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SUSTAINABLE DEVELOPMENT - A METHODOLOGY OF ASSESSING THE LEVEL OF IMPLEMENTATION OF PRINCIPLES SUSTAINABLE DEVELOPMENT AT TECHNICAL UNIVERSITIES IN SLOVAKIA

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Abstract: *Priority for the European Union is implementation of sustainable development principles into industry and creation of a sustainable company. In all areas of industry (engineering, power engineering, mining industry, automotive etc.) must be pre-production, production and post-production stages implemented according to the principles of sustainable development. Education of graduates of universities and employees have a priority position in achieving those principles. For this purpose, the European Union adopted the UNECE (United Nations Economic Commission for Europe) Strategy of education for sustainable development, which defined the objectives and tasks for the three time periods (Up to 2007, 2010 and 2015). For this reason, the aim of article is to analyse how university graduates are prepared for the industry in area of sustainable development. In article has been analysed the larges technical universities in Slovakia: Technical University in Kosice, Slovak Technical University in Bratislava and Technical university in Zvolen. The methodology of evaluation is aimed at evaluating the education process, scientific activities and the institutional performance of universities. The study results show that graduates of universities in Slovak republic are in areas of sustainable development prepare on practise on 25, 5 % that can be regarded as deficient.*

Keywords: Sustainable development, industry, university, quality education.

1 INTRODUCTION

Mankind currently lives in a period which is characterized by the global ecological crisis. A solution which would alter the current, already critical situation rapidly and in a short time does not exist. One of the possible approaches to mitigate this impact is the implementation of a sustainable development (SD), i.e., the balanced socio - economic and environmental development in industry and in next areas of the society. [13] The list of industries that pollute our planet is extensive. Blacksmith Institute and Green Cross Switzerland have prepared report "2012 World's Worst Pollution Problems Report," where was analysed 49 countries. The report identified the ten worst polluting industries and these are: the recycling of lead batteries, the lead industry, mines, tanneries, industrial discharges and /or municipal industrial sites, artisanal gold mining, manufactures, petrochemistry, and drycleaners. [23] The move towards sustainable development is necessary. Environmental policy puts universities into the position of the primary tools capable of performing the fundamental transformation of society towards sustainable development. [18]

The issue of sustainable development must be part of university education. University must inform students of global environmental issues and teach sustainability as broadly as possible across the curriculum. [14] Quality of university education as a service of clients (students, potential employers, and society) is presently a very important goal for university and their faculties [6]. The objective for universities, as stated in the DESD (Decade of Education for Sustainable Development), is to incorporate all aspects of SD into education programmes, practices and policies. [17] Similarly, Waas (2010) observed that because higher education institutions are complex systems, it is essential to focus on the integration of sustainability across all of its activities, responsibilities, and mission. [21]

For this purpose, the European Union adopted the UNECE (2005) Strategy of education for sustainable development, which defined the objectives and tasks for the following three horizons (up to 2007, 2010 and 2015).

Phase I: to 2007 - creation of a solid basis for the initiation of the implementation of sustainable development; research of present policies, legal and organizational frames, financial mechanisms and education activities, detection of all obstructions or limitations, creation of methods and indicators for the implementation of education in sustainable development.

Phase II: to 2010 - implementation of the UNECE Strategy for the education for sustainable development provisions should be in full swing. It appears that the introduction of EMS (Environmental Management Systems) is necessary for the achievement of this phase. In this respect, the countries should analyse the progress reached in the implementation of their national strategies and revise them, if necessary.

Phase III: to 2015 - countries should achieve considerable progress in the implementation of the education towards sustainable development. [19] Despite the wide recognition of this urgent call for responsibility, sustainability practices are still far from being integrated into mainstream university operations and curricula. [7, 9, 21, 22] Shriberg (2002) noted that none of international declarations and charters offer

concrete prescriptions on an operational level for what universities should do exactly in order to contribute to sustainable development. [16]

Several countries of the European Union successfully implemented the sustainable development principles into their national education systems through an introduction of the formal or informal environmental management systems (Denmark, Austria, Germany, Greece, Poland, Spain, Sweden, France and United Kingdom). Experts from this area conducted several studies in the past that examined the development of the environmental management system (EMS) and the implementation of EMS processes at universities throughout Europe. A. Disterheft et al., conducted research at 47 universities that have implemented EMS (ISO 14001, EMAS, Eco Campus) in 14 EU countries.

The result of their study was that ISO 14001 is more represented in Northern Europe, while EMAS is more dominant in Western Europe. [5] A lot of studies exist that deal with problems related to the implementation of EMS at universities.

For example, lack of awareness, interest and involvement which can stem from a lack of policies to promote sustainability at universities. [4, 8, 10, 20]

The way to achieving of SD through the implementation of EMS or other management systems (QMS - Quality Management Systems, EMAS, etc.) on campus is a good way how to SD approximate. But, certification to EMS, QMS or EMAS does not guarantee that the principles of SD are implemented on campus. Process approach represents a form of the management of economic organization which is much older than ISO standards for quality management systems, which appeared in the first decade of the previous century. [11] This approach does not represent a comprehensive solution. If we want to problematic of SD to solve complex we have to realize that SD is composed of three dimensions (environmental, economic and social dimensions) and the universities they are composed of three dimensions (education dimension, scientific activities and institutional framework) too. These dimensions must be interconnected.

Table 1 Matrix of sustainable development at campus

	1st dimension SD EDUCATION	**2st dimension SD SCIENTIFIC**	**3st dimension SD INSTITUCIONAL**
1st dimension HE ENVIRONMENT It is a basic of SD	Environmental oriented school subjects	Projects in area - environment	EMS, EMAS
2st dimension HE ECONOMY It is a tool for achieving SD	Economy oriented school subjects	Projects in area - economy	QMS
3st dimension HE SOCIETY Derivative of first two dimensions and ensure of SD for future generations	Society oriented school subject	Environmental-economy behaviour in the design of technical equipment, lines, etc.	Direction of the company to SD

Environmental dimension is the basis of SD. One of the most watched indicators in any industry are economic indicators. [12] The economic dimension is a tool to achieve of SD. Economic prosperity is a very important element of SD because financially supports development. But economic growth does not lead to an improvement of SD. Only economic growth with reduced impact on the environment can be understood as SD. The third dimension is a derivative of the first two and ensure of SD for future generations. It is associated with social entrepreneurship what can be a pathway to social, economic and political inclusion, particularly of youth, while engendering jobs. [2]

2 SUSTAINABLE DEVELOPMENT OF THE SLOVAK REPUBLIC

According to data issued by the Bureau of Statistics of the Slovak Republic in Slovakia there are 2.600 industrial enterprises with more than twenty employees. Total revenues are mostly represented by engineering (28%), power engineering (18%), chemical industry (13%), and mining industry (9%). They are followed by food industry (9%) and electrical engineering. The highest representation in the Slovak industrial production sectors have medium high technology. In 2010, for instance, the proportion of these industries in the production and sales of the Slovak the industrial production of 42% and corresponded with the values of this indicator in the most advanced countries of the European Union. Dominant position on the creation of added value and thus the contribution to the GDP, industrial production in 2011, manufacture of motor vehicles, trailers and semi-trailers is maintained. The second position is the production and processing of metals and the manufacture of computer, electronic and optical products in the third. [15]

The basic document influencing the current direction of the SD of the Slovak Republic is the Action plan of education and edification for sustainable development in universities and the life-long education system (APEE for SD). APEE for SD (2010) defines measures needed for the implementation of priorities resulting from the UNECE Strategy for education for sustainable development, that, in terms of time, are divided into three phases: to 2007, to 2010 and the last one to 2015. The main task of third phase is to review the achieved progress, and in case of identifying deficiencies, upgrade the measures set up in the UNECE (2005).

Based on the above, by the end of 2015 a clear progress should be made in the implementation of

education for sustainable development; the issue of sustainable development should be integrated into the curriculum at all levels and types of schools in Slovakia as well as all external educational institutions, and the "Sustainable Universities" project should be put into practice and gradually expand to other colleges. [19]

The Commission for Education for sustainable development was the competent authority authorized by the Ministry of Environment and the Ministry of Education responsible, inter alia, for the task of preparing an effective tool for measuring the real state of progress of universities in the implementation of the rules and principles of sustainable development UNECE (2005). The Commission was in charge of the biennial assessment and monitoring of the achieved progress for the purposes of reporting to the European Commission. Despite dozens of implemented international and domestic projects, programs, conferences, seminars and publications, the professionals still have been unable to provide a clear and objective assessment of the state of higher education in the context of sustainable development initiated by the Ministry of Environment and the Ministry of Education and shows that education towards sustainable development is insufficient. The question of progress still remains open and exists only in the realm of ideas, concepts and assumptions.

At the present neither effective tool exist that evaluate the level of implementation of sustainable development principles in universities. Therefore, the aim of article is to analyse how university graduates are prepared for the industry in area of sustainable development. Evaluation methodology has been applied to the three technical universities in Slovakia: Technical University in Kosice, Slovak Technical University in Bratislava and Technical University in Zvolen. To achieve this aim it was necessary to:

1. Perform the analysis of accredited educational programs at universities in the Slovak Republic from the viewpoint of introducing environmentally-economy-society oriented subjects into the education process with the emphasis on the professional profile of graduates.
2. Analyse the position and the environmental behaviour of university managements in relation to the institutional performance, scientific and research activities and communication.

3 THE METHODOLOGY

3.1 Selection of universities for analysis

Analysis, realized by the authors, focuses on the technically oriented universities. The analysis was based on the assumption that science- oriented universities include, by definition, in its curriculum and in the individual subjects, the issue of the SD and that the concepts concerning the nature and landscape protection, or creation and protection of the environment, respectively, are not foreign to them. For technically oriented universities, this assumption is questionable not only because of a large dispersion of the study courses and programs, but also because of a broad industry focus through mining, metallurgy, mechanical engineering, electrical engineering and other areas to the economic sphere. It should be noted that the technical production is the biggest polluter of the environment and therefore, the environmental habits are necessary for graduates.

The research was performed at three Slovak technical universities: Technical University in Kosice, Slovak Technical University in Bratislava and The Faculty of Forestry in Zvolen. The choice was based on the following two criteria: These are universities with the biggest number of students and their localization covers the whole territory of the Slovak Republic proportionally. The analysis was carried out comprehensively at all faculties within all currently selected study programs organized by universities. In total, 442 study programs were analysed.

Table 2 Overview of analysed study programs

	Number of faculties	Number of analyzed study programs		
		1st	2st	3st
Technical University in Kosice	9	73	71	56
Technical university in Zvolen	4	21	25	13
Slovak Technical University in Bratislava	7	41	89	53

3.2 Identification of the subject (environmental, economy and society subjects)

The basic requirement of the APEE for SD (2010) with regards to universities is to "gradually introduce the teaching of sustainable development issues at all Slovak universities and educational institutions; compulsorily in the first degree study to introduce a separate subject SD or integrate SD into selected subjects of the study program on all levels of study ". The aim of the analysis was to identify environmentally, economy and society oriented subjects and their character at all departments of the universities and at all three levels of academic study. Subjects were selected according to a predetermined key. Names of subjects which included the keyword "eco", for example: ecology, ecopedology, ecosystem, and words such as environment, sustainable development and nature, have been clearly classified as key for the analysis. In the case of some subjects, however, it was not clear whether they should be included in the analysis. For this reason secondary keywords were created (renewable energy, natural resources, protected areas, waste, biomass, land reclamation), where it can be assumed that the environmental issues represent at least 50 % of the content. For the economic dimension has been selected keywords like: economics, management, business, business management, marketing and social dimension:

social, human resources. Input data was collected from the subjects of current study programs, information systems, and in case of discrepancies, via direct communication with appropriate staff at the study departments of the faculties. Since this data is provided and updated by a person authorized by individual faculties, it can be considered objective.We have created a database which with input data. The database contains that information's: name of the university, name of faculties, names of study programs at each three level of study, names of environmental subjects, name of economy subjects, name of society subjects and character of these subjects.

3.3 QUANTIFICATION OF DATA

Input data from database were evaluated as follows:

Table 3 Criteria for evaluation

Study program includes:	**The coefficient**
one or more of environmental subjects	1
one or more of economy subjects	1
one or more of society subjects	1
subject with name sustainable development	3
none subjects	0

When establishing the result we assumed that if the amount environmental, economy and social area equal to the number 3 means that the principles of SD are in the study program implemented at 100 %. Table 4 shows the evaluation of Faculty of material science and technology at Slovak Technical University in Bratislava.

Table 4 Demonstration of evaluation one of study program in terms of meeting the requirements of SD in educational process

Slovak Technical University in Bratislava **Faculty of material science and technology**				
Name of study programs	**Environ. subjects**	**Economic subjects**	**Society subjects**	**Results**
1st				
Applied Informatics and Automation in Industry	1	1	1	100 %
Occupational safety and health	1	1	1	100 %
Quality of products	1	1	1	100 %
Material engineering	1	1	1	100 %
Personal work in industrial enterprise	1	1	1	100 %
Computer support of production technologies	1	1	1	100 %
Industrial Management	1	1	1	100 %
Teaching of practical subjects in technical studies	1	1	1	100 %
Production technologies	1	1	1	100 %
Production equipment's and systems	1	1	1	100%
2st				
Applied Informatics and automation in industry	0	1	0	33 %
Integrated safety	1	1	0	67 %
Production quality engineering	1	1	0	67 %
Material engineering	1	1	1	100 %
Processing and application of non-metals	1	1	1	100 %
Machining and assembly	0	1	0	33 %
Computer aided of design and production	0	1	0	33 %
Industrial and art foundry	0	1	0	33 %
Industrial management	0	1	1	67 %
Teaching of practical subjects in technical studies	0	1	1	67 %
Forming	0	1	0	33 %
Welding	0	1	0	33 %
Production equipment and systems	0	1	0	33 %
3st				
Automatization and informatization of processes	0	0	0	0 %
Integrated safety	1	1	1	100 %
Production quality engineering	0	1	0	33 %
Material engineering	0	0	0	0 %
Processing and application of non-metals	0	0	0	0 %
Engineering technologies and materials	0	0	0	0 %
Methodology of Technical Vocational Subjects	0	0	0	0 %
Industrial management	0	1	1	67 %
Production equipment and Systems	0	0	0	0 %

The overall results are shown in Table 5.

Table 5 Results of analysis - pedagogical dimension versus SD

Name of faculties	Fulfillment of requirements [%]			Results [%]
	1st	2st	3st	
Technical University in Kosice				
Faculty of mining, ecology, process control and geotechnology	67	67	30	55
Faculty of mechanical engineering	67	52	7	42
Faculty of civil engineering	67	50	25	47
Faculty of manufacturing technologies	67	33	0	33
Faculty of arts in	78	67	-	73
Faculty of aeronautics	48	44	0	31
Faculty of metallurgy	67	67	19	51
Faculty of electrical engineering and computer science	50	14	0	21
Faculty of economics	67	67	33	56
Technical university in Zvolen				
Faculty of forestry	83	50	22	52
Faculty of wood technology	48	49	0	32
Faculty of ecology and environmental sciences	58	78	33	56
Faculty of environmental and manufacturing technology	67	53	33	51
Slovak Technical University in Bratislava				
Faculty of civil engineering	63	59	8	43
Faculty of mechanical engineering	44	52	0	32
Faculty of electrical engineering and information technology	29	38	2	23
Faculty of chemical and food technology	47	47	0	31
Faculty of architecture	33	88	0	40
Faculty of material science and technology	100	51	22	58
Faculty of informatics and information systems	33	22	0	18

Another question arises: To what extent do the students "actually" encounter this topic during their university studies? To gain an objective picture of the real situation in higher education it is necessary to take into account particular types of subjects, i.e., whether the subjects are compulsory or elective. We have identified a total of 1,829 subjects. From this quantity there were 720 environmental subjects: 304 (42.2 %) were obligatory and 416 (57.8 %) were optional. There were 693 economy subjects: 575 subjects (83 %) were obligatory and 118 subjects (17 %) optional. Subsequently, there were 118 society subjects: 9 subjects (8 %) were obligatory and 108 subjects (92 %) were optional. This means that in order to obtain an objective view of the SD we must reduce results from Table 5 by an average of 55.6 %.

Table 6 Final result evaluation selected universities from the viewpoint of implementation SD principles in the educational process

	Results of the first part of the analysis	Final results
Technical university in Kosice	45.4 %	25.2 %
Technical university in Zvolen	47.75 %	26.5 %
Slovak technical university in Bratislava	35 %	19.5 %

A qualitative side of the content of individual study subjects and specializations at different faculties remains questionable, but this is an issue that cannot be assessed significantly.

3.4 Evaluation of scientific activities and institutional performance towards to sd

SD issues cannot be reduced to and focused on only at the level of the educational process itself. The principles of sustainable development must be implemented mainly in scientific activities and the management and direction of higher education institutions so that they become a completely natural part of the whole organization. The actual learning process and the related creation and deployment of SD oriented courses in all disciplines should be left for the other post-secondary step, during which habits would be supplemented by expertise, so that graduates not only understand the issues relating to the SD, but they can also deal with them in terms of causes and effects, thus being capable of anticipating and dealing with critical preventive environmental situations in practice. Several authors point out that the university system is composed of several dimensions: education, research, university operations and external community. [3] Other authors add another dimension: assessment and reporting. [9]

The selected areas of interest correlate with the challenges arising from APEE for SD set out in the research, communication and institutional performance areas. Input data was obtained from the websites of the

faculties managed directly by the faculties. To determine the outcome we used the same measure as in evaluating of the performance requirements APEE for SD in education. If faculty do or done in the past (5 years horizon) activities within the criteria of the faculty it has assigned coefficient 1. If refrain from any activity we assigned a coefficient 0. When establishing the result we assumed that if the amount of the 9 criteria of equal number 9 means the principles of the SD are the requirements APEE for SD implemented at 100 %.

Table 7 Observance of SD principles in scientific activity and universities management

	Criteria									
Technical university in Kosice	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**Result**
Faculty of mining, ecology, process control and geotechnology	1	1	0	0	0	1	0	0	1	44 %
Faculty of mechanical engineering	1	1	1	0	0	1	0	0	1	56 %
Faculty of civil engineering	1	0	0	0	0	1	0	1	1	44 %
Faculty of manufacturing technologies	1	0	0	0	0	1	0	0	1	33 %
Faculty of arts	0	1	0	0	0	1	0	0	0	22 %
Faculty of aeronautics	1	1	0	0	0	1	0	0	0	33 %
Faculty of metallurgy	1	1	0	0	0	1	0	0	1	44 %
Faculty of electrical engineering and computer science	0	1	0	0	0	1	0	0	1	33 %
Faculty of economics	1	0	0	0	0	1	0	0	0	22 %
Technical university in Zvolen										
Faculty of forestry	1	0	1	0	0	0	0	0	1	33 %
Wood technology	1	1	0	0	0	0	0	0	1	33 %
Faculty of ecology and environmental sciences	1	0	0	0	0	0	0	0	1	22 %
Faculty of environmental and manufacturing technology	1	0	0	0	0	0	0	0	0	11%
Slovak technical university in Bratislava										
Faculty of civil engineering	1	0	0	0	0	0	0	1	1	33 %
Faculty of mechanical engineering	0	0	0	0	0	0	0	0	1	11 %
Faculty of electrical engineering and computer science	1	0	0	0	0	0	0	0	0	11 %
Faculty of chemical and food technology	0	1	0	0	0	0	0	0	1	22 %
Faculty of architecture	0	0	0	0	0	0	0	0	1	11 %
Materials science and technology in Trnava	1	0	0	0	0	0	0	0	1	22 %
Faculty of informatics and information technologies	1	1	0	0	0	0	0	0	1	33 %

Legend:
1. Realization of partnership cooperation with other universities
2. Realization of partnership cooperation with practice
3. Cooperation of universities in projects of expansion of the sustainable development network at primary and secondary schools
4. Implementation of Eco - University project or Sustainable University project
5. Participation in the COPERNICUS-CAMPUS program – the European university network for SD
6. Establishment of management systems at universities (EMS, QMS, EMAS)
7. Disclosure of environmental information about the project
8. The organization of an international conference dedicated to the tasks of education and edification to sustainable development
9. Projects, science and research of the sustainable development at universities

4 CONCLUSION

The aim of article was to analyse how university graduates are prepared for the industry in area of sustainable development. In any case, it was not an effort to create a ranking of the best or worst schools. The methodology consists of two parts: 1. An analysis of the application of the principles of SD in education and 2. Analysis of the implementation of SD principles for the scientific activities of universities and institutional performance.

The results of the first part of the analysis showed that Technical University in Kosice meets the requirements SD to 25.2 %, Technical University in Zvolen to 26.5 % and 19.5 % of the Slovak Technical University in Bratislava (Table 6). After averaging these partial results at a total result of compliance SD in educational settings is 23.7 %. Analysis showed that in the educational process has occurred most economically targeted subjects, less environmental subjects and least experienced with social subjects. Of the 1,829 articles identified, only 18 subjects had the title keyword sustainable development. The analysis can be seen as the higher the level of study team in curriculum are fewer articles focusing on some part of SD.

The second part of the analysis showed that the implementation of SD principles in the scientific activities and institutional performance Technical University in Kosice fulfilled to 36.8 %, Technical University in Zvolen to 24.75 % and 20.43 % at Slovak technical university in Bratislava. After averaging we get the result of 27.3 %. From analyse it is obvious that the interest in the issues examined by universities is oriented mainly towards cooperation with other universities and institutes of the SAS (Slovak Academy of Sciences), as well as collaborative partnership with practice. Relationships between higher education institutions and practice are generated at the appropriate level, not only at home but also abroad, which might suggest that the exchange of knowledge and educational exchanges for students and teachers are good. Research activities are also very well directed. Technical University of Kosice as the only among the assessed universities has introduced the quality management system according to EN ISO 9001, which, in essence, includes the basic principles of environmental management. Other areas appear to be problematic, particularly the organization of

international conferences dedicated to the SD, where only two faculties were successful, as well as the implementation of the Eco – University project and participation in the Copernicus – Campus program.
Averaging the results of these two analyses, we get the overall result of 25.5 %. This means that university in Slovakia meet the requirements arising from APEE for SD to 25.5%.The outputs of the analysis cannot be considered satisfactory and sufficient. The achieved number could be considered a success in 2007, when the first phase resulting from APEE for SD ended, and the situation in higher education could be considered properly underway and directed, which was the aim of the 1st stage (horizon up to 2007). Currently, when the tasks arising from APEE for SD should be "in full swing" and the principles of sustainable development should be implemented in all types and levels of schools, 25.5 % can clearly be regarded as inadequate. One of the ways to improve the situation and raise interest of the faculty managements and the Ministry of Education is to integrate the requirements of APEE for SD (2005) in accreditation conditions for study programs of colleges and universities. Results of analysis clearly shows deficiencies in the education system and confirms that the mere creation and deployment of subjects is inefficient, if they are not given necessary attention in the form of changes in the type of subject eligibility, from elective subjects to compulsory ones.

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