

Modern Perspectives in Bulgarian Engineering Education Through the Prism of Experts From the IT sector (Empirical study)

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Abstract. We are witnessing a confluence of technology, information, communication and artificial intelligence that emphasizes the importance of soft skills, communication skills, critical thinking, problem solving, teamwork in engineering. This, in turn, necessitates an emphasis on interdisciplinary training by educational institutions in the preparation of engineering personnel, in accordance with the requirements of business in the IT field. The research was conducted on the territory of the city of Sofia in the Republic of Bulgaria, where a significant number of small and medium-sized IT companies are positioned with opportunities to hire graduating students and accordingly, the experts working in them to assess their competences, but also to assess the requirements of those for training of engineering staff from universities in the IT sector. From this point of view the purpose of the publication is to establish from a certain group of respondents some modern perspectives in Bulgarian engineering education from the point of view of business representatives. Based on the purpose of the study a questionnaire was drawn up and sent to respondents to assess what knowledge and skills future IT engineers should possess. This necessitated the use of a quantitative approach through an online survey that was randomly sent to 24 small and medium-sized IT enterprises. The completed and returned surveys are from 59 experts, representatives of 16 enterprises. The research showed that IT business experts need IT engineering personnel who have not only narrowly specialized knowledge in the relevant professional field, but also interdisciplinary ones with a wide range of work and decision-making skills.

Keywords: Engineering education, IT sector, empirical study, modern perspectives

I. INTRODUCTION

The rapid development of modern information and communication technologies and innovations in IT practice have widened the gap "needs of business - training of engineering personnel". This set new requirements and

challenges in the training of engineering IT specialists, which also reflects the educational system in the Republic of Bulgaria. The emergence of new technological applications, related not only to the dynamics of the development of artificial intelligence, but also to modern IT technologies, forced not only universities worldwide, but also those in the Republic of Bulgaria to adapt to a change in approach and in general the model for training in modern IT specialties. The leadership of the visionary higher schools realized the need to change the curricula and programs to follow the new and unique educational and practical trends in the IT sphere worldwide. They were the catalyst for numerous scientific publications, as a result of the application of artificial intelligence, modern IT technologies and software products in corporate practice.

II. THEORETICAL RESEARCH AND SOME ASSUMPTIONS REGARDING MODERN PERSPECTIVES IN BULGARIAN ENGINEERING EDUCATION IN THE IT SECTOR

In the world scientific literature, the issue of engineering education is becoming more and more relevant, as in recent years scientific production has been published with a different context, both in terms of the training and preparation of engineering personnel, and concerning current problems and issues in the relevant educational system [1], [2], [3], [4]. The general tone of the publications advocates the idea of quality engineering education through basic knowledge in the relevant engineering field, the creation of programs and initiatives to stimulate learning in engineering sciences, developing professional competencies for lifelong learning, etc. [5], [6], [7]. The theoretical preparation of science engineering students is linked to the acquisition of competencies from real practice, the acquisition of knowledge and skills that will help them to adapt more easily in their early career from their work activities, the acquisition of experience through mentoring relationships, etc. n. [8], [9], [10], [11], [12].

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In order to respond to the new educational trends in the IT industry, a large part of the modern and responsive universities have adapted their educational documentation and training practice according to the needs of the business. Proceeding from the application of new technological solutions in the business practice of modern IT companies and the scientific response in the literature, in the general effect of this activity, priority directions for training IT engineering personnel in the educational system were identified. In recent years, there has been an unprecedented interest in the introduction of disciplines that are the object of scientific and practical-applied interest in the universities, namely:

- *Artificial Intelligence (AI)*. It caused a particular boom in the field of IT technology, mainly through the emergence of OpenAI ChatGTP and Google's Gemini, as well as the development of AI by companies such as Microsoft, Apple, Alphabet, etc. The rapid development of AI and its application in all spheres of public life and business [13], [14], [15], imposed high standards for its study at universities by future engineers in the field of the IT industry. The modern aspects of AI are a prerequisite for acquiring new knowledge not only about the technical parameters of the process and the technology of work, but also about the ethical aspects of its application, so that AI is of help to man, not to eliminate him from his inherent professional, psycho-social and communication activities.

- *Internet of Things (IoT)*. Cutting-edge technological solutions, such as AI, blockchain technologies, 5G and others, create new possibilities for the application of intelligent connecting devices that are part of the IoT. As IoT [16], [17] is seen as a new technology to automate, manage and control public and business operations through smart objects interacting with each other with other Internet-enabled devices, they are increasingly being introduced as academic subjects in universities. This is necessitated by the modern requirements to build a network of physical devices, vehicles, appliances and other physical objects embedded with sensors, software and network connectivity to collect and share data in an attempt to build "smart factories" or "smart public buildings and objects".

- *Blockchain Technology (BT)*. With the growth of databases as a result of the development of business technology, a mechanism is needed to share data and information in an appropriate business network. In corporate structures where data and information are key, both in terms of their internal business processes and customer relationships, blockchain technology creates records and history of databases that are interconnected and can only be used by authorization of network members. Since blockchain technology is increasingly used in the digitalization of companies business transactions [18], [19], academic disciplines are also being studied at universities that prepare IT specialists to work in a blockchain network.

- *Additive processes (AP)*. Relate to the creation of three-dimensional objects from a digital file by laying down successive layers of material until the object is created, with the exception of volumetric 3D printing [20], [21]. Studying disciplines related to additive processes is important in preparing IT professionals to work with

specialized 3D software for modern manufacturing technology.

- *Virtual Reality (VR)*. It has an essential role in various aspects of society and business, as it uses computer modeling and simulation of various objects so that through interactive devices a real idea of the objects can be obtained in a virtual way through an artificial 3-D visual or other sensory environment [22], [23] The study of disciplines related to virtual reality allows creating IT professionals to represent objects in a three-dimensional computer-generated environment.

- *Modern IT directions*. They are related to the preparation of IT engineers in the field of programming, big data, network technologies, information and cyber security, cloud computing, use of software applications and platforms for virtual work, application of interdisciplinary areas in IT technologies, etc. [24], [25], [26].

From the point of view of engineering education in the IT industry, it is clear that the requirements for the training and realization of highly qualified engineers are greater than ever, because the development of IT technologies is at such a peak level that it is necessary to acquire new knowledge and skills that are beneficial not only to the cold ones who are trained in the IT specialties, but also to the business. In fact, in the conditions of higher education in the Republic of Bulgaria, several key moments stand out, which define a trend in the last few years in the field of the IT sector, with the following basic prerequisites:

First, students graduating from universities have relatively good practical and less theoretical training in the field of IT technologies, dictated by the so-called technological generation of children, who from an early age begin to use and adapt to the available technology (computers, smartphones, tablets and other technical devices). In essence, this is a prerequisite for them to develop technical knowledge and skills which, at a later stage of their studies, will help them to be rewarded with modern technical competences in higher education. The problem here, which in time will affect their professional commitments and relationships, is the lack of so-called "soft skills" (which is one of the priorities of the business according to data from the survey) because the emphasis is on the technical part of the technology and relevant applications, ignoring basic communication requirements to reconcile them with the human activity of communication (even virtually).

Second, the training of engineering specialists in the field of IT technologies requires a new approach that not only corresponds to new requirements in terms of technology, meets business practice and creates added value, but also develops "soft skills". Despite the fact that we are in the age of machines, and AI is gaining more and more speed in various areas of the public sphere and business, interpersonal and administrative processes (even through the use of technical devices) cannot yet be excluded from work of people, regardless of the advancement of technology. Although the Covid-19 pandemic has shown that people are already highly dependent on technology that facilitates work processes and communication at a distance, it reinforced another fact - along with technical ("hard") skills, "soft" skills are also needed, which already are not a supplement, but a

concomitant part of the work of the human factor with technology. We have already witnessed from business practice that modern IT companies work digitally in the implementation of various strategic and operational business projects, hold project meetings, IT specialists participate in virtual teams, occupy managerial positions, lead people, etc. In addition, it is already perceived as a narrow-minded understanding that IT specialists work only with technical devices, because today they increasingly need to understand human resources, business indicators for the formation of added value, digital marketing, finance and investments, etc. All this requires them to have not only "hard", but also "soft" skills, especially when they communicate with people and must show leadership qualities and potential or be entrepreneurs with financial literacy, regardless of whether this will be in a conventional or digital workplace environment.

Third, the training of engineering specialists in the field of IT technologies requires a close relationship with the users of personnel, in order to establish not only the need for a certain type of IT experts, but also to maintain the interest and aspiration of students to study in the field of information and communication technologies. This relationship with business (users of personnel) must have a multifaceted application and correspond to the strategic vision and policy of the universities in the Republic of Bulgaria for conducting high-quality training in the field of IT technologies. In the general context of the educational service in IT specialties and the preparation of qualified IT engineering personnel, regular meetings with business representatives should be held, personal attention should be paid to training and practical work with students, student symposia, days of "open doors", business-shared resources for training and practical activities and initiatives, practical internships, etc.

Fourthly, the training of engineering specialists in the field of IT technologies also requires a change in the education model itself, which from a strong emphasis on technical knowledge and skills should be adapted to interdisciplinary scientific fields that create basic technical competencies in the field of IT technologies, but also to develop the "soft skills" among the students - the future IT engineers. This means regularly updating the study documentation for the relevant specialties, requesting the opinion of business experts and, of course, following good practices in foreign higher education institutions. The role of the teaching staff in the education of students in IT specialties should not be underestimated, i.e. with the change of curricula and programs, disciplines should be laid down that also cover "soft skills", as well as be tied to the technical requirements for education in the IT field.

Fifth, with the change of curricula and programs in universities and the basic study documentation for engineering majors in the field of IT technologies, not only the emphasis of teaching should be changed, but also the knowledge and skills of the academic staff themselves. They are also part of this process and must adapt to the new realities of business, to be scientifically grounded in the theory of the relevant issue and tied to the needs of real business.

- *High level of teaching from the academic community, according to the new requirements and the*

practical application of IT technologies in corporate business. Since high technologies are developing at a rapid pace in society and business, new technological solutions and practical applications for the IT industry are constantly emerging, therefore conventional and current knowledge and skills are already daily replaced by new, more up-to-date ones, according to the needs of the corporate business structures. This means that the knowledge and competences of the academic staff must meet the future needs of the IT industry, because the maxim that what is needed today, tomorrow has already lost its meaning, and sometimes is inapplicable, justifiably applies. The academic staff in the field of engineering IT education and, accordingly, the management of the universities must follow the principle of what is needed as knowledge and skills of the students, according to what is sought as competencies in real business. And here there is usually a discrepancy between academic teaching in the IT sphere and the real needs of business, which often do not correspond with the capabilities of the academic staff to respond to the new challenges facing the training of engineers in the IT industry. This, of course, reflects not only the quality of education and training of IT engineers in universities, but the connection with practice is also broken, and as a result, graduating students are leaving, whose knowledge and skills are not needed because they do not correspond to modern conditions in IT the business.

- *Integration in the educational and scientific process of experts from practice.* Not a small part of the universities in the Republic of Bulgaria rely only on available academic staff, which is not always a prerequisite for a high quality educational service and, above all, bringing students to the knowledge of current trends and technological innovations in the IT industry. In fact, this is a prerequisite for the appearance of the above-mentioned statement that what the academic staff does to train students - future IT engineers can lead to disastrous results, which also reflect the general understanding of the quality of higher education, if only of theoretical training and teachers do not have serious experience in companies or do not practice in real business. In other words, education and science in the IT sphere require not only academic staff to work on research and teaching at the university, but experts from practice to train the future engineers in the IT sphere of novelties, specificity, technology and process management in the real IT business. Therefore, one of the requirements for achieving a high quality of education (and scientific activity) in IT majors at universities in the Republic of Bulgaria is the attraction of experts from real practice, who will participate not only in the educational process of students, but also to provide support through coaching of colleagues from the academic staff for modern achievements and results in IT practice.

III. EMPIRICAL ATUDY OF MODERN PERSPECTIVES IN BULGARIAN ENGINEERING EDUCATION THROUGH THE PRISM OF EXPERTS FROM THE IT SECTOR

The presence of business in the training process is essential for future personnel in the labor market, especially in the IT industry. As it became clear, the dynamic development of information and communication technologies required the acquisition of new knowledge and skills by the trainees. This, in turn, requires improvement and renewal of study courses and disciplines

in universities preparing engineering personnel. Obtaining up-to-date and modern knowledge allows future engineers to quickly adapt to working conditions in business organizations. Businesses rely on a skilled and educated workforce to drive innovation, productivity and economic growth. This was also confirmed by the results of the study. A total of 16 small and medium enterprises from the IT sector offering software solutions were surveyed. In this sense, the investigated enterprises carry out basic activities such as: design, development, implementation and maintenance of integrated information systems, software solutions in the field of business (finance, accounting, human resources, project management), specialized IT systems, etc.

The question arises, "To what extent does engineering education in Bulgaria meet the modern requirements of business?" In this regard, regarding the preferences of business organizations from the IT sector in Bulgaria regarding what knowledge and skills future engineering personnel should possess, an empirical study was conducted among 59 experts from a total of 16 small and medium-sized organizations (Fig. 1)¹, part of the results of which are presented in the following figures.

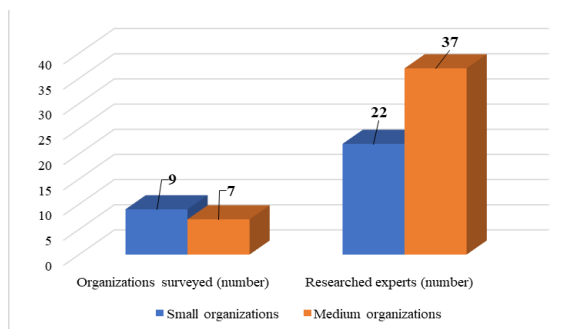


Fig. 1. Researched organizations and experts

Bulgarian educational institutions do not manage to cope so quickly with the technological progress, necessitating a change in the curricula and disciplines in which engineering personnel are trained. Unfortunately, in the majority of higher education institutions, the rate of change in educational documentation lags significantly behind the rate at which business requirements for new knowledge and skills change. This also makes an impression from the following figure (Fig. 2), where the responses of the surveyed experts predominate, according to which the engineering disciplines and their content are not sufficiently adequate to the modern requirements of business - a total of 56% of the surveyed responded with "Rather not" - 45% and No - 11%. Only 30% answered with "Rather yes" - 21% and Yes - 9%.

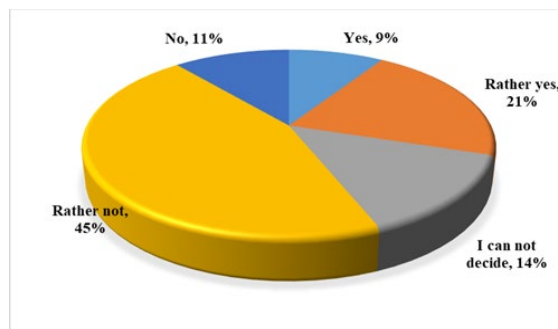


Fig. 2. Answer to the question "Do you think that the studied engineering disciplines and their content are adequate to the modern requirements of business?"

These results indicate that educational institutions should reorient their strategy towards building a close relationship with business, even more so. It is necessary that this relationship be strongly expressed from secondary education and then continue in higher education institutions as well. The Triangle "Secondary Education - Higher Education - Business" represents the interaction between three fields, each of which plays an important role in the selection of future personnel for career development and contributes to the overall development of society.

Close interaction and cooperation between business organizations and universities allows:

- ✓ **Of business organizations** - the hiring of prepared engineering personnel with up-to-date knowledge and skills;
- ✓ **Of universities** - maintaining adequate information on the state of the labor market and rapid adaptation of engineering personnel by developing modern training courses that meet the modern requirements of business.

There is no doubt that the rapid pace of technology will not lead to change in organizations related to human resources. Moreover, with the emergence of new technological applications, a number of business processes are automated, several categories of jobs appear and / or merge, as well as the emergence of new ones. Many of these new professions are the product of artificial intelligence [27, 28].

This is precisely why business organizations require universities to include in their curricula training in the field of modern technological applications. This is also shown by the results of the conducted survey, where artificial intelligence takes precedence - 52 of the respondents believe that it is AI that should have priority in the preparation of engineering personnel, followed by augmented reality applications (46 respondents) and in third place blockchain technologies (34 answered) (Fig. 3).

¹ Small and medium-sized enterprises are those with less than 50 employees and between 50 and 250 people, Law on Small and Medium-

sized Enterprises in the Republic of Bulgaria, [Online]. Available: <https://lex.bg/laws/ldoc/2134682112>. [Accessed: Jan. 5, 2024].

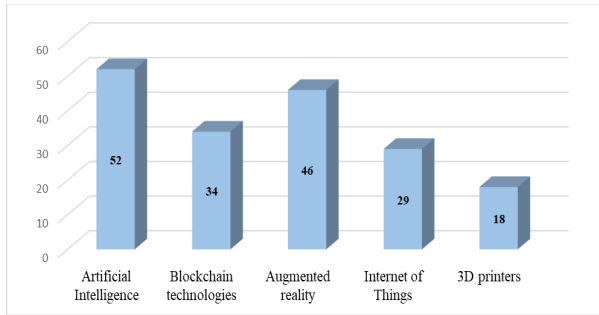


Fig. 3. Answer to the question "In your opinion, which modern technological applications should be given priority in the training of engineering personnel?" (More than one answer is possible)

In addition, the implementation of modern AI-related technologies increasingly requires employees to have a skill set and navigate areas such as ethics, leadership, emotional intelligence, change management [27], as well as knowledge and skills in the field of human resources, digital marketing, project management.

And if a few years ago the technical disciplines/sciences studied in the engineering majors were strongly advocated, to date they are only a fundamental component in the preparation of engineering personnel. Business needs are increasingly in the area of personal qualities and knowledge from other areas (Figs. 4 and 5).

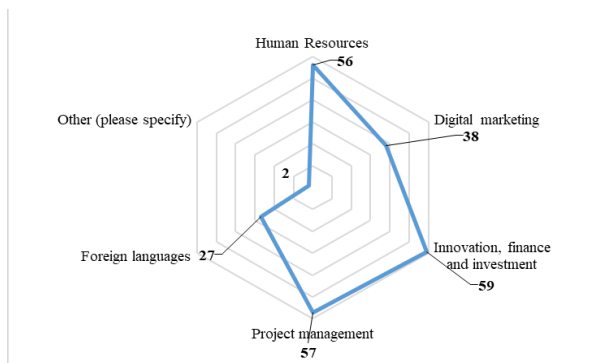


Fig. 4. Results of an answer to the question "In which of the specified fields, in addition to knowledge in the field of engineering (technical knowledge), do engineers need to have?" (More than one answer is possible)

It can be seen from fig. 4, with full unanimity, respondents indicated that engineers should also have knowledge of innovation, finance and investment (59 respondents), followed by project management (57 respondents) and human resources (56 respondents). This fact is not accidental. Any change in modern organizations is already carried out with the help of project management and human resources, which in turn requires the possession of specific knowledge and skills in these areas.

To survive in an increasingly competitive environment, businesses need personnel who can manage change, a challenge facing 21st century engineers. Engineering graduates in this new era must be able to move from technology to solutions and from solutions to operations. This requires a wide range of skills [27]. Good intuition and other personal qualities such as "teamwork skills", creativity, good judgment and effective communication are becoming increasingly valued and sought after [29].

We are witnessing an amalgamation of technology, information, communication and artificial intelligence, which emphasizes the importance of soft skills, communication skills, critical thinking, problem solving, teamwork. These are exactly the requirements of the business for the future engineering personnel, which is also evident from the results indicated in the following figure (Fig. 5).

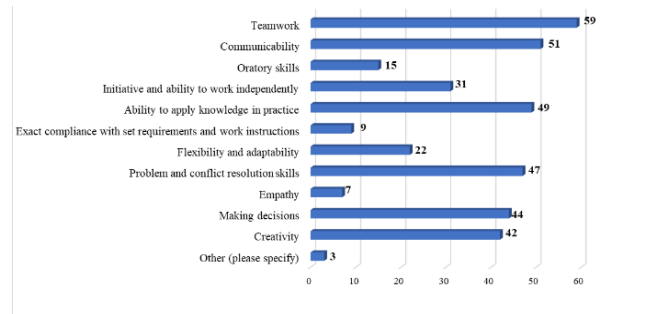


Fig. 5. Results of an answer to the question "What soft skills and personal qualities do you think engineering graduates need to possess?" (More than one answer is possible)

As we can see from the fig. 5, the first three places are occupied by teamwork skills - unanimously 59 respondents, followed by communication skills (51 respondents) and the ability to apply knowledge in practice (49 respondents). Skills such as: problem and conflict solving (47), decision making (44) and creativity (42) were also preferred by more than half of the experts surveyed.

The increased presence of experts from practice in the process of training engineering personnel in universities is extremely important. The partnership with business ensures that the curricula are in line with the current needs of the IT industry. This helps to develop skills and competencies that are directly related to labor market requirements, making graduates more employable. The preferred forms of partnership by IT business organizations and a higher education institution are indicated in the following table (Table 1).

TABLE 1 RESULTS OF THE ANSWER TO THE QUESTION: "WHAT FORMS OF PARTNERSHIP SHOULD THERE BE BETWEEN YOUR ORGANIZATION AND A UNIVERSITY PREPARING ENGINEERING PERSONNEL?" (MORE THAN ONE ANSWER IS POSSIBLE)

Forms of partnership	Number of respondents
Provide mentorship during the practical training and student internships provided for in the curricula of the engineering majors	58
Conduct periodic meetings with graduate students for career prospects and job positions	43
Conducting annual "open days" supporting professional orientation for students	36
Provision of paid student internships	52
Development of joint research projects	38
Participation of experts from practice	56

It can be seen from the table that almost all surveyed experts (58 respondents) prefer to be involved in the learning process, through mentoring during practical training and providing student internships, as well as active participation of teachers from practice (56 respondents). In

this way, the business provides future engineers with hands-on experience by involving them in real projects and applications. The holding of annual "open days" supporting professional orientation for students as a form of partnership between an organization and a university preparing engineering personnel occupies the last place - 36 answered.

IV. CONCLUSION

Obviously, the rapid development of IT technologies and software products in society and business require modern companies to have highly qualified IT specialists. This process is invariably related to the preparation of IT engineering personnel from the universities to respond with knowledge and skills to the new challenges in the IT sector and the needs of employers. All this is related to a two-dimensional process of the education system and business, which must cooperate. The purpose of this publication is set precisely in this context, i.e. to conduct a survey among IT experts from randomly selected small and medium-sized organizations in the Republic of Bulgaria in order to evaluate and analyze the requirements and needs of business from IT engineering specialists, according to the possibilities of the educational system and higher schools to prepare for real practice qualified engineers in the IT sector.

The following main contributions have been achieved as a result of the publication:

- Based on a study of the scientific literature on the problem, some assumptions regarding the modern perspectives in the Bulgarian engineering education in the IT sector have been derived.

- Through the survey, the requirements and needs of the business of a certain sample of respondents (IT experts from small and medium-sized Bulgarian business organizations) were established, regarding modern perspectives in Bulgarian engineering education and the training of IT engineers. In summary, it can be noted that employers in the Bulgarian IT business require highly qualified engineering personnel who have knowledge in accordance with the new trends in IT technologies, from which it follows that universities should adapt their documentation and qualification of the academic staff to the avant-garde theoreticians - application processes in the IT sector. On the other hand, there is a tendency to change the approach to education and training of IT engineers by emphasizing interdisciplinary training from educational institutions, in accordance with the requirements of business in the IT sector. In this regard, in addition to technical skills, IT engineers must also be trained in "soft skills" such as communication, collaboration and adaptability in the rapidly changing work environment.

- The conducted preliminary research on the requirements and needs of the business of a certain sample of respondents (IT experts from small and medium-sized Bulgarian business organizations), regarding modern perspectives in Bulgarian engineering education and the training of IT engineers, is a prerequisite for generating information for a future large-scale study on the relationship "education-business" in the IT sector.

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