A QUANTITATIVE AND QUALITATIVE ANALYSIS AND ASSESSMENT TECHNICAL AND TECHNOLOGICAL LEVEL OF THE MACHINERIES AND EQUIPMENTS IN HIGHER EDUCATION IN BULGARIA

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ABSTRACT

Purpose: to develop own methodology for complex evaluation of the technical and technological level of the machineries and equipments used in Bulgarian Universities. It is made evaluating on available machineries and equipments on the base of the age, adequacy and utilization of machineries and equipments in high education institutions in Bulgaria by means of their functions, productivity, reliability, technology and est. It is pointed the needs from such machineries and equipments, which will increase the level of our high education. Methods: It is observed 5 groups machineries and equipments from class 38 belonging to nomenclature ISIC. The assessment is realized by means of 6 groups indicators A, B, C, D, E and F at their simultaneously examining. Results: Through the obtained complex assessment of the used machineries and equipments in Bulgarian Universities is established the level of the instruments on which the students are trained. Conclusion: It is made conclusions and proposals for improving the conditions of the techniques and technology in Bulgarian Universities.

Key words: machineries, equipments, indicators, assessment, high education, methodology, modernizing, utilization.

INTRODUCTION

It is very important for our Ministry of education, youth and science in Bulgarian to know the level of the instruments, which are used for teaching in our Universities. This investigation is made independently with the purpose to create a methodology for complex evaluating of the technical and technological level of the instruments and to trace some proposals for their improving.

The investigation is performed in following directions:

A. to establish technical and technological level of the important part of the available

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machinery and equipment, which are used this year in the universities in Bulgaria;
B. to outline the needs from machineries and equipments in the Universities in general and especially only for these universities, for which we have information about them.

A. Assessment of the age, adequacy and utilization of machineries and equipments in higher education institutions in Bulgaria
For this purpose we worked out methodology for complex assessment of:
qualities of the machineries and equipments about their functions, productivity, reliability, technology, ages and so on, which are available and used in the universities for teaching, training of the students in general;
material and technical foundation - degree of their introducing, modernizing and effective using in some universities, from which we have obtained direct information.

For realizing these purposes we composed a system of indicators by means of them we are evaluated the state and level of the techniques (machinery and equipment) in the universities in our country. It is made test to do complex

assessment of the available and used machinery and equipment in the universities by means of combining indicators for description different aspects of the machinery and equipment state.

In this connection (with regard to this) are analyzed the base part of the techniques, for which we have chance to collect alone information about their ages, material recourses, which are made, their possibility, technology and purposes.

These machineries and equipments belong to class 38 from the nomenclature ISIC. Within the range of the investigated and grouped machinery and equipment in the universities are represented in the following **Table 1**:

Table 1. *The range of the investigated nomenclature*

Class	Nomenclature Technique	Meas ure	Investigated Groups	No investigated groups				General for class
381	**Metal articles without machinery and equipment**	Count %	5 29,42	1 5,88	10 58,82	1 5,88	- -	17 100
382	**Machinery and Equipment without electric**	Count %	120 58,26	63 30,58	8 3,88	8 3,88	7 3,40	206 100
383	**Electric machinery and equipment**	Count %	16 48,48	8 24,24	9 27,28	- -	- -	33 100
384	**Means of transport**	Count %	17 36,17	22	3	5	-	33 100
385	**Control-measurement instruments and Apparatus**	Count %	9 60	2	4	-	-	
	Total	Count %	167 52,52	96 30,19	34 10,69	14 4,40	7 2,20	318 100

In the list of the investigated machinery and equipment are pointed additional marks A, B, C, D, E, F. The meanings of these designations are as follow: A means these available machinery and equipment, which are used in the university and we evaluate them. These techniques are made in our country. B - involve these machinery and equipment, which are used in the universities but don't make in our country; C - content these technique, which are produce in our country, they are used in the universities, but didn't evaluate by us; D involves this technique, which is dripped out from using (discarded) and E - involve this technique, which in the process of the assimilating and for it we haven't information for its assessment according to the indicators, which are involved in our methodology for analyzing and evaluating the state of the machinery and equipment in the universities.

As there isn't detail information about the techniques in all universities in our country, we investigated only these, which are used and available in the most of them. For these machinery and equipment we looked for such appropriate information for analogical techniques in other countries for comparisons. These observations are extracts, but they are enough for our investigations.

The examined techniques are mainly machinery, equipment, and means of transport, devices and instruments for the used techniques. They are arranged in groups from technical equipments with approximately homogeneous character sketch. Every group contents more from one technical equipment.

There are some machinery and equipment, which are specific for different universities.

The examined technique in the universities in general doesn't satisfy their needs. The reasons and conclusions will be point at the end of our statement. The computers and electronics belong to class 385. In group 383 are involved equipment with mechanical components. At the same time there is specific technique, which is characteristic only for some universities. They will be discussing too. These teeniest are related to the medical universities and university for theatrical and film arts.

The specific devices and machinery will be excluding because we haven't information about their technical indicators. Some of these instruments are involved in class 385.

Methodology for complex evaluation.
For defining the complexity and the suitability of the available and used technique we must

use two coefficients a and p. The first a represents the value for one kg from a given kind of machinery or equipment for $1. We accept that with the perfecting of the technique will decrease their weights. At the same time the prices will increase. With the help of the coefficient p we make experiments to evaluate the speed (rate) for renovation of the available and used technique in the universities. The dimensions of the two coefficients are evaluated with the help of 6 classes. The range, which these parameters vary at their classes, is as following:

For a: 0-2,5   2,5-5,0   5-10   10-20   20-40 over 40;

p: over 25 years; from 25 to 15; from 15 to 10; from 10 to 5; from 5 to 2 and less 2.

Between the valuations a and p exist defined relations. They are - the more eldest is used technique the more cheaply for $1. We know that not always coincide the price of the technique with their complexity. For example, sometimes a old technique (which used at the moment in the Technical university in Sofia, connected with laboratory at thermo technique or used generators) with low coefficient for p (more technical stable) the operating price doesn't correspond on it complexity.

Simultaneously the prices of the bought technique during the years before 1998 have different rates of the inflation. They strongly vary. In this way they don't give possibility to analyze their state of the available and used technique, their quality and indicators are discrepant (disproportionate). Nevertheless with the help of them we have possibility to rich such idea, which give us assessments for evaluating a intellectualism of teaching process. We always take in mind that these technique are used not only as a means for teaching and knowledge, but for training of the technical abilities, for tracing all technical news in corresponding spheres, for increasing of the effectiveness on the teaching technique.

On the grounds of system factors, which characterized technical parameters of the available and used technique in the universities we make an attempt to evaluate their state and possibilities to be use in the next time. These factors also are grouped in four groups: **base** - for description important performance of the

machinery and equipment; **operating** - for showing the intending of this technique in the educational and scientific processes; **composed** - it contains such components from which are composed machinery and equipment; **economic** -defining the effectiveness of the using technique.

We composed for this purpose technical sheet for every machinery and equipment with all base indicators. We haven't direct information from some universities. It is necessary to perform independent observation and evaluating the state of their machinery and equipment. The obtained assessments give us an idea for all indicators, which are involved in our investigations. We accept that these assessments may use for our purposes. They gave data for the (technical and technological levels. At the same time in the universities there isn't any information about the new technique, which exists at the moment in the world. They need some prospects about these machinery and equipment that wish to buy in the perspective and first of all are used in analogical universities in different countries. The technical sheet contents different factors:

For quantities level's evaluating of the machinery and equipments in the universities is offered by us a criterion and methodology in accordance with them all assessments are transformed to one and same scale for measurement. For this purpose the beginning degree for every factor are evaluated with value one. The next increasing from one degree to another is calculated by this dependence. The quotient q of the geometric progression is changed in the interval [1, 2]. It depends on the importance of the every factor.

This quotient has three values: 2, 1,68 and $\sqrt{}$. The accepting on these values for evaluating the (technical and technological level for all machinery and equipment in universities are turned out that plausible way for approximately expressing of the assessments for all factors in every groups. It depends on their character sketches and possibilities.

The coefficients for characterizing the factors in 6 levels are as following:

1	2	3	4	5	6	**Min**	Max

Group A-base	
1. Type of technique (heavy, medium and so on) - **1,68**	2. Are there "new-how"- **2**
3. Spent time for teaching and training - **2**	4. Spent time for practical studies - **2**
Group B - operating (intending of the technique)	
5. Casting iron -**2**	6. Steel casting -**2**
7. Casting of colored metals -**1,68**	8. Strategy casting -**2**
9. Casting under pressing -1,68	10. Other types casting works - $\sqrt{2}$
11. Hammering - $\sqrt{2}$	12. Stamping - $\sqrt{2}$
13. Tempering- $\sqrt{2}$	14. Hot processing -**1,68**
15. Metallizing –**1,68**	16. Production of tools - **1,68**
17. Matrix for stamping - $\sqrt{2}$	18. Casts and models- $\sqrt{2}$
19. Measurements instruments and calibre - **2**	20. Coppersmith's trade - $\sqrt{2}$
21. Production of the mechanisms- $\sqrt{2}$	22. Special machinery – **2**
23. Medium size stampimg-**2** Group C-composed	24. Mechanical components - $\sqrt{2}$
25. Hydraulics- $\sqrt{2}$	26. Pneumatics-**1,68**
27. Vacuum installation - $\sqrt{2}$	28. Electrical control - $\sqrt{2}$
29. Electricity - High voltage circuit - $\sqrt{2}$	30. Electronics - $\sqrt{2}$
31. Linear and angle measurement-**2**	32. Measurement of Temperature, pressure and so on – **2**
33. Optic-**2**	34.Others-**1,68**
Group D - economic	
.35. Loading of the machinery and equipment - **2**	36. The number of the students, training up on one machinery - **2**
37. The expenditure of the energy for one machinery per year and total for the university - **2**	38. Duration for using of the machinery and equipment (defining their live circle) - 1,68
39. Realizing of the additional incomes from the used technique in the universities - **2**	

For every kind of machinery and equipment are composed (compiled) technical sheet. In all squares of this sheet is given a weight. It depends on acceptable above values (2, 1,68 and √2). For some indicators have two values: min and max. With the help of these costs we calculate their average. We fill up in technical sheet only these factors, which are connected with corresponding type machinery and equipments.

The general (total) value   for a given type machinery and equipment in 1998 is arithmetic sum from the weights for the different values for all 39 indicators involved in four groups indicators. It obtained by means of summarizing of all assessments for all 4 groups (base, operating, composed and economic). The two factors a and p don't take into account at summarizing of the other assessments.

For the complexity (quantity) of the available and used university's technique are obtained min and max values for corresponding assessments of the factors A, B, C and D. As a result of these two values are found their average value. It is

complex assessment for technical and technological level for all investigated machinery and equipment, which are used in higher education. It involves the influences of all 39 indicators in 4 groups. But it doesn't show the needs from these or other technique and if they use enough effectively for teaching and research work.

The complexity (technical and technological level of the technique) in the universities is got for all 39 factors. The technical sheets are established only for the observed from us specifications for the available and used machinery and equipments. These results are generalized for 167 types of machinery and equipments. The range for changing the degree of the complexity of all machinery and equipments is in the interval from 20 to 240. The investigated technique are divided in 6 classes N_j, j = 1, ... , 6 in dependence of the value I_{up}. This coefficient is obtained as a sum from the factors A, B, C and D in three variants (min. max and average). The degrees of the complexity are:

	N_1	N_2	N_3	N_4	N_5	N_6
I_{up}	**5-15**	**15-30**	**30-60**	**60-120**	**120-240**	**over 240**

RESULTS

The investigated 167 machinery and equipments are classified at their complexity in dependence on these classes. In table 2 is given the breaking of the machinery and equipments and their relative weight in own subclass and total for class 38 of the ISIC. It depends on their technical and technological level and their qualities.

The analysis of all data in this **Table 2** shows, that the predominating classes at their complexity are III and IV, which represent 49,1% and 35,3% for all involved in the investigation machinery and equipment. The VI and I classes are empty multitudes. It indicates that there is not one from this technique doesn't belong to these classes. The II and V classes have significance 9,6% and 6,0% according to total amount machinery and equipment.

Table 2. *The investigated nomenclature according to the ISIC Index of complexity*

Class	Name	Index of the complexity				Total number of group
		N_2	N_3	N_4	N_5	
381	**Metal articles without machinery and equipment**	5 100	-	-	-	5 100%
382	**Machinery and Equipment without electric**	7 5,8%	59 49,2%	47 39,2%	7 5,8%	120 100%
383	**Electric machinery and equipment**	3 18,7%	13 81,3%	- -	- -	16 100%
384	**Means of transport**	- -	6 36,3%	8 47,0%	3 17,7%	17 100%
385	**Control-measurement instruments and Apparatus**	1 11%	4 44,5%	4 44,5%	- -	9 100%
	Total	26 9,6%	82 49,1%	59 35,3%	10 6,0%	167 100%

These data show us that the available techniques in the universities are too old. Even these machinery and equipments, which are obtained from the program "Tempus" and other different joint projects, are already "out of data". At the same time these machinery and equipments are that, which contribute to increase the technical and technological levels of the complexity in the aggregate of the groups and their classes.

The dominated classes with respect to the complexity are III, IV and V. At these classes belong 151 machinery and equipments, which represent 90,4% from total number of the investigated machinery and equipment. These results confirm the necessity from increasing the complexity for every kind of classes. It is possible only by means of replacing them with new, which have to answer on all contemporary requirements for the technique.

By means of data in table 3 are evaluated the level of "new-how" in the used techniques and the need for their renovation (indicator (3), the low values for this indicator is a proof for the need from the renovation of all machinery and equipments in almost universities in our country to be our teaching on the contemporary level.

The factors from group A for almost all classes have the biggest relative weight according to the factors B, C and D (see **Table 3**). This is peculiarly ostentatiously for the subclasses 383 and 385, where are involved the computers. It is stipulated first of all that these subclasses content such machinery and equipment, which need ceaselessly require to renovate. The assessments of these factors are such that they show the need for their increasing. The reasons for this is because by means of them are realized teaching only special intellectual processes. They must correspond with all contemporary achievements in the science.

Table 3. Average assessments

Class	Name	Factor's group				Average index of the complexity
		A	B	C	D	
381	Metal articles without machinery and equipment	11,4 53,9%	2,4 11,4%	6,4 30%	1,0 4,7%	21,4 100%
382	Machinery and Equipment without electric	25,3 41,3%	7,1 11,6%	13,8 22,5%	15,1 24,6%	61,3 100%
383	Electric machinery and equipment	18,3 42%	6,2 14%	15,5 35,5%	3,7 8,5%	43,7 100%
384	Means of transport	28,5 29,6%	9,2 9,6%	19,2 23%	22,2 37,8%	96,5 100%
385	Control-measurement instruments and Apparatus	33,9 68%	3,4 6,8%	11,6 23,2%	1,0 2%	49,9 100%
	Average for the investigated Nomenclature	29,4 43%	7,1 10,4%	17,4 25,6%	14,3 21%	62,8 100%

By means of factors from group C are established that classes 383, 385 and 384 have the biggest complexity, but independently from these results arise the need for using of the machinery and equipment in teaching activity on such, containing more and with the biggest complexity as whole technique and such technological processes by means of which the lecturers may demonstrate the new achievements of the sciences and techniques. They will be in the condition to increase the knowledge. After that the lecturers and the students may continue their scientific and practical activities.

The factors from group D have high value at the means of transport. For this machinery is possible to repair every time with own means, to change individual parts and to use again and again.

At the same time subclass 385 needs from ceaselessly improvements of their character sketches. The reason for this is their using for measurement, control, hydraulics, pneumatics, freezing plant and computers. Their levels must increase ceaselessly. But the value of this factor is only from 2 to 8,5%. This result shows considerable low level of these machinery and equipments in the universities in our country and needs from their quickly replacement with new one.

In the **Table 4** are given the values of the coefficient a for examined machinery and equipment. The data show for all classes coefficient is reached the most class III. These results indicate also that used technique have value from $2,5 to $5 per 1 kg. It points that these machinery and equipments are on low technical and technological levels. With the help of this coefficient a are demonstrated in the teaching prices the old technique and old technological processes.

Table 4. The ball assessment for the coefficient a

Class	Name	1 0-2,5	2 2,6-5	3 6-10	4 11-20	5 21-40	6 Over 40	Average index of the complexity
381	Metal articles without machinery and equipment	- -	2 40%	3 60%	- -	- -	- -	5 100%
382	Machinery and Equipment without electric	3 2,5%	39 32,5%	47 39,2%	19 15,8%	7 5,3%	5 4,2%	120 100%
383	Electric machinery and equipment	1 6,2%	2 12,5%	13 81,4%	- -	- -	- -	16 100%
384	Means of transport	1 6%	8 47%	8 47%	- -	- -	- -	17 100%
385	Control-measurement instruments and Apparatus	- -	- -	1 12%	4 44%	2 22%	2 22%	9 100%
	Total for investigated techniques	5 3%	51 30,5%	72 43,1%	23 13,8%	9 5,4%	7 4,2%	

The values of the coefficient p (**Table 5**) for examined university's machinery and equipment show their relatively slowly renovating with regard to world tendency. The structures of the subclass 385 (Control-measurement instruments and Apparatus including computer techniques) are changed

more quickly. They belong to the 3 and 4 degree with respect to our assessments. These estimations confirm the needs from ceaselessly refining the machinery and equipments as using the patterns for teaching and training in the universities in our country.

Table 5. *The ball assessment for the coefficient p*

Class	Name	1	2	3	4	5	6
		Over 25	From 25 to15	From 15 to 10	From 10 to 5	From 5 to 2	Less 2
381	Metal articles without machinery and equipment	- -	3 60%	- -	2 40%	- -	- -
382	Machinery and Equipment without electric	2 1.7%	22 18.3%	39 32.5%	31 25.6%	14 11.7%	12 10%
383	Electric machinery and equipment	- -	2 12.5%	8 12.5%	9 56.5%	3 19.7%	- -
384	Means of transport	- -	2 11.8%	7 41.5%	4 23.5%	4 23.5%	- -
385	Control-measurement instruments and Apparatus	2 1.2%	29 17.4%	50 29.9%	49 29.3%	24 14.4%	13 7.6%

DISCUSSION

The obtained quantities assessments for technical and technological level of the available and used machinery and equipments in the universities are very lowly. They are proof for need from renovation and totally replacement with new machinery and equipments corresponding to the world patterns.

The higher results for some investigated factors are got mainly for these machinery and equipments (chiefly computers), which are supplied from different programs, for example "Tempus", scientific investigated activities financing by Ministry of education and science and so on. With the help of these programs is provided the next technique: SYEP with different modification, Subject Code 514 (710, 510, 312, 511) %for medical University, computers, printers, scanners, Internet Server, Copying Machines, slid projection cameras, multimedia computer laboratory for foreign teaching. Such techniques are in:

Economic university in town Varna:
Transportable searchlight, video projection system, satellite system and so on.

Civil University in Sofia:.
Equipment for furniture of 3 educational hall, educational computer's laboratory and equipment for geophysics department;

Chemical Engineering University in Sofia:
First of all - computers.

University in town Velico Turnovo "Sv.Sv. Kiril and Metodi" :
Equipment for computer Laboratory, audio-visual centre for preparation of didactic materials.

Food University in town Plovdiv :
stands and equipments for improving laboratory activities for thermo technique and automation.

Technical University in Sofia
Enlarging and renovating for part of material and technical foundation, computers.

University for National and world economy:
Computers.

By means of bilateral contracts with different terms between Medical University in Sofia and Aristotel's university in Solun -Greece, Medical Department at the University "Uluda" in Bursa -Turkey and University's Hospital Inselspital in town Bern -Switzerland for partial equipments.

CONCLUSIONS

B. To outline the needs from machinery and equipment in the universities in general and especially only for these universities, for which we have information about it.

The analysis on material and technical foundation (machinery and equipments in the universities and quantitatively evaluating of their condition and purposes allow us to make some essential conclusions:

1. The Machinery and equipments, computers and special techniques, which are used for

teaching or practical studies in the universities, are out of date;

2. The Machinery and equipments, which are in the availability in the universities in our country, are insufficient as for satisfying the needs of the lecturers, as for the students;

3. The improving of the machinery and equipments in defined directions ensure the expanding the possibilities for contemporary scientific investigations in different spheres and the using own scientific achievements for lecturer's purpose;

4. The refining and renewing of the machinery and equipments create a prerequisite for giving and obtaining of scientific knowledge on the level of different countries, which are patterns with their traditions;

5. Contracts with Bulgarian's firms and scientific organizations are insufficient. The amount of the obtained resourses is minimized;

6. The available techniques in the most universities (national academy for theatre and film arts, Technical University and others) are very old and amortized. They are need of repairing, but at preliminary analysis of the their expedience;

7. Sometimes the intensive exploiting of the contemporary techniques quickly is amortized as video techniques, film projectors, monitors and so on;

8. The creations of new subjects require new equipment for suitable laboratory, renovating of the equipments and extension with modern patterns;

9. In almost all universities is necessarily computing of the library and information activities, Initiating modern information technology and software;

10. It is necessarily developing of the long-term programmers for modernizing of the equipments;

11. Some of necessarily machinery and equipments have national importance. Their supplying and using have not only educational meaning, but and practial one. Such equipments are: for analysis and control in food industry, medical equipment, control environment conditions and others;

12. In technical university there is high velocity informational network, which is needed of extension its capacity;

13. In connection with build up of the system for evaluating the quality of education according to the accredit commission must supply with special equipments;

14. There isn't informational-computer's centre in every university in our country, which leads erection necessity of modern communication systems;

15. Universities are badly needed of available technique (as multimedia computer laboratory for foreign language education in system and many their like.

16. In every one of the universities must have informational-computer's centre.