Uliana Sadova,
Tetiana Stepura,
Olga Korytska

FORMATION OF DIGITAL DATABASES IN MONITORING OF REALIZATION OF EDUCATIONAL-INTELLECTUAL POTENTIAL OF THE REGIONS OF UKRAINE

The object of research is databases of graduates of educational institutions that need to be digitalized and prepared for analysis. The study highlights the formation of a digital database out of the graduates among educational institutions for monitoring the implementation of educational and intellectual potential. Monitoring procedures for tracking the implementation of educational and intellectual potential are an important component of making managerial decisions to balance supply and demand in professional labor markets, make better use of the human potential of economic development, and reform educational institutions in accordance with the latest public needs. Monitoring procedures for tracking the employment of graduates are an important element of Education Management. The study highlights the technology of preparing and forming databases of graduates of educational institutions for further work with them (conducting a survey, summarizing and visualizing its results) using Microsoft Excel. For this purpose, methods of intelligence analysis of data, ranking and classification of statistical populations, and data mining technologies are used. Approaches to structuring and coding graduate data are described. The mechanism for creating a digital database is provided with arguments and descriptions of all the structural components of the database: fields, headers, and records. The description of the sequence and results of working with databases is given on the example of data from graduates of higher educational institutions of the Lviv region. These technologies for working with databases were obtained during the implementation of the regional development project within the framework of EU sectoral support, which was implemented in the Lviv region (Ukraine) in 2018–2020 with the participation of the authors. The proven method of forming digital databases highlighted in the study is only a stage of monitoring the implementation of the educational and intellectual potential of graduates of educational institutions of the Lviv region. Method can be used and scaled to other regions of Ukraine without significant changes or to educational institutions of different levels with minor clarifications. At the same time, the creation of such databases at the national level would increase the effectiveness of monitoring the employment of graduates. The proposed methodology is universal and allows for national research, as well as provides opportunities for international comparisons of educational and intellectual potential.

Keywords: *digital database, educational and intellectual potential, labor markets, data mining, technically correct data.*

1. Introduction

In the context of the development of a digital society, changes in the content of Labor, and socio-economic instability, the problem of finding tools for balancing supply and demand in professional labor markets is acute. Monitoring tools for the development of educational and intellectual potential are effective for resolving such imbalances and making managerial decisions on the compliance of the volume, specialization, and content of training specialists. It is about systematic monitoring of the effectiveness of implementing the educational and intellectual potential of graduates of educational institutions in the labor market. The issue of efficiency is considered primarily from the point of view of their employment, priority in their specialty, as well as their satisfaction with their education. Such monitoring procedures were successfully implemented in the Lviv region (Ukraine) within the framework of the Regional Development Project «Monitoring the implementation of the intellectual potential of graduates of universities and vocational schools in the border region: social partnership, State and regional order». The results of the Graduate Survey are available on the resource [1].

To implement monitoring procedures, it is necessary to form a high-quality information base. Conceptual approaches to data mining for business needs are described in [2]. The work [3] provides many questions of preparing data for analysis in more detail, both from the point of view of managers and from the point of view of IT specialists. Other works address certain problems of data preparation (using the R language [4]), theoretical issues of Database Management [5, 6]. As well as the characteristics and areas of application of different types of databases [7]. The work [8] is an important contribution to the problem of preparing data for socio-economic research in the R language. The strong example of using databases in economic research is paper [9]. This proposed study explicates the results obtained in previous publications and the authors' own experience in preparing data using Microsoft Excel for specific needs of monitoring the implementation of the educational and intellectual potential of graduates of educational institutions of the Lviv region. The importance of the implementation of such monitoring is grounded in [10].

The object of research is databases of graduates of educational institutions that need to be digitalized and prepared for analysis. *The aim* is the development of methods for forming digital database is for monitoring the implementation of the educational and intellectual potential of the regions of Ukraine (on the example of the Lviv region).

2. Research methodology

The following scientific methods were used in the study:
– a systematic method in building logical connections in the system of monitoring the implementation of educational and intellectual potential;
– methods of ranking and classifying a statistical population – for systematizing data;
– methods of intelligence data analysis – for selecting meaningful data;
– data mining technologies – for extracting and cleaning data.

3. Research results and discussion

For effective implementation of monitoring procedures, including survey methods, the necessary step is to obtain and prepare input data [8]. A Generalized Scheme of the stages of work in monitoring the implementation of the educational and intellectual potential of the regions of Ukraine is shown in Fig. 1.

1. *Definition of a business problem* – the degree of realization of the educational and intellectual potential of the regions of Ukraine. One of the ways to conduct monitoring is to survey graduates of educational institutions, in this study of higher education institutions (HEI). This also includes planning the process of obtaining information and selecting personnel to complete the task.

Information about graduates of the HEI is an internal management report. It is usually located in the Department of employees for scientific and pedagogical work and social development, for example, the Department for employment and relations with production or the Department for career development and cooperation with business. And each department has information about the number of graduates and their success in employment.

2. *Data collection*. Based on this data, the database is filled in. This is the so-called «raw data» [4] and their correct transfer to the digital database requires an individual approach and the competence of a specialist in filling the database. There are two options for completing the task: creating a structured template for submitting «raw data» in the most acceptable version for filling the database, or performing additional technical work during direct filling of the database (moving to stage 3). The choice of option depends on the capabilities of the personnel resource of the performers of the tasks set.

At the same stage, the important issue of consent to the processing of personal data is resolved. If an employee of the educational institution works with databases, such consent was given by the graduate upon admission.

3. *Creating a database includes*: creating a database, filling it with data («raw» or technically correct, depending on the approach and competence of the specialist) and working with the database in accordance with the tasks set.

4. *Working with data* involves transferring the completed database to specialists (in our case, from Social Research, which, based on the records of graduates, will provide questionnaire surveys of graduates of the HEI regarding their employment in the mode of a telephone interview or filling out an electronic questionnaire).

5. *Data Analysis*. The results of questionnaire surveys on the educational and intellectual potential of the regions of Ukraine based on the results of the fourth stage are analyzed by well-known statistical and mathematical research methods.

6. *Visualization of results* is a graphical representation of the results of research and dissemination of the information received.

In this article, let's consider in detail the third and fourth stages of work related to the formation of the database.
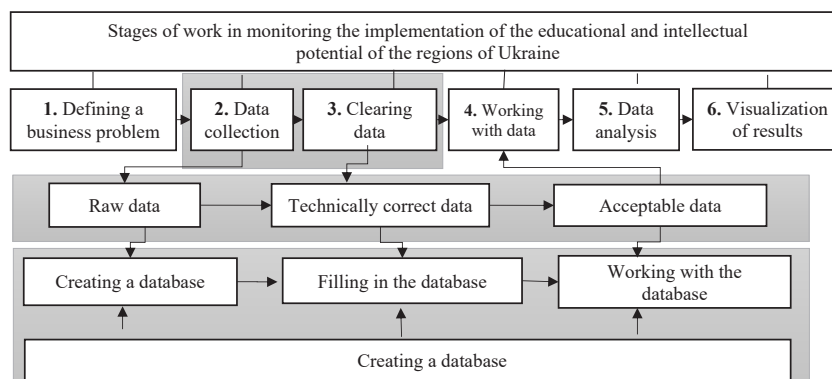

Fig. 1. Stages of work in monitoring the implementation of the educational and intellectual potential of the regions of Ukraine (developed by the authors)

A database is an organized set of structured information in electronic form placed in a computer system [5].

There are several types of databases: relational, object-oriented, distributed, graphical, open source, data warehouses, cloud databases, etc. [6].

Creating a relational digital database of HEI graduates was performed in the Microsoft Office Excel environment. Its advantages are widely known [11–13]. Elements in a relational database are organized as a set of tables with a certain number of columns and rows. That is, at this stage of research on the development of the educational and intellectual potential of the regions of Ukraine, the database is an electronic list of graduates of the HEI.

Creating a list is preceded by a clear understanding of its structure and meeting a number of conditions. Among they: the same type of data for each column of a digital table, the presence of headers, the absence of blank rows, and compliance with the conditions for using personal data.

The structural components of the database are fields, headers, and, in fact, records [14]. Here it is important to note that the number of fields is extremely important, because their allocation depends on the information completeness of the database, the complexity of filling and the effectiveness of further use. Headings should contain clear and concise information – field names.

A record is data about a specific graduate of the HEI.

The following fields and their headers have been created in the database of graduates of the HEI:
– number in order within the specialty;
– number in order of end-to-end numbering;
– HEI name;
– HEI code;
– educational degree;
– year of graduation;
– graduate code;
– last name, first name of the graduate;
– branch of major, name;
– branch of major, code/number;
– specialty, name;
– specialty, specialty code/number;
– department code/number;
– the source of funding;
– contact phone number;
– contact phone number, fixed;
– email address;
– responsible contractor for providing information, surname, first name;
– responsible contractor for providing information, position;
– responsible contractor for providing information, e-mail;
– responsible contractor for providing information, contact phone number;

– performer of filling out the database, last name, first name;
– database filling contractor, position;
– database filling contractor, email address;
– database filling contractor, contact phone number.

A fragment of the database of graduates of the HEI in Microsoft Office Excel is displayed in Table 1.

The number in order within the specialty is required for assigning an individual graduate code. The number in end-to-end numbering order indicates the number of entries in the database.

The name of the HEI refers to general information about the graduate. The HEI code is assigned from the Register of subjects of educational activity [15]. To increase the efficiency of working with the database, it is advisable to have text and numeric fields with information about the HEI.

Educational degree: applicant of higher education of the first level – Bachelor or second level – master.

The «year of release» field allows making the database comparable in dynamics and supplementing it every year.

The graduate code is the most important field in the database. It is necessary due to compliance with the requirements for the use of personal data. To do this, two fields are created in the database: with the graduate code and last name, first name, patronymic, depending on the level of access to confidential information that the user will have.

The individual code of a graduate of the HEI is formed by the name of the HEI, specialty, year of graduation and serial number within the specialty in the list of input data:
– the first letter is the HEI code/number;
– the next three digits are the specialty code;
– the next two digits are the year of admission code;
– the next three digits are the serial number of the student within the specialty.

Assignment of the HEI code/number is possible in two versions: as a three-digit code of the HEI from the Register of subjects of educational activity, or with the encoding of the HEI in the letters of the English alphabet. A fragment of codes/numbers for encoding the HEI of the Lviv region is shown in Table 2.

For example, the first graduate of specialty 051 of the Lviv Polytechnic National University in the digital database for 2018 will have the code A05118001, the second graduate – A05118002, and so on (Table 1).

Last name, first name, patronymic of the graduate – confidential information about the graduate.

The branch of knowledge, specialty (name and code of the industry) are selected in accordance with the list of branches of knowledge and specialties approved by the government of Ukraine, in which applicants for higher education are trained [16].

Table 1

Fragment of the database of graduates of the HEI in monitoring the implementation of the educational and intellectual potential of the regions of Ukraine

1	Po No. 1	Po No. 2	HEI code	Year of graduation	Graduate code	Branch of knowledge, industry code/number	Specialty, code/number
2	A	B	D	F	G	I	K
3	1	3683	97	2018	A05118001	05	051
4	2	3684	97	2018	A05118002	05	051

Note: developed by the authors

Table 2

Fragment of codes/numbers for encoding HEI
(the first letter of the graduate's code)

HEI	First letter of the graduate code
Lviv Polytechnic National University	A
Ivan Franko National University of Lviv	B
Lviv University of Banking	C

Note: developed by the authors

The department code is needed to link a specific graduate to its department, because there are training options when different departments train specialists of the same specialty. Let's recommend coding departments within each HEI depending on the organizational structure of the University:

– the first two digits are the institute/faculty codes/numbers (it is appropriate to start numbering from 10, because 01, 02, etc. at the beginning of the numeric field, Microsoft Office Excel displays incorrectly, deleting 0 by default);

– the next two digits are the department code (in order 01, 02, 03, etc.).

Table 3 shows a fragment of the table on coding institutes and departments at the Lviv Polytechnic National University.

Table 3

Coding of institutes and departments on the example
of Lviv Polytechnic

Institute Code	Abbreviation of the Institute	Department code	Name of the Department	Department abbreviation
Institute of Administration and Postgraduate Education				
10	IAPE	1001	Administrative and Financial Management	AFM
10	IAPE	1002	Theoretical and Applied Economics	TAE
10	IAPE	1003	Management Technologies	MT

Note: developed by the authors

The source of funding – budget funds (assign 1 in the field) or funds of individuals and legal entities (assign 2). This field will help to conduct a more thorough analysis of the information received about the employment of graduates at Stage 5.

In the «contact phone number» field, specify the existing phone number of the graduate. The «contact phone number, corrected» field is used to format the «phone» field according to the standard format of such data (0 mobile operator code)-xxx-xx-xx or (0 area code)-xxx-xx-xx.

A graduate's email address is another opportunity to conduct a questionnaire survey.

The following fields contain data and contact information about responsible performers for providing «raw data», as well as specialists involved in creating a database (there may be several of them).

Based on the generated digital database of graduates of the HEI, questionnaire surveys were conducted regarding their employment and the quality of educational services, the results obtained were summarized, processed and visualized [1].

A promising area of this research should be considered formation of a database of graduates on a regional scale. It will allow the comparative analysis of the results obtained depending on the location of the HEI and the place of employment of the graduate. Also should develop methods of the accumulation and processing of information in dynamics. This is due to the fact that the database formation mechanism is universal and can be applied to creating, filling in, and working with any research object.

4. Conclusions

So, in the course of the study, a mechanism for forming a digital database of graduates in monitoring the release of the educational and intellectual potential of the regions of Ukraine was proposed with argumentation and description of all the structural components of the database: fields, headers and records. This will make it possible to create similar databases for each HEI or individual region of Ukraine, as well as make interregional comparisons and create an all-Ukrainian digital database. This, of course, will make it possible to qualitatively and quantitatively assess the implementation of the educational and intellectual potential of not only the regions, but also Ukraine as a whole in the results of monitoring. The proposed methodology is universal and allows for national research, as well as provides opportunities for international comparisons of educational and intellectual potential. This is of scientific relevance and importance for professionals from other countries.

References

1. Monitorynh realizatsii intelektualnoho potentsialu vypusknykiv zakladiv vyshchoi ta profesiino-tekhnichnoi osvity prykordonnoho rehionu: sotsialne partnerstvo, derzhavne i rehionalne zamovlennia. *IntellectLviv.* Available at: https://intellectlviv.com/site/zpto

2. Provost, F., Fawcett, T. (2013). *Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking.* Sebastopol: O'Reilly, 385.

3. Pyle, D. (1999). *Data Preparation for Data Mining.* Morgan Kaufmann. Available at: https://www.temida.si/~bojan/MPS/materials/Data_preparation_for_data_mining.pdf

4. Jonge, E. de, Loo, M. van der (2013). *An introduction to data cleaning with R. Statistics Netherlands.* Available at: https://cran.r-project.org/doc/contrib/de_Jonge+van_der_Loo-Introduction_to_data_cleaning_with_R.pdf

5. What Is a Database? Database defined. *Oracle Cloud Infrastructure.* Available at: https://www.oracle.com/database/what-is-database/

6. Nishtha, J., Sahil, P., Mehak, A., Ishita, K., Dishant, G. A. (2012). Survey and Comparison of Relational and Non-Relational Database. *International Journal of Engineering Research & Technology, 1 (6),* 1–5.

7. Radoev, M. (2021). Contemporary Trends in the Development of Databases. *Ikonomiceski i Sotsialni Alternativi, 1,* 5–15.

8. Marets, O., Sysan, O. (2021). On data preparation for analysis in socio-economic research. *Visnyk of the Lviv University. Series Economics, 61.* Available at: http://publications.lnu.edu.ua/bulletins/index.php/economics/article/view/11418

9. Vries, G. de, Arfelt, L., Drees, D., Godemann, M., Hamilton, C., Jessen-Thiesen, B. et. al. (2021). The Economic Transformation Database (ETD): content, sources, and methods. *WIDER TECHNICAL NOTE, 2,* 105. doi: http://doi.org/10.35188/unu-wider/wtn/2021-2

10. Hrynkevych, O. S., Sadova, U. Ya., Levytska, O. O. (2020). International experience in monitoring graduates' employment and ways of its application in Ukraine. *Demography and Social Economy, 1 (35),* 126–138.

11. Mariza, M. (2015). Advanced spread sheets – Microsoft Excel 2010. *Open society for idea exchange (ODRAZI)*. Zagreb, 54. Available at: https://www.infobooks.org/pdfview/6608-advanced-spreadsheets-microsoft-excel-2010-mariza-maini/

12. Davenport, J. H., Grant, J., Jones, C. M. (2020). Data Without Software Are Just Numbers. *Data Science Journal, 19 (1)*. doi: http://doi.org/10.5334/dsj-2020-003

13. Meyer, D. Z., Avery, L. M. (2008). Excel as a Qualitative Data Analysis Tool. *Field Methods, 21 (1)*, 91–112. doi: http://doi.org/10.1177/1525822x08323985

14. Microsoft Excel Manual (2015). *University of Mary Washington.* Ver. 1, 44. Available at: https://adminfinance.umw.edu/tess/files/2013/06/Excel-Manual1.pdf

15. *Reiestr sub'iektiv osvitnoi diialnosti.* Zaklady vyshchoi osvity. Available at: https://registry.edbo.gov.ua/

16. *Pro vnesennia zmin do pereliku haluzei znan i spetsialnostei, za yakymy zdiisniuietsia pidhotovka zdobuvachiv vyshchoi osvity* (2021). Postanova Kabinetu Ministriv Ukrainy No. 762. 07.06.2021. Available at: https://www.kmu.gov.ua/npas/pro-vnesennya-zmin-do-pereliku-galuzej-znan-i-specialnostej-za-yakimi-zdijsnyuyetsya-pidgotovka-zdobuvachiv-vishchoyi-osviti-i070721-762

Uliana Sadova, *Doctor of Economic Sciences, Professor, Department of Theoretical and Applied Economics, Lviv Polytechnic National University, Lviv, Ukraine, ORCID: https://orcid.org/0000-0002-0930-5885*

✉***Tetiana Stepura,*** *Doctor of Economic Sciences, Associate Professor, Department of Theoretical and Applied Economics, Lviv Polytechnic National University, Lviv, Ukraine, e-mail: tetiana.m.stepura@lpnu.ua, ORCID: https://orcid.org/0000-0002-1070-0508*

Olga Korytska, *PhD, Assistant, Department of Theoretical and Applied Economics, Lviv Polytechnic National University, Lviv, Ukraine, ORCID: https://orcid.org/0000-0002-4852-188X*

✉*Corresponding author*