F. F. YUSIFOV, PhD (Information Technology), Head of department
Institute of Information Technology of ANAS
AZ1141, Azerbaijan, Baku, B. Vahabzade str., 9A
E-mail: farhadyusifov@gmail.com
ORCID: 0000-0002-9114-9972
Scopus ID: 21935461000

N. E. AKHUNDOVA, master (Computer science), Engineer
Institute of Information Technology of ANAS
AZ1141, Azerbaijan, Baku, B. Vahabzade str., 9A
E-mail: nermine.axundova26@gmail.com
ORCID: 0000-0002-9883-0349

ANALYSIS OF DEMOGRAPHIC CHARACTERISTICS BASED ON E-DEMOGRAPHY DATA

The introduction of digital technologies, the Internet and social media into human life provides new information and data sources for the study of demographic behavior. The article studies the analysis of demographic characteristics based on e-demographic data. The creation of an e-demographic system is one of the urgent issues for demographic research, the management of demographic processes and for the study of demographic behavior. The article is devoted to the analysis of demographic indicators. The article examines the existing international experience in the field of e-demography, analyzes the current state of research in the field of creating a single population register. In order to build an e-demographic system, it is proposed to integrate public registers in various fields into a single platform through a personal identification number. Demographic analyzes can be conducted information on social networks, mobile phones, banking systems, insurance companies, via traces in various search browsers. The article analyzes demographic characteristics based on e-demographic data. The experiment examined the analysis of demographic characteristics of graduates who studied abroad. Demographic analysis was conducted according to the age, sex, marital status, education level, specialty, country of study and other indicators of the graduates. K-Means model was used to divide the graduates into different clusters. According to the experience, it is possible to divide graduates who studied abroad into clusters according to their age. Thus, graduates of each cluster can be surveyed according to other demographic indicators. E-demography creates new opportunities for social

research and population data monitoring. The establishment of an e-demographic system will allow for population statistics, online census monitoring, in-depth analysis of demographic processes and the study of demographic behavior. Citizens of each cluster will be able to conduct different analyzes according to income, field of work, education and other indicators. The research proposes to build an e-demographic system on the basis of a single state register. In future research, the data in the various registers will be analyzed in depth.

Keywords: e-government, e-demography, population register, migration, demographic characteristics, demographic research.

Introduction. The demographic indicators of the population were registered through censuses from ancient times. However, because these figures were in manuscript form, demographic research required time and resources.

Work on the creation of population registers in various countries began in the 1970s [1, 3, 4]. However, despite the creation of separate information systems, it was not possible to create a single population register for the country for various reasons, including the lack of funding, ICT in many countries, and other reasons. But at present, the creation of a population register in developed countries is realized not only by government agencies, but also by giant banking systems and insurance companies, and the work is carried out under the guise of determining the social status of citizens, their purchasing power. It is possible to obtain information on the number of population, socio-demographic structure, the cause, duration and other information of migration in a certain period via the information in the register. Integration into a single platform creates new opportunities for conducting various demographic analyzes based on the data in the register, and forecasting certain indicators of the population.

E-demography is an effective tool for conducting social research and monitoring of population data and is one of the key components of e-government [1, 3]. Analysis of data collected in state registers plays an important role in the study of demographic data. Researchers [1, 5, 6] note that "e-demography, using all personal data (even insignificant at first glance), can measure and predict demographic changes by assessing the consequences of the digital revolution, as well as determine the demographic behavior of citizens".

One of the main factors that make the statistical use of data collected in state registers possible is the existence of a single identification system or a single identification number for different sources and resources. It is very difficult to coordinate and integrate different registers in the absence of a unified identification system. The e-demography system creates new opportunities for intellectual analysis of data collected in state registers. In this regard, in order to create an e-demographic system, electronic registers in education, health, insurance and other areas should be created and integrated into a single platform. Current technologies allow you to connect all available state registers in a short time using only the PIN. The main sources of demographic research are search queries on web browsers, social media data, data collected in state registers, e-service data,

citizen satisfaction indicators, feedback on government-citizen relations, and so on. The analysis of the big data collected in these sources will allow to complete the existing researches and to form new ideas and knowledge related to demographic behavior.

The article examines the existing experience in the field of e-demographic construction, reviews relevant work and examines existing approaches in the field of demographic data analysis. E-demography is based on the analysis of demographic characteristics.

Relevance of research. E-demography is an effective tool for conducting social research and monitoring of population data and is one of the key components of e-government [1, 3]. Analysis of data collected in state registers plays an important role in the study of demographic data.

The purpose of the article. The main sources of demographic research are search queries on web browsers, social media data, data collected in state registers, e-service data, citizen satisfaction indicators, feedback on government-citizen relations, and so on. The analysis of the big data collected in these sources will allow to complete the existing researches and to form new ideas and knowledge related to demographic behavior.

Scientific novelty. The article examines the existing experience in the field of e-demographic construction, reviews relevant work and examines existing approaches in the field of demographic data analysis. The article provides the analysis of demographic indicators based on e-demographic data.

Research methods. Demographic analysis is performed using the K-means clustering method. Researches in the field of e-demography in the international practice were analyzed, a literature review was conducted. The research was based on the data of graduates who studied abroad. The demographic characteristics of graduates is analyzed by who studied abroad on the platform Jupyter Notebook 6.1.4. The data in the registers for each individual were integrated through the PIN and the experiment was conducted on the basis of the obtained dataset, and the results obtained for the indicators were visualized graphically.

Related demographic studies. Demography is a discipline of science that studies the number, distribution and composition of the population, their changes, the causes and consequences of these changes, the relationship of socio-economic factors and population change [1, 2].

The creation of a population register in developed countries is realized not only by government agencies, but also by giant banking systems and insurance companies, and the work is carried out under the guise of determining the social status of citizens, their purchasing power. The creation of a single population register for demographic research and effective analysis of population data is very important. Experience shows that before the digital age, demographic surveys collected and processed statistically relevant data. There are various approaches in the literature to the use of digital data in the study of demographic processes.

For example, while the use of Internet data to study fertility in the country is still in its infancy, it is believed that promising results will be achieved. Research in this area seeks to study and monitor demographic behavior by analyzing search engine queries [5, 7]. The rapid development of ICT has completely changed people's lives and explores the limitations and risks posed by data protection, especially for migrants [8].

Currently the development of digital technologies, the expansion of the Internet, the popularity of social networks, the advent of Internet devices, tracking devices, smart watches and tablets have radically changed people's lifestyles, created new sources of personal information, new opportunities to address social and economic issues. Using the Internet as a source of information to better understand and predict demographic processes is one of the most important tasks facing the state. Online labor markets such as Facebook, Twitter, Amazon, Craigslist attract participants by conducting surveys. Social networks allow you to target individuals based on different demographics, interests, and behaviors [9, 10, 11].

The study [12] shows the advantages and disadvantages of using digital traces for demographic research. Digital traces published online are becoming increasingly important sources of information for sociologists and those interested in demographic research. The study discusses the benefits and challenges of using digital trace for social and demographic research, as well as analyzes existing demographic surveys that use digital trace creatively to study birth, death, and migration processes.

The study [13] examines Facebook ads as a demographic tool for measuring urban-rural disparities. The study shows the potential of digital census, offered by the Facebook Advertising platform, which has more than two billion users, to measure rural-urban inequality. The results of the study highlight the need to improve existing tools and methodologies for the inclusion of less representative groups in digital demographic surveys.

In a study in [14], it was possible to obtain information about people who participated online and offline during an anonymous online interview. This approach is based on the kinship and friendship of people on social networks.

According to another study conducted on Facebook, recruitment was carried out through advertisements in various parts of the website. This ad links to an external site and contains various images. It is possible to study the age, sex, interests, behavior of users viewing these pictures [15].

According to the experience of Twitter users, the CrowdFlower application is reliable for determining the age of users according to their photos, and for determining the gender of users through the Face ++ application. The proposed calibration method allows you to determine the population of Twitter users by age, gender, location [16].

In Sweden, it is possible to assess the coverage of individuals using data from a single population register. The level of coverage of migrants has been

assessed, and if the individual's coverage is appropriate, it is possible to estimate the birth and death rates by age [17].

According to a study [18], Facebook is the most widely used social network globally. Data from the Facebook advertising platform were taken to study demographic processes. It conducts various surveys according to the user's age, gender, interests, friendship network and other demographic indicators and distinguishes users from each other.

In another study, Google tracked the number of queries for the keywords "pregnancy" and "birth" in the search engine, as a result of which it was possible to plan the birth potential and the number of births a few months in advance [19]. The study [20] used a system that automatically detects search queries related to the flu in the Google search engine. The system, which analyzes five-year search queries, has played a major role in detecting influenza-like illnesses in the United States. Demographic surveys can be conducted at the micro and macro levels [6].

In some countries, information from tracking devices (daily movement trajectory, health information) is used to reduce risks to public health and safety [9, 5]. The discovery of geographical areas for the study of demography is an important feature for determining the direction of migration, the location of the population. Geolocation services are used to study an individual's direction of movement within or outside the country. It is possible to detect the route of an individual through the geolocation service on mobile phones. Using online maps in Google Map, Google Latitude, Twitter, Facebook, Wikipedia and other open internet applications, it is possible to get information about the geographical location by sharing various photos and videos on social networks [5, 21].

Demographic information can also be obtained from the population. The study [22] showed WikiTree users analyzing the relationship between family members and their spouses. A database such as Familinx has been created using data from platforms such as Geni.com and WikiTree, which allows users to find family members and create online generation data [9, 22].

In study [1] deals with the formation of an e-demographic system based on a single state register for demographic research and the use of information in registers in demographic research. It is believed that all state registers should be integrated, and the information in the register is an important source of demographic research. Researchers suggest using ETL, Big Data, OLAP technologies for demographic data analysis [1].

The Vienna Institute of Demography has developed a "Birth Barometer" to monitor fertility in Austria and Vienna, using administrative data sources [23]. The use of web search queries can potentially lead to the creation of birth rates for a number of countries.

Germany also performs various functions through census records. Planning for the population, transport, real estate, health, education and other areas through census records is the basis for public administration. Since mortality

and birth rates are calculated based on these figures, census rates are also the basis of demographic research [24].

The study [25] examines the use of electronic registry systems in the population census. The purpose of the study is to summarize international experience in the use of electronic registry systems for the census in European countries and to take into account the experience of Ukraine. The experience of using registry systems for census purposes has been studied based on the experience of two European countries, Finland and Estonia. The study notes that the experience of developed countries can be useful for Ukrainian statisticians in organizing the next census.

A single population register will be created in the Russian Federation by 2025. The census was traditionally conducted until 2020, the citizens submitted their information by filling out a questionnaire with the website. All information will be collected in the registry to be created and updated online. The register will be available to all government agencies, information will be exchanged online [3, 26].

The first experience in creating a population register belongs to the Scandinavian countries. The main advantage of demographers in the Scandinavian countries was the use of personal registration data, efforts to expand and coordinate individual census data and various other registers in countries such as Belgium and the Netherlands [4].

In study [27] examines the use of population registers for migration and integration research in Denmark and Sweden. Studies show that registries provide systematic, objective data with the potential to collect high-quality data that is completely accessible to researchers in Denmark and Sweden. At the same time, the researchers suggest that the integration of registers and the integration of administrative data with the survey data will allow researchers to conduct more in-depth research, identify patterns and future research directions.

The X-Road platform has been used in Estonia since 2001. This platform allows the reliable and efficient exchange of information in all public services between other systems. X-Road is the first platform for automatic data exchange between countries, including Estonia and Finland. The X-Road platform facilitates the interaction between the citizen and the state and the exchange of information during the implementation of various electronic services. The information in the various state registers is linked to each other through a personal identification number [28].

It is possible to obtain information about the general population, to establish contacts between family members, to monitor demographic processes in small areas, to obtain registration information, marriages, divorces and other demographic behaviors through the Norwegian Population Register. There is legislation to protect confidentiality and access to information for research [29].

It is proposed to establish an e-demography system in Azerbaijan on the basis of a single state register. All state registers must be integrated into the

Table 1. **Individual characteristics transferred
to e-demographics system (In case of Azerbaijan)**

						Registers
	Education	Medicine	Migration	Property	Justice	
$PIN_1(t)$	Diploma certificate	Diseases health card	Departures: education health	Registration e-cadaster	Change of last name conviction	
$PIN_2(t)$	Study abroad other	Diagnostics	Arrival to country	Apartment	Notary	
. . .	...	...	...	...	...	
$PIN_N(t)$	Vocational education	Disease history	Arrival of foreigners	Technical passport	Civil status act	

Source: compiled by authors.

e-demography system created on the e-government platform. The e-demographic system in Azerbaijan corresponds to the eastern model [3].

Analysis of e-demographic data. Conceptually, it is proposed to build an e-demography system on the basis of a single public register. In this case, all public registers, databases and portals must be transferred to the e-demography system. We believe that if we are talking about an e-government platform, all public registers must be integrated, and all the data collected in the register is an important source for demographic research.

The transfer of all public registers to the e-demographic system on the basis of the PIN creates ample opportunities for the study of individual characteristics. Table 1 shows the individual characteristics of the registers and databases transferred to the e-demographic system in the case of Azerbaijan. Formation of e-demography system has the potential to improve the understanding of demographic processes, conduct more in-depth research, perform analyzes at different levels and sections from socio-demography to population geography and medical demography. For example, as shown in Table 1, if we take information about a person as a vector on the basis of PIN (t) depending on time, at different levels and sections, data on indicators such as education, medicine, property, etc. can be analyzed. There are also broad opportunities for socio-demographic research in different areas, the study of demographic characteristics in one area and the study of demographic behavior. Although the data collected in the separate registers are structured, the intellectual analysis of the large data

Social welfare	Finance	Bank	Government services	Population	Address
Pension salary	Funds transactions	Bank operation	E-services government agencies	Date and place of birth	References
Social status	Credits	Transfers	Communal services	Parents, children	Interactive map
...	...	...	...	...	...
Statistics	Tax	Accounts	Fields	Marital status	Address information

collected in these sources will allow to deepen the existing research and gain knowledge related to demographic behavior.

In this study, demographic analysis was conducted based on the data of graduates who studied abroad, integrated into a single register for experimental assessment. Demographic indicators of graduates studying abroad include age, gender, marital status and other characteristics. For the experiment, data on graduates were taken from the Kaggle [30]. After data cleaning, we selected the columns needed for research from data. These figures are hypothetical data and were used for the experiment.

Suppose that information about graduates is stored in two separate registers (population and education registers). A dataset of 100 graduates integrated into a single register was obtained. The personal data of graduates and information about education were collected from these datasets. This data set contains each person's personal identification number, gender, age, profession, work experience, marital status, level of education, specialty, country of study and duration of education. Table 2 shows information on graduates who have studied abroad. There is personal information about graduates in 5 categories.

Table 3 shows the education information of graduates studying abroad. Educational information is available in 4 categories.

Both datasets are integrated using an individual identification code (PIN) in Table 4. It is possible here to get both educational and personal information of each graduate through PIN at the same time.

Table 2. **Personal information of graduates**

PIN	Gender	Age	Profession	Work experience	Maritals tatus
458994	Male	23	Healthcare	2	Married
458989	Female	22	Engineer	1	Married
458996	Female	24	Actor	2	Married
459000	Male	25	Executive	2	Married
459001	Female	24	Lawyer	3	Single

Source: compiled by authors based on a dataset were taken from the Kaggle [30].

Table 3. **Alumni education information**

PIN	Level of study	Specialty	Country of study	Duration of study
458994	Bachelors	English language and literature	Turkey	4
458989	Bachelors	Engineering	China	4
458996	Master	Medical education	Russia	2
459000	Master	Programming	Italy	2
459001	Bachelors	Medical education	Turkey	4

Source: compiled by authors using a dataset [30].

Table 4. **Information about graduates**

| PIN	Gender	Age	Profession	Work experience	Marital status	Level of study	Specialty	Country of study	Duration of study
458994	Male	23	Healthcare	2	Married	Bachelors	English language and literature	Turkey	4
458989	Female	22	Engineer	1	Married	Bachelors	Engineering	China	4
458996	Female	24	Actor	2	Married	Master	Medical education	Russia	2
459000	Male	25	Executive	2	Married	Master	Programming	Italy	2
459001	Female	24	Lawyer	3	Single	Bachelors	Medical education	Turkey	4

Source: compiled by authors.
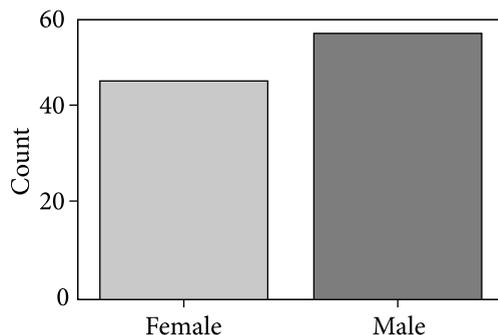
Fig. 1. Gender distribution of graduates
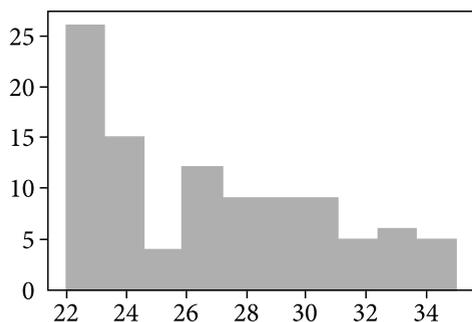*Source:* compiled by authors.

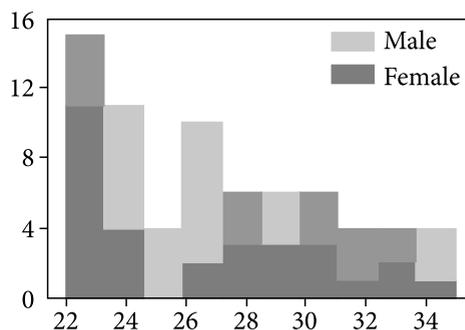**Fig. 2.** Age range of graduates
Source: compiled by authors.

Fig. 3. Age distribution by sex
Source: compiled by authors.

The dataset were analyzed and the diagram in Figure 1 shows the gender distribution diagram of the graduates who studied abroad. According to this diagram, it seems that there are more men among the graduates who studied abroad.

Figure 2 shows a diagram of the distribution of graduates by age group. The analysis shows that the number of graduates in the age group of 22-24 is the majority. Figure 3 shows the age distribution by gender. According to this chart, the number of male graduates in most age groups is higher than the number of female graduates.

Indicators of graduates studying abroad by marital status were also analyzed. Figure 4a shows that the number of married graduates is higher than that of single graduates. Figure 4b shows that there are more male graduates among married and single graduates.

The distribution of graduates by specialties and gender is shown in Figure 5. This chart shows that most women study in the Marketing specialty and most men study in the Computer Engineering specialty.

Figure 6 shows the distribution of graduates by age groups of 22-25, 26-30, 31-35. As can be seen from the diagram, most of the graduates aged 22-25 completed their education in Programming and Marketing, 26-30 years old in Com-
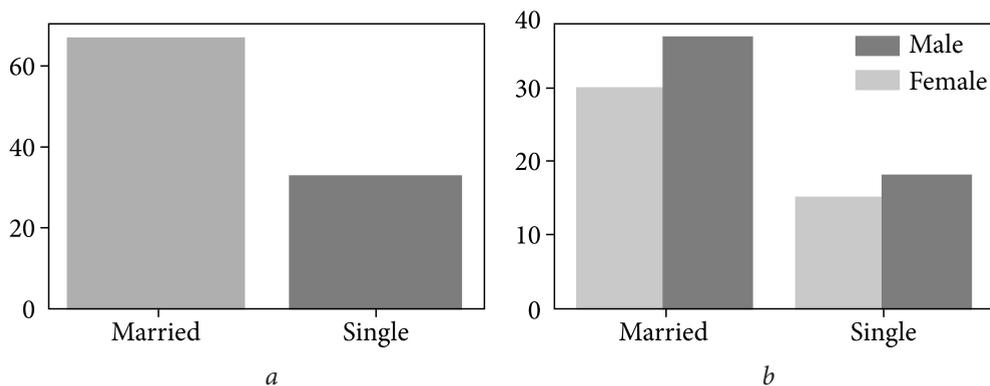
Fig. 4. Ratio of graduates according to marital status
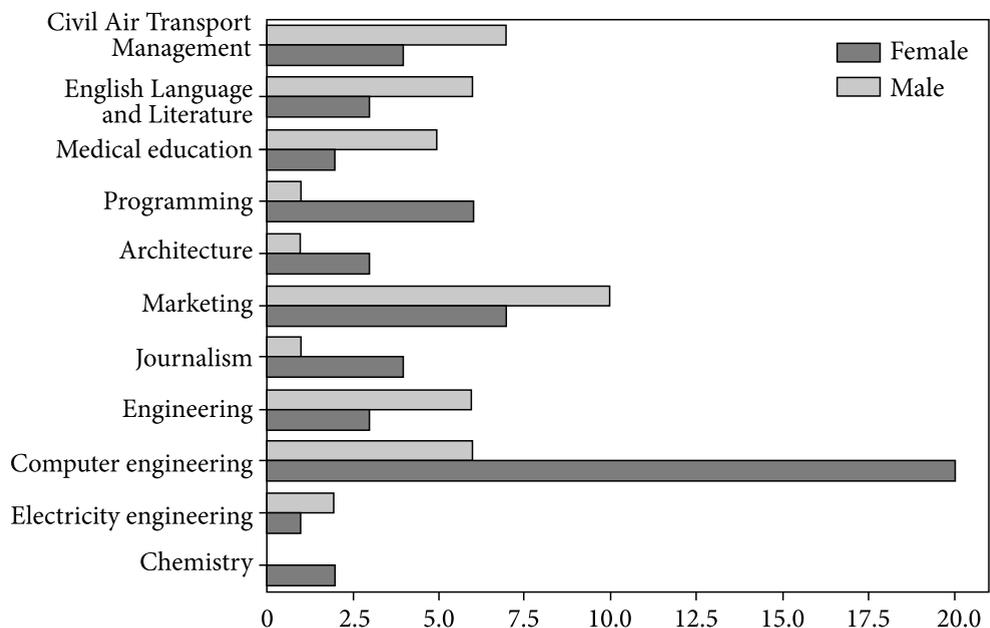*Source:* compiled by authors.

Fig. 5. Distribution of graduates according to their choice of specialty
Source: compiled by authors.

puter Engineering, and 31-35 years old in Marketing. According to these indicators, almost all graduates were trained in Computer Engineering, Programming and Marketing.

Using the study in Fig. 6, the countries in which the Computer Engineering, Programming, and Marketing graduates studied were analyzed. Most Programming graduates studied in Poland, Computer Engineering in China, and
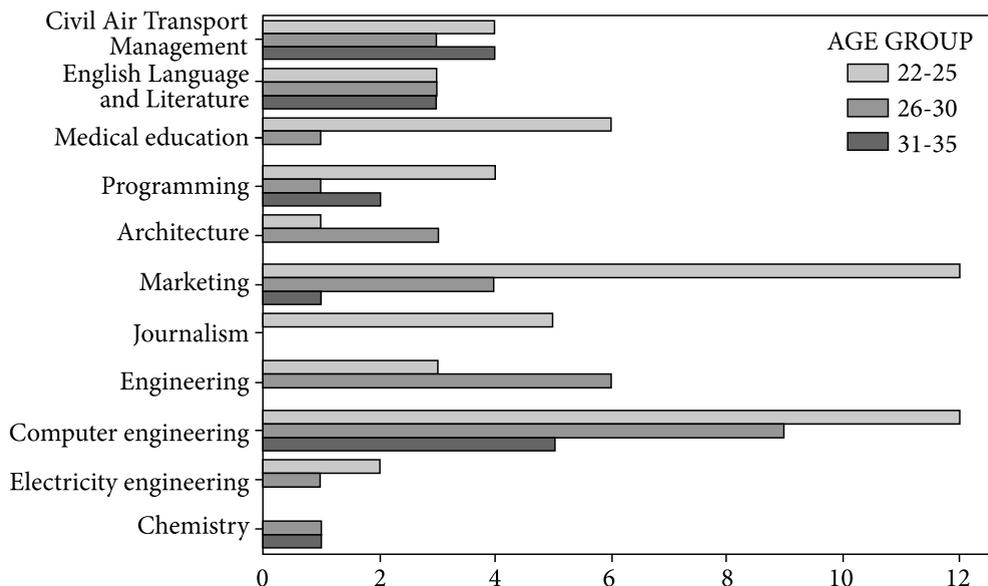
Fig. 6. Age range according to the choice of graduates
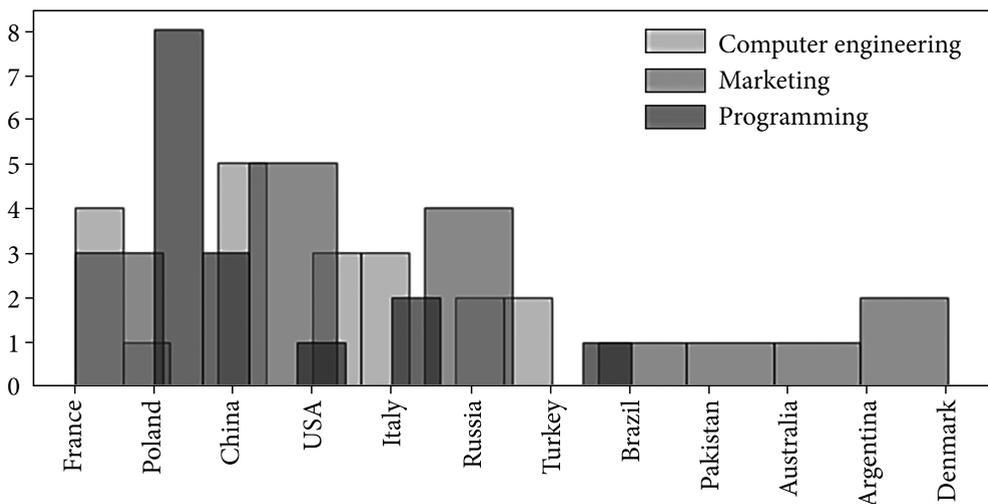*Source:* compiled by authors.

Fig. 7. Distribution of graduates by country according to their choice of specialty
Source: compiled by authors.

Marketing in the United States and Russia. The distribution of graduates by country according to the specialties they study the most is shown in Figure 7.

As the research deepens, it seems easier to analyze age and length of service data. In order to determine conformity according to other characteristics, the indicators are replaced by categories with a certain ranking accordingly as

shown in Table 5. Correlation is calculated according to the indicators. As a result, it is possible to determine whether the relationship between the indicators is good or bad.

Demographic analysis is performed using the K-means clustering method. Graduates are divided into 3 clusters according to age ranges. The distribution of the relationship between the age and length of service of the graduates by clusters is shown in Figure 8. Fig. 8 shows that the clustering is done according to age ranges.

As a result of the division of citizens into clusters, it will be possible to make the right decision based on the indicators in the clusters. Citizens of each cluster will be able to conduct different analyzes according to income, field of work, education and other indicators.

Research shows that although demographic data are used for population registers, they are very limited, even if the registry provides biographical data on a person's life cycle and events over a period of time. From this point of view, the creation of an e-demographic system as a single state register for the analysis of not only the population register, but also other state registers for effective demographic research is very important. Literature review shows that although the data of population registers are currently used in demographic research, there are no approaches to the use of data from other state registers and the creation of an e-demographic system. Note that different e-demographic models may be proposed depending on the priorities, e-government building models and strategies of the countries. The research proposes to build an e-demographic system on the basis of a single state register. We believe that if we are talking about the e-government platform, all state registers should be integrated, and all the data collected in the register play an important role for demographic research. In this approach, an e-demographic system is created on the basis of a single state register and operates independently of the functions of the e-government. The creation of an e-demographic system has the potential to improve the

Table 5. **Data with numerical values only**

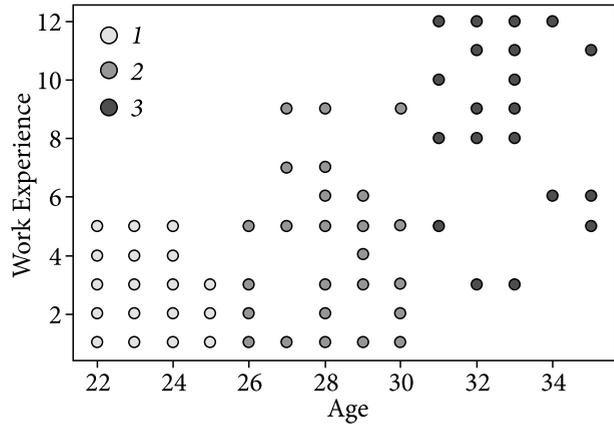| PIN	Gender	Age	Profession	Work experience	Marital status	Level of study	Specialty	Country of study	Duration of study
458994	0	23	6	2	1	1	2	10	4
458989	1	22	5	1	1	1	8	4	4
458996	1	24	1	2	1	2	11	9	2
459000	1	25	4	2	1	2	10	6	2
459001	0	24	3	3	0	1	11	10	4

Source: compiled by authors.

Fig. 8. Relationship between age and work experience
Source: compiled by authors.

understanding of demographic processes, conduct in-depth research at different levels and segments, from socio-demography to population geography, migration processes to medical demography. Given the urgency of the topic, future research will consider the issues of intellectual analysis of large data collected in state registers in order to conduct various in-depth demographic analyzes.

Conclusion. Socio-economic situation, births, deaths, migration, terrorist attacks, wars and other indicators that affect demography are constantly changing. An e-demography system should be set up to study and track demographic processes online. For the formation of an e-demographic system, various electronic state registers must be integrated into a single platform. Once these registers are integrated, it will be possible to conduct more in-depth, effective demographic research. Establishment of an e-demography system will allow for in-depth analysis of population statistics, online census monitoring, demographic processes and demographic behavior.

The article consider the analysis of demographic indicators based on e-demographic data. Researches in the field of e-demography in the international practice were analyzed, literature review was conducted. The research was based on the data of graduates who studied abroad. This data is hypothetical and experimental. The data in the registers for each individual were integrated through the PIN and the experiment was conducted on the basis of the obtained dataset, and the results obtained for the indicators were visualized graphically. Due to these analyzes, information on the social status of the population, working conditions, level of employment, income, etc. more in-depth research is possible. The analysis of future research can be applied in a wider range of areas.

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Ф. Ф. Юсіфов, канд. наук (інформаційні технології), голова департаменту
Інститут Інформаційних технологій АНАН
AZ1141, Азербайджан, Баку, вул. В. Вахабзаде, 9А
E-mail: farhadyusifov@gmail.com
ORCID: 0000-0002-9114-9972
Scopus ID: 21935461000

Н. Е. Акхундова, майстер (комп'ютерні науки), інженер
Інститут Інформаційних технологій АНАН
AZ1141, Азербайджан, Баку, вул. В. Вахабзаде, 9А
E-mail: nermine.axundova26@gmail.com
ORCID: 0000-0002-9883-0349

АНАЛІЗ ДЕМОГРАФІЧНИХ ХАРАКТЕРИСТИК
НА ОСНОВІ ДАНИХ ЕЛЕКТРОННОЇ ДЕМОГРАФІЇ

Впровадження цифрових технологій, Інтернету та соціальних медіа до сучасного життя дає нову інформацію та джерела даних для вивчення демографічної поведінки. У статті проведено аналіз демографічних характеристик на основі електронних демо-

графічних даних. Створення електронної демографічної системи є одним з актуальних питань для демографічних досліджень, управління демографічними процесами та вивчення демографічної поведінки. У статті презентовано міжнародний досвід у сфері електронної демографії, аналізується сучасний стан досліджень у сфері створення єдиного реєстру населення. З метою побудови електронної демографічної системи пропонується інтегрувати державні реєстри в різних сферах до єдиної платформи через особистий ідентифікаційний номер. Демографічний аналіз може проводитись у соціальних мережах, мобільних телефонах, банківських системах, страхових компаніях за допомогою слідів у різних пошукових браузерах. Так, у статті проаналізовано дані експерименту щодо демографічних характеристик випускників, які навчалися за кордоном, на основі електронних демографічних даних. Демографічний аналіз проводився відповідно до віку, статі, сімейного стану, рівня освіти, спеціальності, країни навчання та інших показників випускників. Модель K-Means була використана для поділу випускників на різні групи. Випускників, які навчалися за кордоном, можна поділити на вікові групи, а випускників кожного кластеру — обстежити за іншими демографічними показниками. Електронна демографія створює нові можливості для соціальних досліджень та моніторингу даних про населення. Створення електронної демографічної системи дасть змогу проводити статистику населення, онлайн-моніторинг перепису, поглиблений аналіз демографічних процесів та вивчення демографічної поведінки. Громадяни кожного кластеру будуть спроможні проводити різні аналізи за доходами, сферою роботи, освітою та іншими показниками. Дослідження пропонує побудувати електронну демографічну систему на основі єдиного державного реєстру. У майбутніх дослідженнях дані у різних реєстрах будуть усебічно проаналізовані.

Ключові слова: електронний уряд, електронна демографія, реєстр населення, міграція, демографічні характеристики, демографічні дослідження.