, the mining and geological terms serve to extend students’ cognitive horizons. Students are expected to recognise institutional concepts such as “University of Mining and Geology” (also appearing as the acronym “UMG”), the names of the units within the structure of UMG (again written in full or given as abbreviations), terms referring to certain courses of study and sciences. The inaccuracies in the translation of lexical units from terminology are mainly due to:

1. A still insufficiently good command of this terminology in the foreign language and in Bulgarian. Students are yet to become acquainted with it in specialisation course units;

2. The lexical peculiarities of the source language (e.g. the

complicated compound nouns and noun structures are typical of the German language and “ökologische Sauberkeit” appears in Bulgarian as the equivalent of “ecological purity”/“екологична чистота” instead of “environmental protection”/“опазване на околната среда”; the places of the two nouns that constitute the compound word are shifted);

3. Insufficient insight into the text, translating literally and without taking into account the specifics of terminology (e.g. “rocks” is rendered into Bulgarian as “камъни”/“stones”] instead of “скали”; “underground construction” – as “подземна конструкция”/“underground structure”] or “подземен строеж”/“underground building”] instead of “подземно строителство”; “raw materials” – as “сурови материали” or “необработени материали” [“unprocessed materials”] instead of “суровини”).

However, all participants in the project have tried to find an appropriate translation. What is optimistic in the case of those students who have encountered difficulties in translating terms is that there is yet another semester of foreign language training ahead of them. In the course of this, they will improve their cognitive skills by working only with foreign literature on mining and geological subjects. Some for them will be introduced to, while others will extend their capacities with specialised texts and will work on the acquisition of the relevant technical terms in the foreign language.

On the **syntactic level**, we check students’ knowledge and skills related to the construction of the sentence, the relationship between sentence parts, the types of sentence in terms of communication objectives or composition. Students have shown good knowledge of the rules according to which words combine in phrases and sentences. They are able to express themselves correctly in Bulgarian, taking into account the differences in the word order (e.g. in English sentences in the Passive Voice, word order is fixed, whereas in Bulgarian, we can displace the words without changing the meaning of the sentence; in German, in certain cases there is a sentence-final word order, i.e. the verb is at the end of the sentence; yet, students have taken into consideration this peculiarity and have not transferred this rule in their translation into Bulgarian).

On the **general-grammar level**, we have checked the knowledge of students in the foreign language module on:

- Types of sentences (declarative, interrogative and imperative);

- Specific verb categories (major verb tenses – the present, the past, and the future; modal verbs in English; voice – the passive voice; the past participle);

- Categories of nouns/adjectives – gender (in French and Spanish); case (in Russian); article (the English definite article “the” has been massively rendered incorrectly and with full disregard for the rules of the articles with the nominative and with the objective case in Bulgarian).

On the **stylistic level**, issues are analysed that are related to the use of: forms of modality expressing politeness; formal speech. In most cases, the norm has been rendered correctly in the translated text into Bulgarian. Students have experienced certain difficulties in translating formal speech, which is in the conditional mood in French and Spanish. Repetitions have been observed in some of the texts (e.g. “the basis on which it is based”; “are building the underground metro in Sofia metro”; “and last but not last”).

The analysis of the execution of the assigned tasks provides information on how successful the educational

process is/has been in the module in foreign languages for special purpose at the UMG "St. Ivan Rilski".

Expected results

After the project implementation, we expect to achieve the following results: developed cognitive skills of students; developed ability to work with specialised materials and with technical literature; improved skills to identify technical terms in a foreign language; enhanced communication skills of the trainees; determining the impact of the knowledge of the native language on the perception of terminology in a foreign language; determining the trends and degree of influence of foreign terminology on the Bulgarian terminology; FLT that encourages students' interests and stimulates their self-esteem; FLT that is consistent with the contemporary educational trends.

In terms of enhancing students' cognitive skills, the benefits for the students from their work on the project are as follows:

- Elaborating on texts from the scientific field of the three faculties, and not only from the narrow scientific orientation of each course of study, will introduce a competitive element in the work of the students;

- Students will directly participate in the process of documentation of the correct Bulgarian meanings of technical terms in the module in foreign languages for special purpose. Thus, their activity in the training process will be encouraged;

- The gradual mastering of terms will increase students' self-esteem. It will also broaden students' scientific horizons with topics from other courses of study. Besides, it will be an incentive for the continued search for scientific knowledge;

- Students' individual referencing and research work will also contribute to the more sustainable management of technical terminology;

- A direct consequence of the above will be the ease in working with specialised foreign texts in the process of their further education and their better occupational fulfilment;

- Last but not least, mastering a terminological minimum, combined with associative capacities, could provoke some of the prominent students to cross the boundaries of the foreign language they study and look for analogies in other languages.

The benefits for the lecturers from their work on the project are as follows: the comparison of the results from the students' work in the different language groups in English, German, French, or Spanish, and Russian will help the lecturers to outline common difficulties in their mastering of terminological units and in making a technical translation into the various languages; a comparative research of students' work at the end of one semester and at the beginning of the next will make it possible to increase the efficiency of FLT for special purposes in the field of mining and geology.

Conclusion

These are the results of the first part of the research carried out. Students from all three faculties have manifested skills to work with an unfamiliar technical text that, in terms of difficulty, is consistent with their level of knowledge. They have been able to recognise and translate into the Bulgarian language words defined as technical terms.

The lecturers from the Department of Foreign Languages will continue to work on the implementation of the project according to the plan laid.

A detailed analysis of the project work and the final results will be published at the end of the year in the annual edition of the Department of Foreign Languages and Sports (DFLS) "Proceedings of the DFLS".

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ON THE PROBLEM OF THE AIM AND TASKS OF PHYSICAL EDUCATION IN UNIVERSITIES

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ABSTRACT. Physical education in universities is an important social sphere of application of sports. In essence, it is an integral process that combines diverse sporting knowledge, tools, methods and approaches for achieving its goals and tasks. In this sense, the complex-integrative nature of the impact of purposeful physical activity on students in the physical education process predetermines in a sense the need for a wider view of its essence as a social phenomenon and pedagogical process. That is why, the goal we set out was to look into modern aspects of the aim and tasks of physical education in universities. Although it is theoretical, the publication reflects also elements of application purpose of the process with the students. And this process also has a part in solving questions of a philosophical worldview nature, since it affects the personality of the trainees not only physically but also multilaterally. As a result of the analysis, not only the aim and tasks of physical education in the universities are formulated from a contemporary point of view, but also three main components are drawn out for each of the structures of the sport (physical) culture, of the student's personality, and in the content of the educational process in the universities.

Keywords: physical education, Universities, higher education, integrated process, sports knowledge, goals and tasks, social phenomenon, pedagogical process, components

ПО ПРОБЛЕМА ЗА ЦЕЛТА И ЗАДАЧИТЕ НА ФИЗИЧЕСКОТО ВЪЗПИТАНИЕ ВЪВ ВИСШИТЕ УЧИЛИЩА

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РЕЗЮМЕ. Физическото възпитание във висшите училища е важна социална сфера на приложение на спорта. По същество то е интегрален процес, съчетаващ в себе си разнородни спортологични знания, средства, методи и подходи за реализацията на неговите цели и задачи. В този смисъл комплексно-интегративният характер на въздействието, оказвано от целенасочената двигателна активност върху студентите в процеса по физическо възпитание, предопределя в известен смисъл и необходимостта от по-широк поглед върху същността му като социално явление и педагогически процес. Ето защо, **целта**, която си поставихме бе да разгледаме в съвременната теория някои аспекти на целта и задачите на физическото възпитание във висшите училища. Макар и да има теоретичен характер публикацията отразява и елементи от приложната насоченост на процеса със студентите. А този процес има отношение и към решаването на въпроси с философско-мирогледен характер, тъй като въздейства не само физически, а многостранно върху личността на обучаваните. В резултат на анализа не само са формулирани със съвременен звучене целта и задачите на физическо възпитание във висшите училища, но и са изведени по три основни компонента в структурата на спортната (физическата) култура на личността на студента и в съдържанието на учебния процес във висшите училища.

Ключови думи: физическо възпитание, висши училища, интегрален процес, спортологични знания, цели и задачи, социално явление, педагогически процес, компоненти

Introduction

Physical education in universities is an important social sphere of application of sports. In essence, it is an integral process that combines diverse sporting knowledge, tools, methods and approaches for achieving its goals and tasks. According to Bachvarov (2000), the unity of knowledge from the theory of physical education, pedagogy, psychology, physiology, anatomy, biomechanics and others as a sporting approach would in general be incomplete without the methodological basis of philosophy for the essence of physical exercise. The same author (2000; 2003) believes that the complex-integral nature of the impact of intense physical activity on humans predetermines in a sense the need for a wider view of the essence of physical education as a social phenomenon and pedagogical process. This process has its specific functions and purpose, since it is based on purposeful

motor activity. On the other hand, the process (physical exercise) also has a bearing on the solution of questions of a philosophical-ideological nature, since it affects not only physically but multilaterally the learner's personality.

That is why, the goal we set out was to look into contemporary theories of some aspects of the purpose and tasks of physical education in the conditions of the higher schools.

In modern theory there are different nuances in determining the purpose of physical education in the education system. For example, in the Soviet and subsequently in the Russian education system, which has also reflected on us, the goal of physical education in the universities is aimed at "shaping the physical culture of the personality ... as a concept that characterises the education, physical readiness and physical perfection of the person" (Buyanov, Pereverzeva, 2011). To this end, Zaynetdinov et al. (2009) add "building

capacity for purposeful use of the various means of physical education, sport and tourism to preserve and strengthen health, psychophysical training and self-preparation for future professional activity".

In recent years, physical culture has been seen not as a single phenomenon but as a sustainable quality of the personality (Marinov, 2014). It is a natural bridge that makes it possible to connect the social and biological development of man in the best way possible. The individual educational, educative and healing tasks of physical education in universities are determined by the structure of the physical culture of the personality, which is composed of three components, according to Ilinic (2001): A. Operative. B. Motivational. C. Practical. They are united and related to the professional orientation of this type of culture and the formation of the personality (Marinov, 2014). The individual tasks are limited to:

- Awareness of the role of physical exercise in personality development, in the preparation for professional activity.
- Understanding the scientific-practical foundations of physical exercise and healthy lifestyle.
- Formation of motivational-valued relationships in students and the need for regular exercises.
- Mastering a system of practical skills and habits for preserving and strengthening health and developing psychophysical abilities.
- Provision of the professional-applied physical training of the students for their future profession.
- Acquiring experience of using sporting activities to achieve professional goals.

The development of the personality through physical education in universities is seen as an active impact not so much on the physical abilities of the student but on his/her feelings and consciousness, psyche and intellect which provide the following socio-psychological manifestations: positive motivation, value orientation, interests and needs in the sphere of physical activity and healthy lifestyle. In this direction, Nikitina (2006) concludes that "the essence of a person's physical culture lies not so much in the acquired knowledge, skills, habits, abilities, and above all human attitudes towards self-knowledge, self-development, self-improvement, self-regulation, the transformation of their nature into the process of deliberate and systematic execution of various physical exercises, hygienic and quenching procedures based on the social experience everyone gets in the process of physical education ...".

Here is the place to emphasise, as Bachvarov (2000) asserts, that physical education as a particularly useful activity has its own bio-social nature. The importance of motor activity (labour, dances, tourism, sports, etc.) in all its types and forms of realisation in human development has been proven for a long time. On the other hand, the realisation of this natural-biological need for movement in the form of purposefully organised motor activity in various sports-pedagogical (lesson and out-of-focus) activities has underlined social functions. These are not only health as a social necessity but also the contacts between individuals, groups and societies. The social dimensions and importance of sporting activity can also be understood through its role as a factor in a healthy lifestyle and a way of counteracting the negative phenomena in society - alcoholism, addiction, prostitution, crime and others.

As far as the Bulgarian education system is concerned, in historical plan the purpose of physical education in schools was formulated in 1897 (Mateeva, 1992). In the "Programme for the 5th Grade Girl Schools and the Lower Grammar School", then, the Ministry of National Education formulated the objective of the discipline "Gymnastics" (as the subject was called then) as follows: "The gymnastics' goal is to strengthen the body; to establish natural and correct movements and proper state of the body".

The given definition of the goal has evolved over the years, where on foreground besides the esthetical, also the healing effect from the activities is being presented. This priority of physical education among students became more pronounced in the later curricula in 1922, 1925, 1933, and in 1964 when education reform was carried out. And if until then, in none of the formulated goals, there was specialised knowledge, later on in the programme of the discipline "Physical Education" of 1973/74 that omission was corrected. The matter of adding the applied and scientific knowledge in the curriculum content, which enhances the activity of the students in the process of physical education, was seriously covered.

In the specialised literature (Rachev et al., 1984; Mateeva, 1985; Ilvanov, 1996; Tzolov, Ivanov, 1998; Bachvarov, 2000; Ivanov, 2004; Ignatova, 2006; Slavchev, Slavchev, 2007; Slavchev et al., 2010; Gavrilov et al., 2016) there are many complementary formulations of the goal of physical education in higher schools. For example, one of the authors Ivanov (1996) has the most complete view of this objective by formulating it in three directions in the following way:

1. Objectives arising from the public nature of physical education and sport in the overall socio-economic system.
2. Objectives arising from the personal nature of physical education.
3. Objectives arising from the specifics of the teaching-pedagogical activity and the teaching of the discipline.

For each group of objectives, he points out in detail the expected results from the learning process.

Other authors (Bachvarov, 2000; Margaritov et al., 2003; etc.) summarise the goal of physical education with students as a content of four elements: A. Use of physical exercises as a useful and complete tool B. Developing emotional and psychosocial qualities, C. Developing useful physical qualities and motor skill habits, D. Developing and maintaining high physical and functional fitness.

Bachvarov (2000) summarises that under the conditions of higher education physical education as a learning process must pursue three main goals (tasks):

1. Developing endurance as the basis of human vitality.
2. Providing maximum knowledge for personal usage of physical exercises for durability and reactions until the end of life.
3. Knowledge to control physical fitness in an age aspect.

During the course of physical education, students must be convinced of the need to maintain and control their physical fitness. This means that lessons should help to increase the educational content of the "Exercise for Life" motto.

On this basis, Tzolov, and Ivanov (1998; 2004) perhaps most fully have formulated the purpose of the physical education learning process in higher schools. They state it in the following way: "giving students the necessary knowledge about the effective use of physical exercise and sports in their lifestyle, forming them with practical skills and habits for

physical exercise and sports, helping to improve psychophysical working capacity and the general motivating of their motor culture, strengthening their state of health, preparing for future performance of their work and socialisation in society".

Davidov and Davidova (2008) point out that "strengthening the health of students, building vital motor habits and developing physical qualities and abilities, building hygienic habits, acquiring knowledge in the field of physical culture and sports, education of moral and volitional qualities are the main tasks placed through physical education in the university".

The authors mentioned here elaborate in more detail the individual tasks in three directions:

1. *Educational tasks*, which consist in giving theoretical knowledge about the use of physical exercise and sport by students, the formation of practical skills and habits for exercising and sports, enhancing the motor skills culture, forming the basic motor skills of the technique of the chosen sport and more.
2. *Health tasks*, which are meant to help the physical development of the students, to improve their functional capacity, to strengthen their health and to maintain their high working capacity, to healing and prophylactic means, etc.
3. *Upbringing tasks* that involve the development of moral and volitional qualities, the formation of spiritual and aesthetic values, a sense of duty and collectivism, friendship and mutual assistance and socialisation. Tzankova (2008) confirms this by transforming these tasks in the following directions:
 - *Educational field* - the formation of the necessary knowledge, skills and habits in the students in order to increase the general functional training, by widespread use of the means of physical education at home and the preparation for work and creative realisation.
 - *Hygiene* - helping to strengthen health and maintain the proper functioning of bodies and systems to ensure employability during training.
 - *Professional applied application* - forming in students special knowledge, motor habits and motor skills to ensure physical fitness for the upcoming professional activity

In this direction Stoev (2013) outlines the following three components in the content of physical education: socio-psychological, intellectual and motor.

- *Socio-psychological education* is related to the process of formation of philosophy, beliefs and needs for the assimilation of the values of sports culture.
- *Intellectual education* is related to the formation of a complex of philosophical, medical-biological, pedagogical and other knowledge related to physical education and sport.
- *The motor activity* is aimed at forming motor skills and habits, increasing the level of physical training and the possibilities for rational use of the motor's own potential.

Conclusion

The achievement of the designed goal and the tasks of physical education in the Bulgarian universities can be achieved by effectively solving the many problems faced by the educational process, among which are the necessity of: improvement of the curricula and the methodology for conducting the lessons; increasing the number of hours required by the subject; raising the educational content of the subject and raising the interest in it, by giving the students more knowledge about the purposeful use of physical exercises as a means of health, vitality and beauty, for counteracting negative situations and active socialisation in society, etc.

An important point in the learning process is, however, as pointed out by Tomova et al. (2010) the goals and tasks to be solved in unity: "They must ensure the successful learning of the educational content, create the necessary personal fitness and readiness for the subsequent, systematic self-exercise of the physical exercise and sport necessary for the lifelong maintenance of the healthy way of life, viability and employability".

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EDUCATIONAL PROJECTS – AN INSTRUMENT FOR RAISING THE POTENTIAL OF HUMAN RESOURCES

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ABSTRACT. Education as a high public value is the key to the preparation of human resources in the modern conditions of the rapidly changing labour market, the development of specific skills and personal qualities (teamwork skills, mutual assistance, understanding, initiative, creativity, entrepreneurial spirit, attitudes towards informed solutions, international, intercultural and inter-religious tolerance), the path for acquiring professional qualification and inclusion in the European educational space. Education is defined as one of the most conservative social sectors. This is the result of both its internal characteristics (continuity, attitudes and time for changing scientific and pedagogical paradigms, etc.), as well as of the requirements of the society itself (family and traditions, financial resources, etc.). In recent years, education in our country has become one of the subjects of greatest public importance. There is a growing prevalence of the opinion on the need to redefine the objectives of Bulgarian school education in view of the new requirements of dynamic globalisation and the challenges of a highly competitive labour market within the European Union. Educational projects are one of the leading tools that underpin social and occupational development and the desired change. In Bulgaria there has been a talk of educational reform for a long time, various proposals for changes have been made, new practices have been introduced, taken from the European model of education and training, but the real reforms are partial and extremely insufficient.

Keywords: educational projects, personal qualities, pedagogical paradigms

ОБРАЗОВАТЕЛНИТЕ ПРОЕКТИ – ИНСТРУМЕНТ ЗА ПОВИШАВАНЕ ПОТЕНЦИАЛА НА ЧОВЕШКИТЕ РЕСУРСИ

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РЕЗЮМЕ. Образованието като висша обществена ценност е ключът към подготовката на човешките ресурси в съвременните условия на бързопроменящия се пазар на труда, развитието на специфични умения и личностни качества (умения за работа в екип, взаимопомощ, разбирателство, инициативност, креативност, предприемачески дух, нагласи за информирани решения, международна, межкултурна и междурелигиозна толерантност), пътят за придобиване на професионална квалификация и приобщаване към европейското образователно пространство. Образованието се определя като един от най-консервативните социални сектори. Това е резултат както от негови вътрешни характеристики (приемственост, нагласи и време за смяна на научни и педагогически парадигми и т.н.), така и от изисквания на самия социум (семейство и традиции, финансови ресурси и др.). През последните години образованието у нас се утвърди като една от темите с най-голяма обществена значимост. Все повече преобладава мнението за нуждата от предефиниране на целите на българското училищно образование, с оглед новите изисквания на динамичната глобализация и предизвикателствата на високо конкурентния пазар на труда в рамките на Европейския съюз. Образователните проекти са един от водещите инструменти, които лежат в основата на социалното и трудово-професионално развитие и така желаната промяна. В България от доста време се говори за образователна реформа, правят се различни предложения за промени, въвеждат се нови практики, взети от европейския модел на образование и обучение, но реалните реформи са частични и крайно недостатъчни.

Ключови думи: образователни проекти, личностни качества, педагогически парадигми

Education as a high public value is the key to the preparation of human resources in the modern conditions of the rapidly changing labour market, the development of specific skills and personal qualities (teamwork skills, mutual assistance, understanding, initiative, creativity, entrepreneurial spirit, attitudes towards informed solutions, international, intercultural and inter-religious tolerance), the path for acquiring professional qualification and inclusion in the European educational space. Education is defined as one of the most conservative social sectors. This is the result of both its internal characteristics (continuity, attitudes and time for changing scientific and pedagogical paradigms, etc.), as well as the requirements of the social system itself (family and traditions, financial resources, etc.) (Pantaleev, 2005). Education plays a central role in the life of every person and prepares him/her for further professional realisation. Knowledge and skills acquired as a result of education are a key factor for integration or exclusion from the labour market.

They determine the economic impact of education on the labour market. Links between education and employment are multi-layered and higher education is not always a guarantee of (high-paid) work and higher productivity in the economy. A major problem in the education process in preparing the necessary experts is the lack of well-established relationships and contacts between the administration and the higher education institutions to encourage prospective students to seek their public sector engagement (Ivanov, 2018).

The system of vocational education and training is the one that prepares citizens for realisation in the economy and other spheres of public life, creating conditions for acquiring professional qualification (qualification in a profession or part of a profession that includes the set of professional competencies and the necessary for their forming general knowledge and skills) (Zakon za profesionalnoto obrazovanie i obuchenie) and for its continuous improvement. A secondary education programme is professional if its orientation is "primarily

intended to lead participants to acquire the practical skills, know-how and understanding needed to work on a specific profession." Vocational education can be a school-based or part of a dual apprenticeship system. For comparison, general education is only school-based and does not necessarily lead to qualifications relevant to labour market requirements (Ganchev, 2014).

The vocational education and training system has a complex structure covering three areas: vocational guidance (providing information and counseling to pupils and others about their choice of profession and career development), vocational training (ensuring the acquisition of qualification by profession or part from the profession, as well as its improvement) and vocational education (it assures the absorption of the general education minimum for secondary education and the acquisition of a profession).

Vocational training is an integral part of each person's education. It is based on the principles of humanism and democratisation, which require: the commitment of education, respectively training with personal interests and public needs; basic level – a minimum of professional competencies (proven ability to use knowledge, skills (personal, social) during training, at work or in professional and personal development at the completion of a certain level of training; free self-determination – the right of everyone to determine their personal development according to the requirements of the basic educational level, the public needs and interests and the effectiveness of the training - training for everyone in the optimal boundaries and quality of education.

Vocational education and training in Bulgaria offers the acquisition of four degrees of professional qualification that are comparable to the European ones. This system allows each student who has passed a certain educational stage to obtain a corresponding degree of qualification. Degrees of professional qualification are interdependent with the possibility of transition from lower to higher level of qualification (*Obrazovanie za vsichki*, 2002). They are regulated in Article 8 of the Vocational Education and Training Act. According to it the relevant degrees of professional qualification require:

- for the first degree – acquired professional competences for practicing professions, including routine activities carried out under non-changing conditions;
- for the second degree – acquired professional competences for exercising professions involving complex activities carried out under changing conditions;
- for the third degree – acquired professional competences for practicing professions, including complex activities carried out under changing conditions, as well as assuming responsibility for the work of other persons;
- for the fourth degree – acquired professional competences for exercising professions involving a wide range of complex activities carried out under changing conditions as well as assuming managerial responsibilities for the work of others and for the allocation of resources. (*Zakon za profesionalnoto obrazovanie i obuchenie*).

Over the last decades, vocational education and training (VET) has become a key factor in sustainable socio-economic development in Europe. There is a growing need to apply new approaches in vocational education and training. In their realisation it is necessary to take into account the circumstances facing our country. In the short term, they are directly related to the socio-economic situation after the crisis

and to the long-term demographic processes and changes. European initiatives are aimed at improving vocational education and training systems so that these systems can help increase employment and social inclusion, enable everyone to take up lifelong learning and facilitate access to higher education in accordance with the needs of society and the labor market (*Strategia za razvitie na profesionalnoto obrazovanie i obuchenie v Republika Bulgaria za perioda 2015-2020*).

The current state of secondary vocational education and training in Bulgaria reveals a picture of the problems in several directions:

- the quality assurance system for vocational education and training needs updating and adapting to European quality requirements;
- there is no programme for qualitatively improving of the educational and training environment in schools;
- the network of schools in which vocational training is carried out needs urgent optimisation;
- lack of flexibility in school vocational education and training;
- the number of pupils in vocational education sharply decreases;
- there is a steady trend towards inclusion in vocational education of students with low success and poor motivation for training in high-tech professions;
- decrease in the number of trainees in occupations with II and III degree of professional qualification;
- the number of teachers in vocational schools is "melting";
- the "aging" of teaching staff in vocational schools is visible, as well as the obsolete approaches and methods that are applied in the process of training young people;
- there is a pressing need to review the role of the institutions involved in setting up and organising vocational education and training policy in the country;
- it is necessary to update the processes and standards directly related to vocational education and training;
- the vocational education and training system is experiencing the need to apply European tools for modular training;
- there is weak communication between secondary vocational education and business.

The positive effects of education accompany the person throughout his or her active life and provide the opportunity to acquire social knowledge and skills necessary for personal and professional realisation. The vocational education and training system needs qualitative changes that will in the future create trained personnel necessary for the modern, fast-changing and information-secured labour market. In Bulgaria, in recent years, the quality of human resources has dropped considerably, due to a number of significant reasons – lower levels of vocational education and training, lack of innovative methods, outdated curricula and programmes that do not meet the needs of the modern Bulgarian economy, discrepancy between the acquired qualification the possibility of realisation and a number of others. An essential tool for achieving the desired quality educational change and for raising the potential of human resources in our country is the so-called "Educational project". A project in education is a collaborative process, frequently

involving different teacher and educational staff that is carefully planned to achieve a particular aim of learning.

In Bulgaria, educational projects have a long history, but their results are accepted by society with different attitudes and responses. One reason for this is the lack of an assessment of the impact of programmes and projects on the education system. European practice has long introduced project interventions in education and has helped to improve the quality of human resources. Bulgaria, as a member of the European Union, should follow the good practices and impact models for improving the quality of the secondary vocational education and training and its effects on the future professional staff. Project work is this credible opportunity for change and innovation in the education sector.

Educational projects are the group of social projects whose main objectives are related to the achievement of a change in the field of education and education as a whole. This change can be related both to material gains (improvement of the material and technical base) and to the educational process of pupils and teachers. As a result, new knowledge can be acquired, different types of skills (communication, organisational, technical, etc.) can be learned, new relationships and values, learning new patterns of behaviour, etc. (Totseva, Kozhuharova, 2008). This process is called socialisation (Genova, 2009). Personally, one learns basic knowledge and skills; develops his abstract thinking; learns to solve problems; communicates with basic values of society; is trained on professional knowledge and skills, techniques and practices of professional activity, models and standards of professional behaviour that help the person to present and offer to the labour market; prepares for meaningful and complete relations with others; acquires a civilian position. From a social point of view, one develops his sense of commitment, responsibility, desire for a high level of education and qualification, striving for prestige in society, knowledge and skills to cope with the pressures and challenges of the social environment (Genova, 2009). Through educational projects, one becomes socialised and builds himself as a person. It is important in this process to obtain continuous feedback on the development and achievements of the individual pupil.

Educational projects are implemented in the area of secondary, secondary vocational and tertiary education, as well as in lifelong learning. The present study pays attention to the educational projects developed and applied in secondary vocational education and training. In recent years, not only in Europe, but also in Bulgaria, an increasing number of enrichment activities have been carried out on a project basis (Totseva, Kozhuharova, 2008). There are generally two approaches to the implementation of education and training programmes and projects within the European Union. The first approach, conditionally called horizontal, involves activities related to:

- exchange ideas for policies, innovations and good practices within vocational education and training;
- exchange and mobility of learners, creation of opportunities for enhancing language training;
- research in the field of vocational education and training, distance learning and the introduction of information technologies in education.

The second approach is based on the regional principle (a basic principle of support in the European Union). The regions of the EU Member States apply for funds to improve

educational and training activities. This approach also allows for direct investment in educational infrastructure. Increasing the competitiveness and quality of human resources through education and training is the main goal of the thousands of projects funded annually by the European Commission (Pantaleev, 2005).

"The two approaches complement each other and provide education and training institutions with the opportunity to produce and distribute their own know-how, to use already created ones and to use financial resources to implement educational innovations" (Pantaleev, 2005).

The mission of educational projects is rooted in supporting smart, talented and motivated students to work to maximise their potential and capabilities through the projects they are involved in.

The vision of educational projects is their transformation into the means, which will improve the quality of human resources and will contribute to their future professional realisation.

The main objectives of the educational projects are directly related to the achievement of the social and labour-professional development of the participants. School projects play an important role in creating democratic attitudes (to be tolerant and to accept the different, all people to have equal rights in society, everyone to freely express their public position – freedom of speech, etc.) and education in the values of mutual understanding – qualities that accompany the individual throughout his social and professional life. Educational projects aim at developing foreign language, entrepreneurial, communication, presentation, professional, intercultural and many other competences and skills necessary for the realisation of young people. By participating in an educational project, the learner is involved in a learning process - has the opportunity to develop his/her potential, provides an initiative to acquire new knowledge and skills, to learn to communicate and to work effectively in a team, to solve solutions and deal with specific problems, to touch on innovative methods and approaches, to be socially responsible, and develop and implement constructive personal strategies in different life situations.

Project activity is not just a move forward, it is not just enthusiasm and success, there are resources and conditions for "normal work". It also includes a peculiar overview of capacity, human resources, and readiness for change (Pantaleev, 2005). So far, no comprehensive assessment of the impact of educational projects on final recipients (recipients) has been carried out in our country. Expert observations and feedback in this area reveal that:

- pupils are very positive about innovation in education and training;
- the competition, selection for project participation and mobility are extremely positive and have a huge motivating impact on them;
- language training for students is usually good and sometimes excellent for participation in projects;

Lecturers usually observe significant positive changes in the pupils involved in projects (Pantaleev, 2005).

Educational projects in Bulgaria have a positive impact on the development and quality of human resources. The implementation and management of school projects has proved to be a good European practice in Bulgarian secondary vocational education and training and requires the use of

different techniques and technologies in the development of educational projects.

"Projects in themselves represent a violation of established rhythm of work, interconnections and interactions in one system. In this sense, it is accepted to use the term "intervention" without any negative workload. It merely takes into account the fact of interfering with the system." (Pantaleev, 2005). Educational projects are the kind of intervention in the education sector which overturns the perceptions of modern education in Bulgaria and gives new hopes for change. Achieving this desired change is through the use of specific techniques and technologies in developing and implementing educational projects.

All projects are developed and managed using the same methods and using specific techniques and technologies. The implementation of educational projects as a kind of social projects also applies to common methods, techniques and technologies. It is generally accepted that work on projects is divided into different stages, which in the vocabulary of the project activity are called phases of the project cycle.

"The design cycle is the way in which projects are planned and implemented, following a sequence that is pre-agreed. It includes a series of actions that are carried out and evaluated in such a way as to achieve the underlying idea and its stated purpose. The previous practice in implementing projects in education in Bulgaria has shown that project management suffers from a lack of knowledge and skills, namely for the phases of the project cycle and the sequence of actions that ensure success of each phase." (Pantaleev, 2005)

In project management, it is accepted to follow the logical sequence of six main phases of the project cycle: programming; project identification; formulation of the project; negotiation / financing of the project; implementation of the project; evaluation.

Effective management of an educational project involves defining its scope (detailed description of intermediate and final results, including the work required to achieve them); hierarchical alignment and planning of the necessary activities that determine the success of the project; coordinating efforts to achieve the results and objectives of the project; forecasting and analysis of possible risks (unexpected deviations from planned outcomes); quality management (good quality in educational projects is linked to meeting the expectations and requirements of stakeholders and stakeholders) (Totseva, Kozhuharova, 2008); reasonable management of resources (human, financial, technical); ongoing monitoring and evaluation of project implementation. The process of managing an educational project is long, requiring consistency in actions that are subordinate to specific goals and aimed at achieving concrete results for a specified period of time.

Conclusion

In the modern conditions of a fast-changing and dynamic labour market, education is the key factor contributing to the professional realisation and career of young people. The acquisition of specific knowledge, practical skills and

competences at school develops both personal growth and professional development and social inclusion of students.

A major tool for enhancing the potential of human resources are the education projects that represent much more than a training method for modern education. They are the means by which students develop a vast array of non-technical skills and personal qualities highly valued by business. In this way, the young people become socialised and build up as a person. An increasing number of students are willing to take part in an educational project which shows that young people are awake, ready to change and integrate into the European educational space, and to follow the European principles of the concept of lifelong learning.

Bulgarian society must realise the need for reform of our education system and make education a high value and a national responsibility. Bulgarian children deserve quality education and vocational training that meets the European standards and is in line with the challenges of our economic and social development.

The secondary vocational school education in Bulgaria should be based on the Bulgarian traditions and correspond to the European trends. Education policy should focus on improving the vocational education and training system, because it creates and perfects the future professional staff who are developing the economy of our country.

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