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The role of ICT tools in teaching mathematics

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ABSTRACT

The rapid development of technology has made the availability of many ICT tools easy. In that way, their application in education became possible. So, various ICT tools began to be applied in the teaching process in many subjectsand mathematics was no exception. In this paper we will state which ICT tools can be used in teaching mathematics. Then we will state the results of a research on the advantages of using ICT tools in teaching mathematics, conducted among students from the ninth grade in primary school “GoceDelchev" in Sveti Nikole. And finally, the conclusion about the advantages and disadvantages of using ICT tools will be given. In the conclusion we mainly point out that the application of ICT tools in teaching mathematics contributes to facilitating learning, increasing the desire to solve mathematical tasks, raise the teaching process to a higher level and also motivate students to work and learn more independently.

CCS CONCEPTS

• Education• Mathematics

KEYWORDS

ICT tools, technology, teaching process, mathematics

1 Introduction

Technology is essential for learning mathematics and many other subjects. She affects to achieved successand improves students' learning. The integration of technology into the teaching process in the classroom has attracted much attention in the recent years. Providing a rich learning environment and promoting social interaction as well as critical thinking skills are the reasons for the need to include technology in the classroom. The introduction of computers in mathematics education has brought with it optimism for enriching the teaching process by adding a new dimension in mathematics learning.

The traditional school system brings our students to a state of school saturation, a state of passivity and appeared of resistance to school and learning.

The work of the teacher do not decrease with the introduction of modern technologies, but on the contrary, their

role becomes even more significant and responsible. Teachers with a combination of traditional and modern approaches to the study of mathematics should allow students to experience mathematics as a interesting subject.

Mathematics education is as old as civilization. The need to facilitate learning, the need for more interesting teaching, the development of technology, the achievement of the general and specific goals of mathematics are some of the reasons that stated the need for the introduction of ICT tools in the teaching of mathematics.

In addition to the large number of ICT tools, these days software has been used a lot in the teaching process of the mathematic subjects in primary, secondary schools and universities, because visualization play an important role especially in that subjects as we can see in [3]. In that direction was also created paper [8] where is shown that MATLAB is a user-friendly programming language.

Many authors have examined whether students are interested in using information technology resources and whether they have habits of using them as we can see in paper[4].

Ananalysis to find easy resources for teaching mathematics online can be found in [10]. In [1] the authorswant to determine whether online learning affects students' knowledge. The aim of [2] is to draw a conclusion which way of learning (classical way or online) gives better results in student achievement.A comparation of students' attitude between videoconferencing distance learning and traditional classroom environment learning was made in [6].

Application of modern digital technologies in teaching has changed teaching methods. The objective of [7] is to establish a methodology to improve and adapt curricula with the goal of enhancing digital competences of learners according to European standards and the needs of teaching at technical faculties.

E-learning or electronic learning is a modern way of transferring knowledge and skills electronically using software applications that allow 24/7 availability for use by a large number of users. E-learning acceptance and use for teaching staff in Higher Education Institutions are analyzed in [5].In many papers we can find a demonstration of an e-learning application such as [9] where an e-learning application is developed with Adobe Captivate.

2 Overview of ICT tools that can be used in teaching mathematics

The low interest in work of students, the need for more interesting teaching, the need to facilitate learning and the development of technology are some of the reasons forintroducing ICT tools in the teaching of mathematics.The use of ICT tools and activities with them in the classroom in the mathematics subjectshave a significant role. More important for ICT toolsis that they develop greater abilities in students. This should be the aim of any applicable ICT tool in mathematics teaching.

We will list several ICT tools that can be used in teaching mathematicsin the following:

SMART board

SMART board is an interactive format of a board that reacts when something is entered by the users. Smart board are also known as electronic whiteboards, interactive multimedia whiteboardsor interactive whiteboards. They transform traditional teaching into interactive teaching that is specificallyfor modern society.

Smart board affect better student motivation,easier learning and easier maintenance of their attention. With use of smart board students become much richer in knowledge.The introduction of an interactive whiteboard in the classes makes the lectures and the learning process more attractive and meaningful. It allows teachers to be more creative in putting teaching materials.

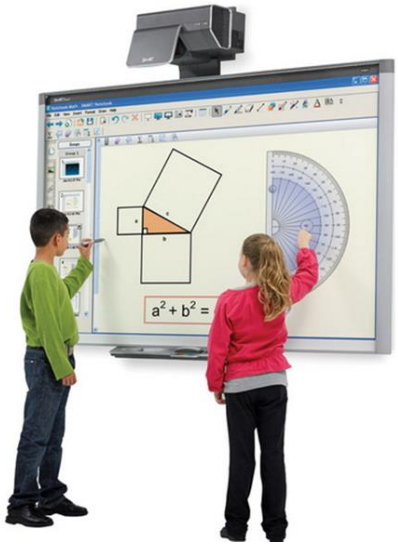

Figure 1. SMART board

Interactive whiteboards encourages active learning among students. Students ask more questions and take more notes than on regular whiteboards and smart boards contributes to more effective group activities.By using an interactive whiteboard, students can collaborate better in the classroom.

Internet as an ICT tool

The Internet as an ICT tool is applicable in every teaching subject and mathematics. Its application is seen through the use pages whose content is strictly related to the material being worked on, as well as Internet sites whose content is more of an entertaining nature - such as those that contain mathematical and logical games and mathematical jokes.Students may also be assigned research homework, for example an assignment that involves finding information on the Internet. Homework may include finding appropriate math passages, pictures of geometric objects, historical information related to mathematics, information about the lives and work of great mathematicians, etc.

Digital textbooks

Digital textbooks represent an electronic form of a traditional, printed textbook. Students can download a digital textbook or access it online on computers or on their phones.

Digital textbooks have started to be used more recently. The views of parents, students, teachers and professors about their use are divided. Some support their use and others point out that their use overloads students because they must read from a computer or some other device.However, the use of digital textbooks has been supported by the digital age in which we live now.

E-learning

E-learning is use for transferring knowledge and skills electronically using software applications 24/7. E-learning is often used to supplement mathematics instruction.When the term online learning is used, one often imagines a virtual classroom accessed by teachers and students from different locations.

Educational software

Educational software for teaching mathematics is software used to model, analyze or calculate numerical, symbolic or geometric data. It is a type of application software used to solve mathematical problems or study mathematics.One of the most used mathematical software in the teaching of mathematics is the GeoGebra software.

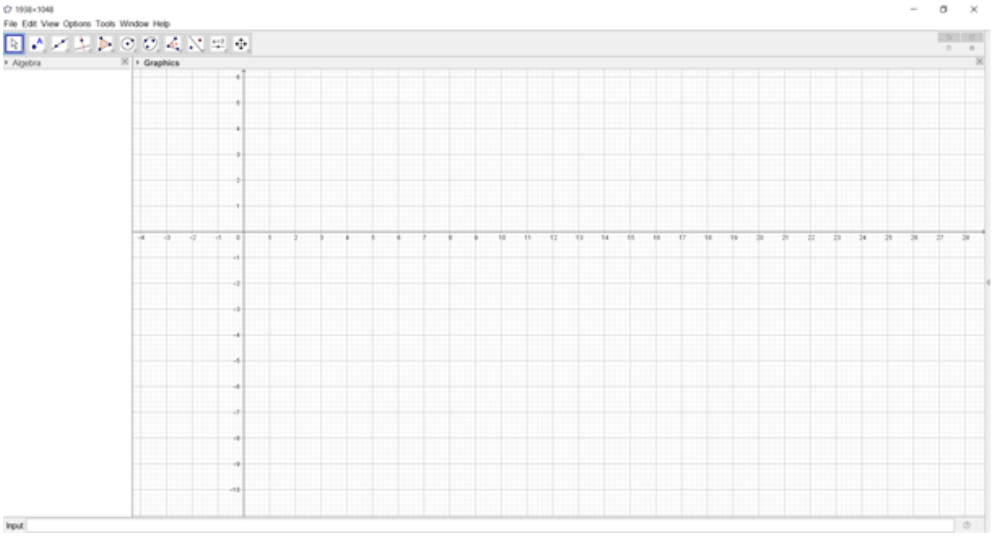

Figure 2. GeoGebra window

GeoGebra is a program for dynamic mathematics that combines geometry, algebra and analysis.Numerous teachers around the world have recognized the potential of the program and recognized that it is program that brings mathematical concepts closer to students. GeoGebra is a free software translated into more than fifty world languages, one of which is the Macedonian language.

GeoGebrasoftware provides a simple representation of complex concepts, and thus a better understanding of them.In recent years, it stands out as a tool that teachers regularly include in their teaching and students easily accept it.

3. The dependence of students' success on the application of ICT tools in teachingmathematics

All the previously mentioned ICT tools make us to think and raise some questions that need to be answered. How much the computer is used in teaching? Are there positive effects of the application of ICT tools in teaching? How justified is the use of ICT in teaching and are the results and reactions positive?

For this purpose, a survey was made with which we can give a partial or complete answer to these questions.

To examine the impact and success of students from the application of ICT tools in teaching, a study was conducted in two classes of the ninth grade in primary school “GoceDelchev" in Sveti Nikole. A survey of students was made to determine how much and if there are any changes in the acquisition of knowledge with the application of ICT tools in the teaching of mathematics.The questionnaire of survey consisted of the following questions:

QUESTIONNAIRE

Question	**Answer**
1. Does using a computer make math class more interesting?	Yes/ no
2. Do I gain more knowledge when using ICT tools?	Yes/ no
3. Do I feel confident using ICT tools during the activities?	Yes/ no
4. Was I able to predict and say the correct answer after each activity when using the GeoGebra software?	Yes/ no
5. Does the use of ICT tools contribute to encouraging students to learn more independently?	Yes/ no
6. Do I manage to work independently and solve problems by applying an appropriate ICT tool?	Yes/ no

7. I enjoy learning mathematics much more using an ICT tool?	Yes/ no
8. Is it good to use ICT tools more often in mathematics classes?	Yes/ no
9. Am I familiar with using GeoGebra software?	Yes/ no
10.Do I master the material more easily using the GeoGebra software?	Yes/ no
11. Does the use of ICT tools contribute to raising the educational process to a higher level?	Yes/ no

28 students were examined, and the results are given in Figure 3:

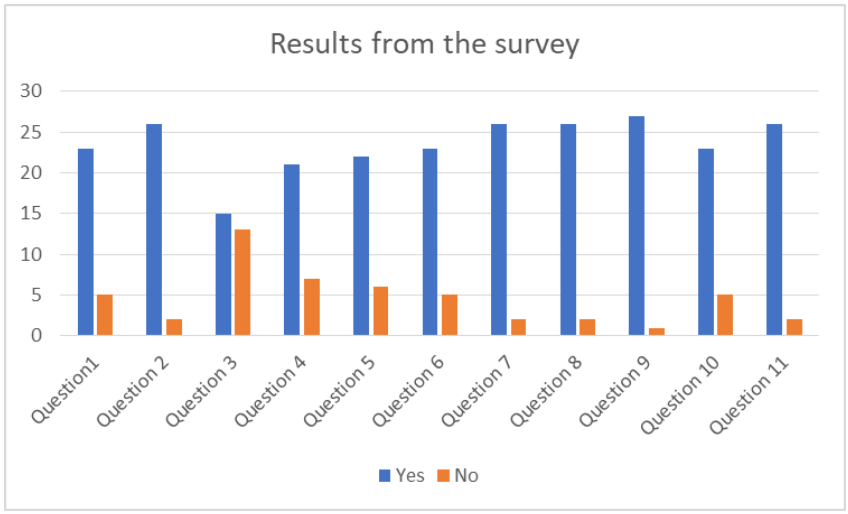

Figure 3. Results from the survey

The results as we can see from figure 3, show that students generally gave positive feedback about using ICT tools in teachingmathematics. However, some of the students stated that they do not feel confident when working with ICT tools in class and at home.

From the research mentioned above as well as from our experience of using ICT tools in teaching we can single out the following advantages and disadvantages related to their use:

Advantages:

- Students acquire digital and audiovisual literacy. It helps students develop digital and audiovisual skills for the future.
- Students are encouraged to participate actively in class.
- The motivation, curiosity and opportunities for experimentation among students increases.
- Class time is used more efficiently. More new things are learned in a shorter time.
- Students with special needs have access to essential material and special ICT tools that they can use for their educational needs.
- ICT enables students and teachers to access learning resources and materials.

Disadvantages:

- A certain level of understanding is necessary to use a large part of ICT tools. If teachers and professors are not trained and don't know how to use them properly, it can be a big problem.
- Technical problems may occur when using ICT tools.
- Students may be exposed to information overload, when ICT tools are used in learning.
- Some of the ICT tools can be expensive.
- The use of technology in the classroom can be distracting for students.

- Unreliable information is everywhere, that is, not everything published on the internet is always correct.

4. Attitudes of students and teachers about the use of ICT tools in teaching mathematics

Teachers are key in embracing the new digital environment in schoolsand universities. It is therefore of great importance to have trained teachers who are able to use ICT in education in a way that will lead to changes from old to new learning paradigms.

Teachers' use of ICT in the classroom depends on a number of factors: availability and access to funds, school support, training in the use of ICT and teachers' personal attitudes towards teaching and learning. If applied effectively, ICT tools can play a significant role in supporting teachingduring the teaching process. Recommendations for the use of ICT by teachers at different levels of education are similar to those of students. In general, students report that they are significantly encouraged to use ICT in the classroom as well as for additional activities at home. Some teachers agree that using computers in teaching is good, but we should not overemphasize their value. They also agree that if schools are not using ICT tools, they are not preparing young people for future where technology dominatesand is represented everywhere. Most of teachers believe that the best way to use ICT tools is to combine them with traditional teaching. The teachers' experience showed that if ICT tools are not used, teaching is not seen as oriented teachingforfuture. Students have generally positive attitudes towards technology and are interested in much introduction of technology in the educational process.They are also interest in use much more technology at home.

5. Conclusion

The conclusion is more than clear. This research gives us a clear picture of the importance of ICT tools and the importance of combining more IT tools during the teaching mathematics.

From the above we can conclude that the use of information technologies, that is ICT tools, in the learning process can definitely be one of the most influential factors for acquiring new knowledge. Information and communication technologies facilitate the individualization of the teaching process, increase creativity in workand productivity in classes.

The application of ICT tools in teaching mathematics contributes to facilitating learning, raise the teaching process to a higher level,increasing the desire to solve mathematical tasks, motivate students to work and learn more independentlyand most importantly to love mathematics.

The impact that ICT tools has in educational institutions is so great so we can conclude that school life without ICT tools is impossible for people who have already used them.

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Optimization of Cloud Costs

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ABSTRACT

A large number of companies and organizations nowadays are making the decision to migrate their applications to the cloud. The resources needed to host their applications are provided by a cloud provider. It determines the price for the resources according to certain criteria. The users of the services pay for the costs depending on the resources they use. After the migration to the cloud, the consumers of cloud resources should try to optimize their costs. This paper presents several methods that we can use for optimization of cloud costs. In addition, it is provided a real case study of application of these methods in practice. According to the obtained results, cloud costs are reduced by about 65%.

KEYWORDS

Cloud, costs, costs optimization, cloud computing

1 Introduction

Cloud technologies are increasingly used nowadays. A large number of organizations and enterprises are planning or have already migrated their systems to the cloud. A migration of Moodle LMS of Goce Delchev University to the cloud is presented in [1]. Spotify, one of the leading media service provider in 2016 migrated everything from on-premises to the cloud [2]. In the same year, Netflix, one of the most famous streaming services, announced its cloud migration [3]. Capital One, a top ten bank in the U.S financial services industry, in 2020 reported their full migration from the on-premises data centers to the cloud including all applications and data [4]. There are a lot of other case studies for transition from own data centers to the cloud [5] [6].

Cloud technologies have a lot of advantages. Some of them are: scalability, flexibility, cost savings, work from anywhere, automatic updates, security, disaster recovery and so on [1] [7]. One of the listed benefits is cost savings. This is one of the first questions that all those who want to make a cloud migration ask themselves. Although this is certainly important, it is not the subject of this research. The purpose of this research is how to reduce the costs

after the migration to the cloud. This is very important for organizations and corporations in order to save as much money as possible. To achieve this, they must optimize the resources they use.

There are several studies that address this topic, but not all of them cover all the methods that can be used for optimization of cloud costs. Weintraub and Cohen in [8] present a model that is used for finding optimal combination of service providers to minimize the cloud costs. They propose three strategies for implementation of the model in organizations. Chaisiri et al. in [9] proposed an optimal cloud resource provisioning algorithm for allocation of resources that are offered by multiple cloud providers. Qi et al. in [10] present a novel cloud service cost optimization method considering multiple impact factors. Netjinda et al. in [11] proposed a new framework for cost optimization where the number of purchased instances, instance type, purchasing options and task scheduling are considered in the optimization process. Osypanka&Nawrocki in [12] present a novel approach for cloud costs optimization using machine learning. They also provided an experimental evaluation of their solution. Couthino et al. in [13] proposed a solution for optimization of cloud resource management in order to reduce payment costs and the execution time of user applications. Kokkinos et al. in [14] present an algorithm for cost and utilization optimization of Amazon EC2 instances. Deniziak et al. in [15] proposed a methodology for cost optimization of cloud real-time applications, which are conformable to the Infrastructure as a Service (IaaS) cloud computing model.

In our paper we present a comprehensive approach for cloud costs optimization. Several methods for effective cloud costs management are discussed. The rest of the paper is structured as follows. Section 2 presents the purpose of our study. Section 3 describes the research methods for costs optimization. The findings and the results of the application of cloud costs optimization methods are shown in Section 4. The last Section 5 is for conclusion and recommendations.

2 Purpose of Study

The main purpose of this paper is to show methods for reducing the costs for resources that we use in the cloud. This research is about costs optimization of resources that implement the IaaS model of cloud computing. This model includes the IT infrastructure that is needed for our applications to work properly such as: compute, storage and networking resources. All these resources are provided, hosted and maintained by the cloud provider in its own data centers. Cloud providers specify theprice for the resources. It may vary depending on the providers and the calculation method. What is important for us as users is to provide resources that will be sufficient to run our applications and have lower costs.

3 Research Methods

After making the decision to migrate applications to the cloud, it is in our interest to monitor the costs that we have for the allocated resources. What if the costs are high? How should we react in this case so that we can fit into our budget? For this purpose, there are several methods that can be used to optimize the cloud costs [19]:

- Identification of unused or idle resources

We must identify the resources we no longer use and no longer need [16] [17]. There is no reason to have costs for them. It is also desirable to discover the resources that are used very little and to use fewer instances to consolidate their computing jobs [18].

- Right-sizing of resources

With right-sizing we can modify the resources in the most efficient way [20]. One example of this is the optimization of servers for memory, storage capacity, computing, throughput, database, etc. This will provide resources with optimal performance in relation to the applications that use them.

- Using appropriate reserved instances and savings plans

Reserved instances are instances for which we pay in advance and reserve for a specific period of time, usually one or three years. Using this method, we can save up to 75% of our costs, which is really useful for every organization [19][21].

- Using Spot instances

Spot instancesare unused VM instances which can be used for a lower cost than the normal on-demand price. They are useful for error-tolerant or flexible applications such as analysis of data, background processing, batch jobs and jobs that get done quickly [22] [23].

- Reduction of data transfer costs

Some services include costs for moving data in different regions, availability zones or between different cloud services. That is why we need to reduce or avoid unnecessary data transfers [24].

- Using cloud native design.

Cloud native applications are deployed andhosted in the cloud [25]. They have all the benefits of the cloud such as: resiliency, flexibility, scaling, etc. The cloud native design offers the following features: microservices, containers, APIs, immutable infrastructure and so on. One example is a system with auto-scaling option. We only pay for the servers that we use according to specified rules and with this we provide costs optimization.

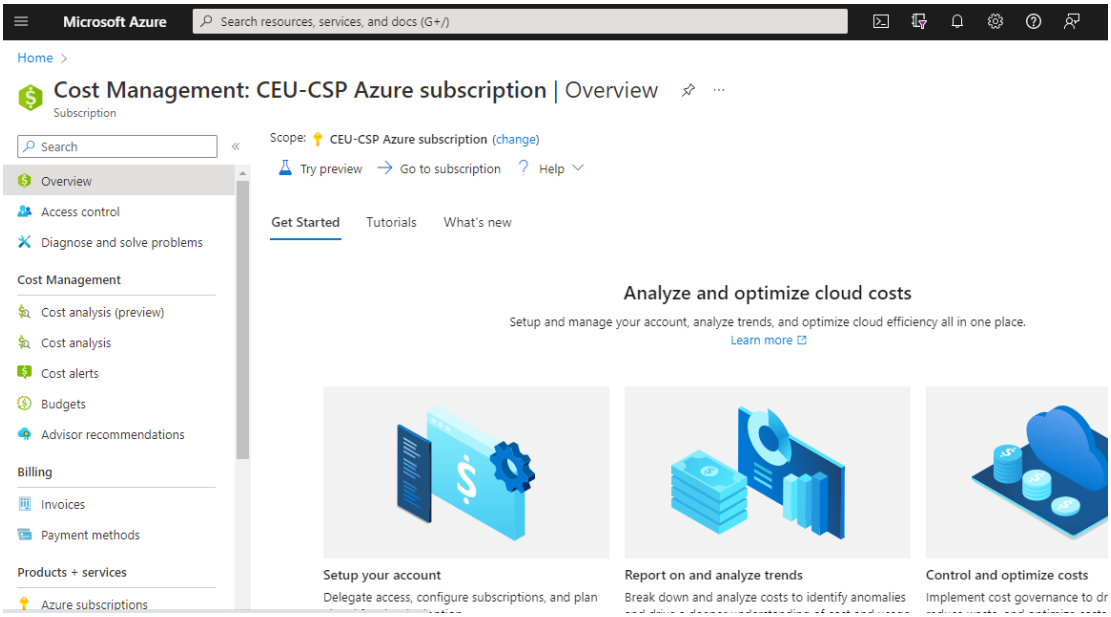

Figure 1. Cost Management tool from Azure platform

Cloud providers offer special tools for monitoring and controlling cloud costs. One such tool is the „Cost Management" in Azure (Figure 1). With the „Cost analysis" option which is part of Cost Management, a variety of analyzes can be provided, such as: accumulated costs by month, service name, region location, resource group name, etc. Using this option, we can also see the actual costs, forecasted costs and the budget if it is provided.

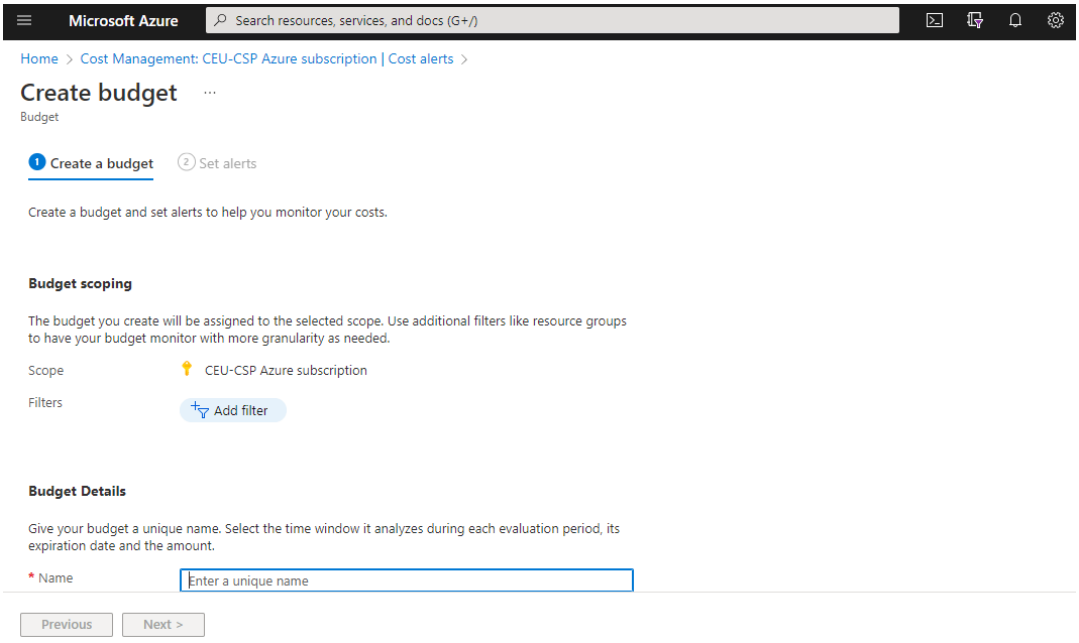

Figure 2. Cost alerts in Azure

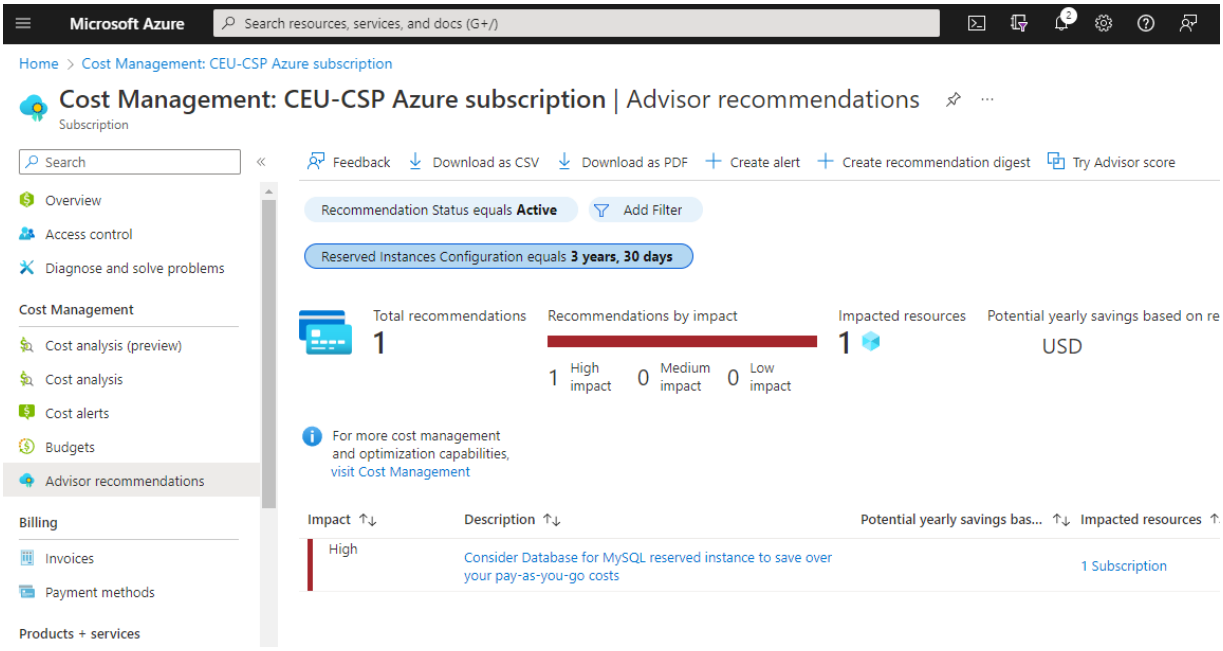

Figure 3. Advisor recommendation in Azure

What is interesting in Azure is that it has the ability to create alerts in case the costs are greater than a predefined budget (Figure 2). Another option that is part of the Cost Management tool is „Advisor recommendations", which gives us advice for optimization and control of the costs (Figure 3).

4 Findings and Results

In 2021, at University Goce Delchev - Shtip, we made a migration of some of our applications from on-premises to the cloud. As a cloud provider we used the Microsoft Azure platform. The cloud configuration for all applications can be seen in Table 1. First, the migration was done for 4 applications (Application 1-3 and Application 5). After 3 months the migration was done also for Application 4.

Table 1. Cloud configuration for all migrated application

Application	Operating System	Instance type	Database	Data Disk:	OS Disk
Application 1	Linux (Ubuntu 18.04)	Standard DS2 v2 (2 vCPUs, 7 GB RAM)	Azure for MySQL (v.5.7) Single Server General Purpose, 2 vCore(s), 100 GB Storage	128 GB Premium SSD LRS	30GB Standard SSD LRS
Application 2	Linux (Ubuntu 18.04)	Standard B2s (2 vCPUs, 4 GB RAM)	Local MySQL database	256 GB Standard HDD LRS	74GB Standard SSD LRS
Application 3	Linux (Ubuntu 18.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	/	128GB Standard SSD LRS

Application 4	Linux (Ubuntu 20.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	32 GB Standard HDD	30GB Standard SSD LRS
Application 5	Linux (Ubuntu 20.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	/	40GB Standard HDD LRS

During our cloud experience, we tracked the costs we incurred for the resources over a 1-year period (October 2021 – October 2022). For this purpose, we used the Cost Management tool from Azure portal (Figure 1).

In the first three months, the costs were slightly higher than expected. That is the reason why we decided to apply methods for optimization of cloud costs:

- *Identification of unused or idle resources* – Before the migration of our applications to the cloud, we created multiple test instances. We used these resources to test the behavior of our applications before they were released into production. To reduce the costs, we deleted these test instances.
- *Right-sizing of resources* – For applications that are not used frequently, we performed appropriate adjustments to the performance of the instances. We changed the type of the instances with lower performance in order to optimize the costs.
- *Using appropriate reserved instances and savings plans* – According to our research, after the third month of the migration, we decided to perform a 1-year reservation for our instances.
- *Using Spot instances* –We have not used spot instances yet, but in the future we plan to use them as test instances in order to reduce our costs if we create new instances that are not reserved.
- *Reduction of data transfer costs* – Data transfer primarily depends on the application that we used. We did not identify any unnecessary data transfers and that is the reason why we did not apply this method to reduce cloud costs.
- *Using cloud native design* – For one of our most demanding applications, we initially used Virtual Machine Scale Set (VMSS) and load balancer for auto scaling. Regarding the given scaling rules, we determined that we did not have inclusion of additional instances. This is the reason why we continued to use regular virtual machine. If you have a large number of users and requests, it is recommended to use auto scaling instances with appropriate rules.

With application of these methods for costs optimization, we observed a reduction in costs. Average costs in the period after costs optimization from January to March 2022 have been reduced by about 65% compared to the period from October to December of the previous year when the optimization methods were not applied. The average costs for the next three months, April-June, are also reduced by about 65% compared to the reviewed months of the previous year. The costs for July are similar to the other monthly costs after the optimization.In the period from August to October, three new applications were added in

Azure (Table 2). This is the reason why the costs have increased. The average costs in the period from August to October have increased by about 76%compared to the average costs of the previous three months. In the next period, we will make a reservation for the newly added instances to reduce the cloud costs.

Table 2. Cloud configuration for the three newly added applications in the cloud

Application	Operating System	Instance type	Database	Data Disk:	OS Disk
Application 6	Linux (Ubuntu 20.04)	Standard DS2 v2 (2 vCPUs, 7 GB RAM)	Local MySQL database	/	128GB Standard SSD LRS
Application 7	Linux (Ubuntu 20.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	/	30GB Standard SSD LRS
Application 8	Linux (Ubuntu 20.04)	Standard B2s (2 vCPUs, 4 GB RAM)	Local MySQL database	/	30GB Standard SSD LRS

5 Conclusion and Recommendations

Optimization of cloud costs is very important for users and organizations who have migrated their applications to the cloud. The savings that will be provided can be used for allocation of new resources or other investments. In this paper we present several methods that can be used for cloud costs optimization. We will focus our future research on finding new costs optimization methods.

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Trajectory-following Algorithm for Arduino Mobile Robot

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Abstract. In this paper - we present our research and experimentation with the Arduino mobile robot. We have developed a control algorithm for robot movement along a given trajectory.The basic methods of operation ofthe Arduino platform, its restrictions, and its main functionalities are explained in the paper. In our work – we have applied the available Arduino software tools and functions.We have developed custom software code for robot movement control, by utilizing the existing software for the motor board of the Arduino robot. We have investigated different algorithms for line (trajectory) following – P, PI, PID. The PID algorithm (proportional-integral-differential) hasproved to be the most efficient algorithm that allows the robot to smoothly follow the line at high speeds without any short-term departures from it. The paper shows how to implement the algorithm, and at the same time how to quickly and finely adjust the parameters of the PID algorithm. We emphasized the importance of having a stable platform for algorithm implementation(line tracking), and for a proper response of the microcontroller's board components.

Keywords: Arduino mobile robot, Microcontrollers, PID algorithm, Trajectory following.

1. INTRODUCTION

The Arduino robot is the official robot of the Arduino company. It is an adjustable and extendable hardware platform suitable for educational and experimental purposes. It is equipped with different sets of sensors, allowing it to move independently, avoid obstacles, follow a given trajectory, etc. As such – it can be used as an experimental robot for military, medical, and other application scenarios.

In this paper, we present our research and experimental work with the Arduino robot platform, as our goal was to create an algorithmthat will enable the robot to move alonga given line (trajectory). Basic methods of operation of the Arduino platform, its restrictions, and its main functionalities are explained in the paper. We have developed custom software codefor robot movement control, by utilizing the existing software (Arduino IDE)for the motor board of the Arduino robot. We have investigated different algorithms for line (trajectory) following – P, PI, and PID. The PID algorithm (proportional-integral-differential) has proved to be the most efficient algorithm that allows the robot to smoothly follow the line.For that purpose, we have utilized its sensors and interfaces, as well as its software IDE. There is also related work in this area - Balaji et al. [1] created and tested a prototype line-tracking robot, which uses an array of ten infrared reflective sensors to track a non-reflective line on a reflective surface. They described various challenges that are specific to the mobile robot line tracking system, and the adaptation of PID control to successfully control the highly non-linear and unstable system. Vijendra et al. [2] applied an array of multiple sensors that detect the black surface so the robot moves along a line. The Arduino robot continuously monitors the signal from the sensors and turns the direction as the line goes. We developed our own PID controller and implemented its software in Arduino IDE, so the robot was able to move along a given trajectory.

The paper is organized as follows: in section 2 we present the robot hardware components, section 3 describes the software programming toolkit (Arduino IDE) – its main functions and commands, and the last section 4 presents the PID control algorithm that enables the robot to follow a pre-defined trajectory (arbitrary line). Finally – conclusions are given and directions for future work.

2. ARDUINO ROBOT COMPONENTS

The Arduino platform is open source, both in its software and hardware specifications, so hobbyists can

assemble simple Arduino modules by themselves. More sophisticated pre-assembled Arduino modules can be purchased and modified as needed ([4], [10]). The hardware comes in many format specifications, from small handheld devices to larger surface-mounted modules. The primary computer connection method is via USB, although Bluetooth, serial, and ethernet form factors also exist.

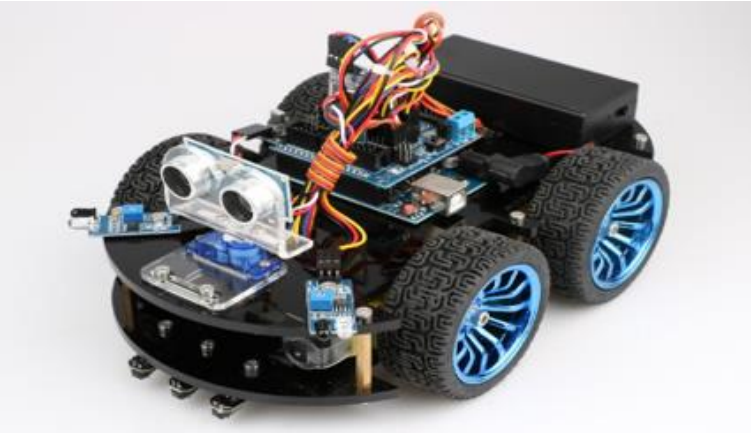


Fig. 1. Arduino Mobile Robot

The Arduino robot consists of two integrated boards. The lower board is called the motor board and its task is to control the operation of the motors that drive the robot. The upper board is used for reading sensors' data and for robot control. Both boards are microcontroller-based using the ATmega32u4 microcontroller.The Arduino board is presented in fig. 2, together with its main components. The components include USB connection, power port, microcontroller, analog input pins, digital pins, crystal oscillator, USB interface chip, TX/RX LED.

The USB port is used to load a specific program from the Arduino IDE to the Arduino board. The board can also be communicated through this port. The Arduino board is powered through an AC-to-DC adapter or a battery. The power source can be connected by inserting a 2.1 mm center-positive plug into the on-board power socket. The main controller features a prominent black rectangular chip with 28 pins. It can be thought of as the brain for Arduino. It interprets both the inputs/outputs and the programming code uploaded to the Arduino. Other onboard components allow communication with this microprocessor during the creation of various projects. The microcontroller used on the UNO board is the Atmega328P from Atmel (a major microcontroller manufacturer).

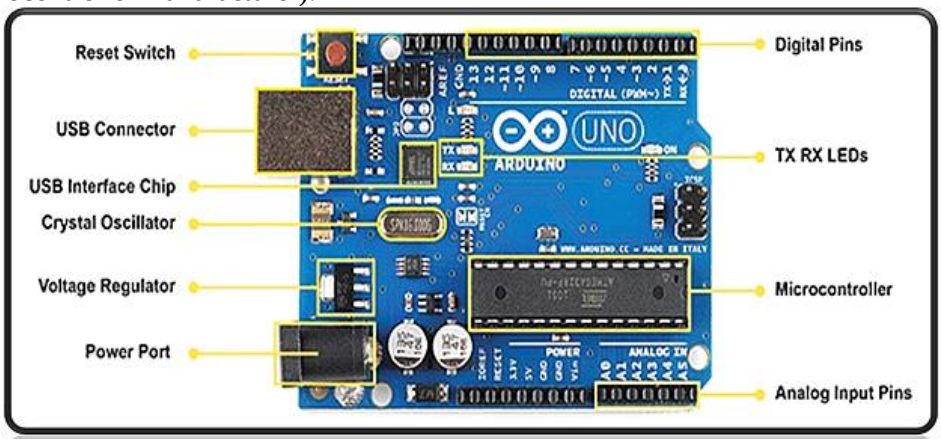
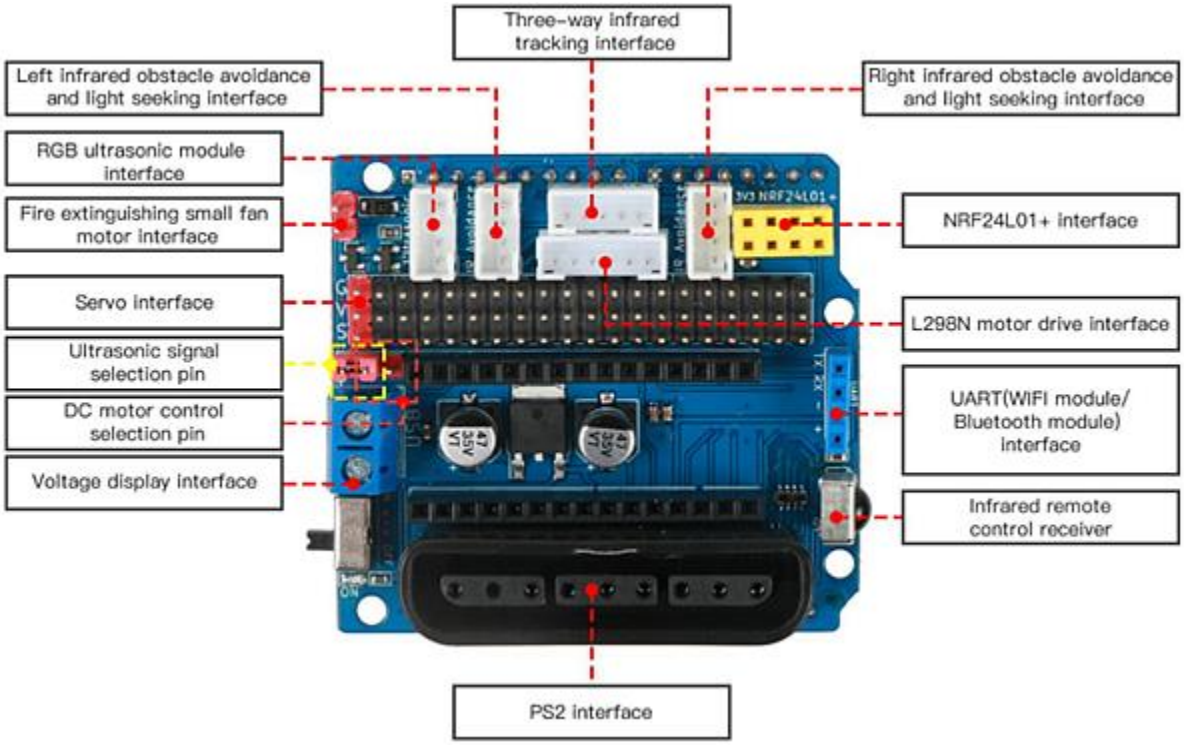


Fig. 2 Arduino main board and components

To move around and detect the environment – the robot is equipped with different sensors (fig. 3). The infrared obstacle avoidance and light search sensorhave a pair of infrared emitting and receiving diodes,

and the transmitting diode emits infrared rays of a certain frequency. When the detection direction encounters an obstacle (reflective surface), the infrared light is reflected back and picked up by the receiving sensor and passed through the comparator. After processing the circuit, the green indicator light will be on, and the signal output interface will output a digital signal (a low-level signal). The effective detection range is 2~30cm, and the working voltage is 3.3V-5V. The detection distance of the sensor can be adjusted by the potentiometer. Due to the use of infrared rays, the anti-interference ability is very strong, and the measurement accuracy is high when the distance is moderate. In addition, the module is easy to assemble and easy to use and can be widely used in many situations, such as robot obstacle avoidance, trolley obstacle



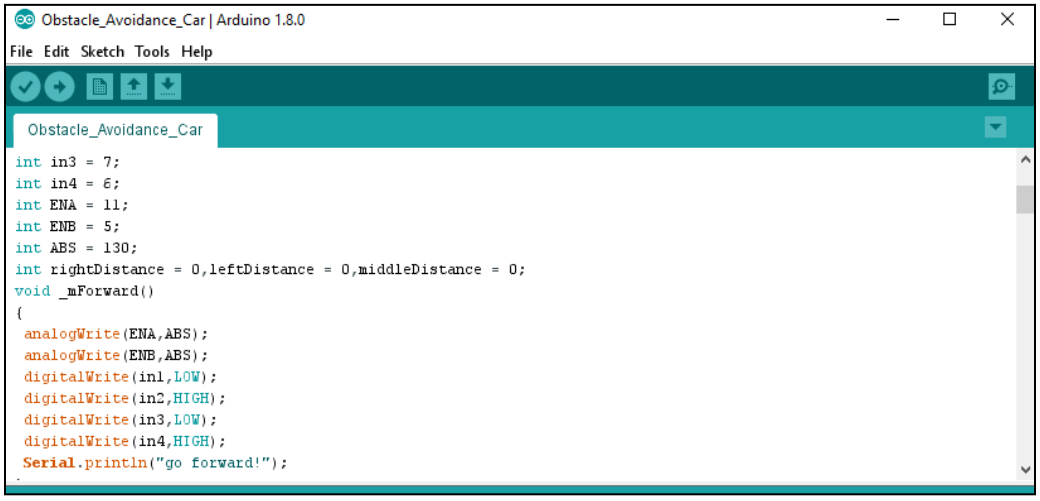
avoidance, pipeline counting, and black-and-white line tracking.

Fig. 3. Arduino board sensors.

3. MOBILE ROBOT SOFTWARE PROGRAMMING

In addition to the standard C programming language functions that can be used, there are also useful functions in the core Arduino libraries that are often used for robot movement and control ([5], [7], [9]). Here we will presentthesespecific functions that are related to the robot motion control.

Within the Arduino robot's library, the main function for moving the robot is the function Robot.motorsWrite(speedLeft, speedRight). The first argument indicates the desired speed of the left engine, while the second indicates the desired speed of the right engine.These values can range from -255 to 255. If a negative value is passed, the motor will run backward, and if a positive value is passed, the motor will run forwards. The robot is stopped by calling the function Robot.motorsStop() which stops both motors.

Fig. 

4.

Arduino Robot Software toolkit

Robot.turn(degrees) and Robot.pointTo(degrees) functions from the Arduino library are also useful functions for moving the robot. Robot.turn(degrees) rotates the robot by a certain number of degrees relative to the current position.If a negative value is passed, the robot will rotate counterclockwise, and if a positive value is passed, it will rotate clockwise. Robot.pointTo(degrees) is a function whose role is to rotate the robot to a certain direction using the built-in compass. As an argument, the direction is entered in degrees -with values ranging from 0 to 359.The difference between these functions is that Robot.pointTo(degrees) rotates to an absolute direction, while Robot.turn(degrees) rotates relative to the current direction.

The state of the motor board in the Arduino robot is called the motor's operation mode. The motor board of the Arduino robot has several predefined operating modes, but it is also possible to define a new one. The operating mode of the motor board can be changed by calling the setMode(mode) function on the control board, with the operating mode identifier as the argument of this function. An identifier is an integer data type.

In order to define a new operating mode, we have to do the following:

1. We declare and assign a unique integer value (identifier) in the files ArduinoRobotMotorBoard.h and ArduinoRobot.h (e.g. #define NAME1 number). Both of these files can be found in the Arduino Integrated Development Environment. In addition to these files, there are other files in the same folder that are the basis of the Arduino robot's operation.
2. In the process() function, which can be found in the file ArduinoRobotMotorBoard.cpp, we should define the code that will be executed in the operating mode.
3. The last thing is to select a new operating mode on the motor board. This is achieved by calling the setMode() function in the Control panelcode, which receives the identifier of the new operating mode as an argument.

In addition to the operating mode, new commands should be defined for the motor board. Commands can be divided into two groups:

- Direct commands (or one-way commands), which represent the commands that the control panel passes to the motor, which then executes them. The motor board does not send any data to the control board. An example of this type of command is motorsWrite(). If we look at this function's code, we see that the control panel first passes the command type, and then the command arguments - the speed of the leftand the right engine. Based on the command type, the motor board knows to expect the speed of the left and right motors - and forwards those values to the right "addresses".

- Interrogative commands (or two-way commands) are commands that the control board sends to the motor board with the intention that the board will respond to them. An example of such a command is the already mentioned updateIR() command. The control panel initiates communication by sending a command to update the sensor value. The motor board reads the command and sensor values, then forwards the requested data to the control board, and the robot executes the command.

4. PID ALGORITHM FOR TRAJECTORY FOLLOWING

In the case of basic control systems, their operation can depend linearly on the error, its integral, or the first derivative of the error in time. Based on this fact, the regulators can be divided into: proportional (P), integral (I), and differential (D) regulators. With the help of these basic regulators, it is possible to form more complex regulators, such as combined PI, or PID controllers. Regardless of the type of regulator and the method of its implementation, the basic requirements for system regulation are stability, accuracy, and speed of response.

The PID controller has three adjustable parameters: gain Kp, integral time constant Ki, and differentiation constant Kd. The presence of proportional, integral, and differential action in this regulator enables obtaining the desired performance such as stability, speed of response, the accuracy of work, and duration of the transition process. In fig. 5we can see the block diagram of the PID regulator, and equation (1) describes the control signal of the PID regulator.

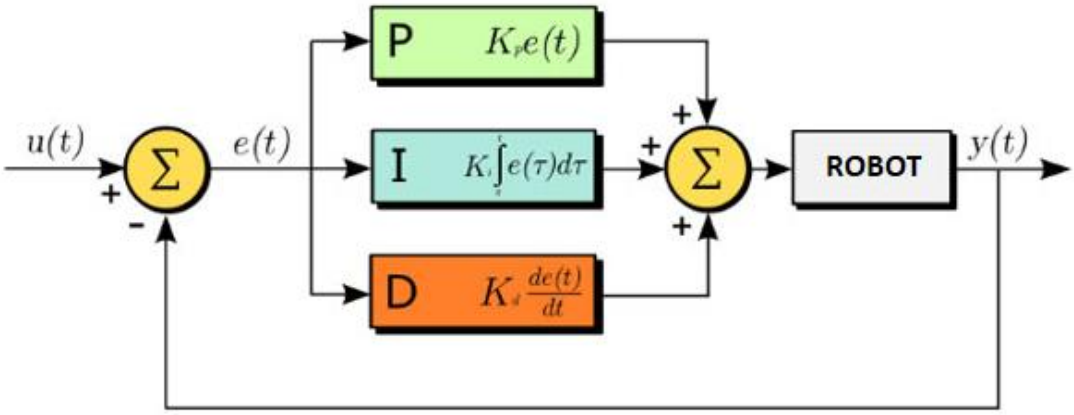


Fig. 5. Diagram of the PID controller

$$u(t) = K_p + K_i \int_0^t e(t)dt + K_d \frac{de(t)}{dt} = K_p(e(t) + \frac{1}{T_i} \int_0^t e(t)dt + T_d \frac{de(t)}{dt}) \quad (1)$$

/ u(t) – control input, e(t) – error signal, Kp, Ki, Kd – PID regulator parameters /

For the line-tracking problem - we have investigated two different algorithms for line (trajectory) following –PI and PID. The PID best performance has shown the best results. For smooth control of the robot, the values for all three parameters Kp, Ki and Kd must be carefully selected. There are several techniques for adjusting the parameters, and the famous one is “Ziegler-Nichols method” (see [1], [2]).

1. The initial values of Ki and Kd are Ki = Kd = 0. In this way, the integral and differential part of the algorithm is turned off.

2. The desired engine speed is set to the lowest possible value.

3. The quotient of the maximum engine speed and the maximum error is taken as the initial value of Kp.

4. Start the robot and observe its movement. If the robot cannot follow the line, the Kp value should be increased. If it oscillates a lot, the value of the Kp parameter should decrease. In this way, the right value for Kp is sought, until the robot starts to follow the line with a slight oscillation. Such a Kp value is

denoted as Kc.

5. It is necessary to calculate dT and Pc. dT is the value between the two measurements and should not be a problem to calculate. Pc is a value that indicates how long one oscillation period of the robot lasts, from the moment the robot goes to one side, returns to the other and repositions itself on the line.

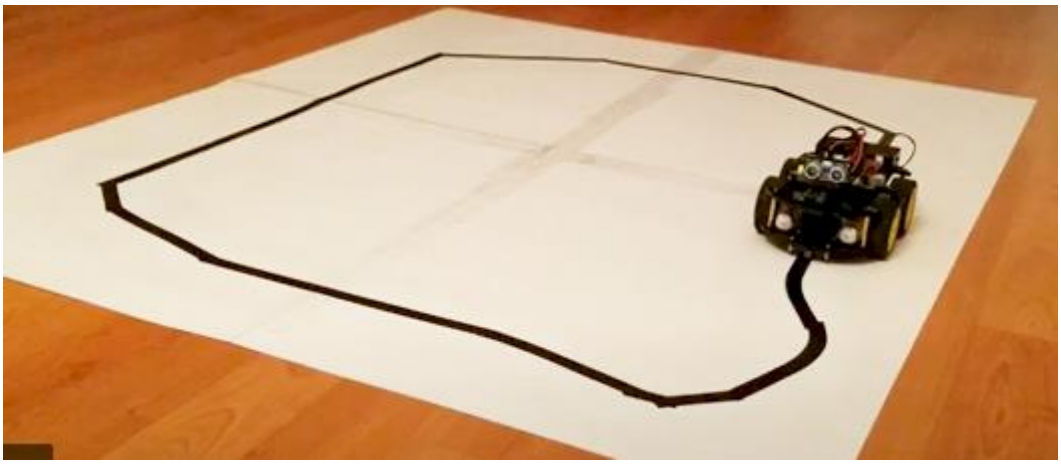


Fig. 6. Arduino robot in action – following a defined trajectory.

For the Arduino robot implementation – a new function `void PIDFollow::followLine()` is defined.In it - the sensor values are read and then mapped so that they are in the range from 0 to 100. Then the error is calculated as the difference between the normalized values of the sensors on both sides(left and right).After each calculation of the error, the total error is calculated, and the previous accumulated error is reduced by multiplying by a factor <1, but >0. After each error calculation, the values of the previous error are remembered due to the need to calculate the differential parts of the formula. The rotation value is calculated according to the PID algorithm (1) and then used in the function to start the robot motor. The value of the parameter Kc is obtained as a quotient of the maximum value of the motor speed (255) and the maximum value of the error (200). Based on the above steps, the parameters Kp, Ki, Kdwill be calculated. By repeating the experiment (moving robot)we can adjust the parameter values (according to the line trajectory), or if their values need to be slightly modified.

5. CONCLUSION

In this paper, we presented our research and experimental work with the Arduino robot platform, as our goal was to create an algorithm that will enable the robot to move along a given line (trajectory). Basic methods of operation of the Arduino platform, its restrictions, and main functionalities were explained in the paper. We have developed custom software codefor robot movement control, by utilizing the existing software (Arduino IDE) for the motor board of the Arduino robot. We have investigated different algorithms for line (trajectory) following – P, PI, PID.

The PID algorithm has proved to be the most efficient algorithm that allows the robot to smoothly follow the line at high speeds without any short-term departures from it. The paper shows how to implement the algorithm, and at the same time how to quickly and finely adjust the parameters of the PID algorithm. We emphasized the importance of having a stable platform for algorithm implementation (line tracking), and for a proper response of the microcontroller's board components.

The aforementioned implementation of the line tracking algorithm provides a framework for further development of the Arduino robot platform and its potential use. There are many parts of the platform that are not covered by this work, such as the compass, sound, screen, and the like, which can be used for future projects. The platform also has the ability to connect with other sensors, which can further be used for the development of various projects and products.

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An Automated Ranking Model of Higher Education Institutions and Academic Staff in the Republic of North Macedonia

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***Abstract*—** The use of Open Data and Machine Learning in the time of contemporary education, especially in higher education, is a problem that has started to be addressed a lot recently, where more work is especially required in this direction. Having an efficient automated model for integrating accumulation, interpretation, and exploitation of open data in university education can be useful to improve the universities in order to better rank and review the research papers, which is very useful in open data in education in general but especially in higher education. The main purpose of this research is to rank the publications of university professors in an open data platform and to provide recommendations in the form of reports generated for third parties of interest. The idea is to make an automated model for integrating accumulation, interpretation, and exploitation of open data in university education in order to rank the published scientific works by applying Data Mining techniques. In order to achieve the required, it is necessary to conduct research that will define the weaknesses and strengths of using Open Data Research Ranking Platform, at the University, as well as the need to apply our proposed model called Research Ranking Platform.

Keywords

Open data, Open Education, Big Data, Machine Learning, Data Mining, and Higher Education

1. INTRODUCTION

Nowadays, the use of technologies and data are already part of our daily lives and professional activities. [1] Technology plays a very important role in almost all areas, so it is vital to be equipped with data capabilities, which enriches us with the ability to understand data and the right way digital technology works.

Currently there is a very large amount of data in the field of education. [2] But these data, if not converted into useful information, remain as unnecessary data. It is imperative that these data be converted and extracted from the information they can use. It is not necessary to do only extract of these data, but we need also to do data cleaning, data integration, data transformation, data mining, and data presentation.

A new trend [3] has already emerged open data which can play key roles in bringing digital innovation to education by engaging students, professors and researchers in data collection activities and allowing them to understand the concept of data through analysis and interpretation in relation to the real world.

The research field of this thesis falls in:

- *Open Data*
- *Educational Data Mining (EDM)*

- *Digitalization*
- *Machine Learning (ML)*

Starting from the basic reasons and the factual situation with the open data in the Republic of Northern Macedonia, the idea of orienting this research was born in this field where the contribution so far is very deficient to say nothing. As a result of all these situations and following the new world trends, the focus of this doctoral research will be exactly the field of open data, where we will try to make a contribution in terms of open data in our country. [4] The fourth industrial revolution led by Artificial Intelligence requires an innovative approach into the evaluation process of higher education, where Open Data if the new beacon for transparency, quality and democratization. [5]

2. PURPOSE OF THE STUDY

The purpose of research in this doctoral thesis is the application of open data in order to improve the universities in order to better rank and review the research papers. The idea is to make an automated model for integrating accumulation, interpretation, and exploitation of open data in university education in order to rank the published scientific works by applying Data Mining and Machine Learning techniques. [6] In order to achieve the required, it is necessary to conduct research that will define the weaknesses and strengths of using Open Data Research Ranking Platform, at the University, as well as the need to apply Research Ranking Platform.

The aim of research in this doctoral thesis is the application of open data in order to improve the universities in order to better rank and review the research papers.

The general goal of any research is to gain a certain scientific knowledge about the subject of the research, which in addition to the scientific one will have a social value and justification. In this context, we should talk about the scientific, i.e., theoretical goal and practical goal of the research. The theoretical goal is to make a scientific description of the subject of research, i.e., the specific case of the need to apply Open Data, Research Rating Platform, in the direction of modernization and digitalization of the Universities, by developing a system that will collect data on professors in terms of their scientific achievements. [7]

The methodological goal of the research in this paper is to check the applicability of several instruments, including literature review, a survey questionnaire to determine the impact of Open Data, in the Universities and creating an algorithm that will collect data from online platforms or websites of the University, training and staffing in achieving the desired goal.

The practical goal of the research, which is in fact the basic goal, is based on the existing theoretical knowledge and the current conditions and needs to define the complexity and scope of the problem to reach practical knowledge of the vision. [8] In that sense, the ultimate goal of the research would be to answer the question of how much each of these relevant assumptions affects the openness of universities in specifying their scientific publications and achievements.

In order to achieve the required, it is necessary to conduct research that will define the weaknesses and strengths of using Open Data Research Rating Platform, at the University, as well as the need to apply Research Rating Platform. [9]

This research would cover the following tasks:

- How Universities are able to adapt to the recommendations that our model exposes?
- How far university professors are familiar with data collection concepts?
- Does it is important for universities and researchers to share their research in an Open Data format?
- Do Universities and researchers see data sharing as a top priority?
- What are the future opportunities for Open Data in Universities in an educational context, and what are the potential challenges to realizing these opportunities?
- What skills and capabilities do Universities need to create value from Research Rating Platform on 'Open data'?

3. RESEARCH METHODOLOGY

Starting from the basic function of this research, which consists in finding a concrete answer to the question what the key assumptions are and what the function of Open Data in modernizing is and digitalization the Universities, it is clear that this is an application of action research. [10] The results of this research will be used to take appropriate measures and activities that will lead to faster achievement of performance improvement at universities, and beyond in other organizations that would benefit from the implementation of this platform.

The research will follow the qualitative research paradigm which is an in-depth penetration into the nature of the problem of the phenomenon under investigation, to a limited number of respondents (universities) with quantification of some of the obtained results whose frequency is significant. [11] The research will be reduced to the interpretation of the findings and offering a solution.

Surveys, interviews, content analysis will be used as data collection techniques. As instruments survey questionnaires that will be filled out by all participants in the research. [12]

The survey questionnaire for determining the effects of the platform on the Universities, consists of data about the respondent and 10 questions related to the functionality of the algorithm.

A) The type of institution

B) Benefits of the platform / algorithm

C) Potential opportunities that will be of benefit to the Universities

Data processing. The data processing will be realized by applying the SPSS program

package through the following phases:

1. *phase: data collection and grouping*
2. *stage: logical check*
3. *stage: data entry into a computer*
4. *stage: verification of the entered data*
5. *stage: processing and tabulation*
6. *phases: graphic design and presentation*

4. PROPOSED MODEL

The main purpose of this research is to rank the publications of university professors on an open data platform. As we can see in the literature review [13], the implementation of Open Data in education, especially in the higher education cycle is a problem that has started to be addressed and more work is also required in this regard. Our main H0 hypothesis is "*The research evaluation platform will improve the performance of research in universities"*, and to prove this, then an automated model should be created which will compile the ranking of publications by university professors. [14]

In order to arrive at such a pattern, we will follow the steps below:

1. *Research crawling*
    a. *Academic staff profile*
        i. *Title of publication.*
        ii. *Field of publication.*
        iii. *Journal of publication.*
        iv. *Impact factor.*
        v. *Year of publication.*
2. *Profile Clustering*
3. *Ranking*
4. *Recommendation.*

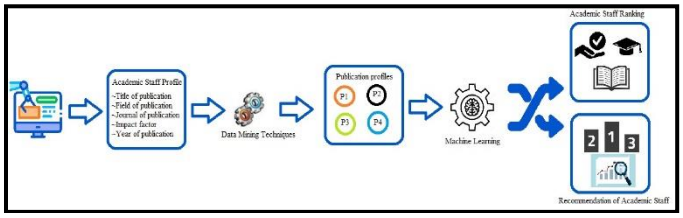

Figure 1: Sketch of our proposed automated model for ranking the publications

In the following we will describe each point in order to provide more detailed information on the methodology for how to implement such a model.

4.1 Research crawling

In order to do a profile for a university researcher (professor), we will use the official data provided by the universities. The data that will be used are the CVs of the academic staff

that also have their publications. Since all universities by the decision of the government are obliged to make public the CVs of the academic staff, [15] then these data will be used to achieve the implementation of such a model. It is not important in what format we get the data, as different techniques will be applied on these data where their normalization will take place.

The next step is to get crawled on some university Web sites. The reason why Web Crawling will be applied is to extract information or CVs that are published from university websites for academic staff. These data will be extracted in certain keywords, where their clustering will also be based on them. These data contain the description of the professor's biography, publications, and field of publication. Based on this information, the grouping of publications by professors offered by universities will be done. These later clustering's will be used to create rankings within the university but also the ranking of the university itself in terms of scientific publications.

4. 2 Profile Clustering

In order to achieve a successful implementation of such a model, it is necessary to initially cluster the scientific publications and group them in the field of publication. [16] Initially with regard to the publications, using the case described in the directions will be clustered into several groups, such as programming, computer networks, databases, etc. Also, on the other hand where the fields of publication will be clustered based on the title and abstract of the publication. How will this clustering become? Initially, each field has its own description, and by collecting keywords that contain the abstracts of the publications then it will be possible to cluster the positions by dividing them into several groups. These groups of publications later will be used for their ranking in their own field but also separately.

4.3 Publication ranking

A very important part of our model is the part of the recommendation that it will be able to give on ranking publications. Our model will not only collect data on professors from university websites but it must also be linked to a website that ranks journals and conferences (*Ranking of Scientific Papers for World Universities*) that we will have as a reference. [17] Our model will show how the publication of professors is evaluated, ie how many points from the rankings that we will create based on the world rankings that we will have as a reference. [18] Based on this we create a system that will be our Research Ranking Platform where it will rank each publication of an article by professors.

4.4 Recommendation

The last step of our model is the system recommendations that it will be able to give where we will generate reports from the ranking of professors and their field of publication.

The reports that will be generated by our proposed model will be accessible to third parties who have an interest in the results generated such as:

- Development of universities - to make a comparison between universities as to who has the most publications, in which area the University has published several scientific papers, comparison of publications between universities for a specific area etc.

- Universities cooperation's - offers the possibility of cooperation of universities for certain staff on a part-time basis for certain fields that will be taken from the ranking of professors' publications. [19]

- Agency for Quality in Higher Education - we provide recommendations that will see if the study program by the university to be accredited has a professor in the relevant field and the professor holding the study program is in the relevant field.

- Project application offices - helps in cooperation for applications for projects of a certain field our platform will generate a report that will rank 10-20 professors who are the best in the respective field in our favor to include them in certain projects.

- Government - who will recruit experts in certain fields for advisors or experts in a certain field for the benefit of the government.

5. CONSCLUSIONS AND RECOMMENDATIONS

Having a new and efficient automated model for integrating accumulation, interpretation, and exploitation of open data in university education can be useful to improve the universities in order to better rank and review the research papers, which is very useful in open data education. [20]

From this research I expect to obtain results that would be useful in the development of universities, i.e.: To make a comparison between universities as to who has the most publications, in which area the University has published several scientific papers, comparison of publications between universities for a specific area etc. The reports that will be generated by our proposed model will be accessible to third parties who have an interest in the results generated such as: universities, Agency for Quality in Higher Education, Ministry of Education and Science of Republic of North Macedonia, Project application offices, Government etc. [21]

This study introduces an automated model for integrating accumulation, interpretation, and exploitation of open data in university education. It aims to lay the basic foundations of the use of open data in universities, based on the factual situation of the implementation of open data in the country and referring to the literature research on the various ideas and forms of how they have implemented those in universities across different countries. [22] Also, this study aims to find and propose a suitable algorithm for the integration, accumulation, interpretation and use of open data of university education in order to use the results from third parties of interest. [23]

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Analyses of Brain Drain, Causes, Losses and Opportunities

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ABSTRACT

The research study focuses on investigation of the brain drain, concept of Causes, Losses, Opportunities. The main objective is to provide a analyses and strategy for the North Macedonia to reverse this brain drain and encourage the sustainable return and placement of skilled emigrants in developing sectors such as IT, digitalization, robotics, digital design, etc. The Western Balkan governments have to reverse this brain drain by following the example of Croatia. In December 2021, Croatia introduced a mechanism to reverse its brain drain by promising Croatian expatriates in the European Union up to 26,000 euros ($29,000) to return and start a business. A systematic review is based on background research of published research. The comparison of the two revealed that he turing reduction is more general than mapping reduction. Insights and discussion of the results are discussed and provided.

KEYWORDS

Brain Drain, Causes, Losses And Opportunities, reverse brain drain

1 Introduction

Brain drain, also known as human capital flight, refers to the migration of highly skilled and educated individuals from their home country to another country, typically in search of better job opportunities, higher salaries, and a better standard of living.One important feature of our everyday life is the increased mobility of the human population. As never before, individuals move between cities, countries, regions and continents. Migrants make ever-growing shares of the population worldwide. Migration has become one of the most important political issues and managing migration one of the most challenging policy areas, spread across several fields, ranging from economic sustainability to national security. Migration policy is one of the most important aspects of European integration as well as the process of European enlargement. People have migrated throughout history in search of basic resources and better living conditions.

According to Friedrich Ebert Stiftung Youth Studies, in 2018, one third of young people from the Western Balkans expressed a “strong” or a “very strong” desire to emigrate from their countries, ranging from 26% in Montenegro, 27% in Bosnia, 30% in Serbia, 34% in Kosovo, 35% in North Macedonia, and 43% in Albania. These figures are even higher in some other studies. According to preliminary findings in the census process, compared to twenty years ago, the country’s population decreased by at least 10% and approximately 6-700,000

Macedonians moved abroad.

As in many post-communist countries, the flow of the highly skilled has likewise been identified as one of the major obstacles for North Macedonia's socio-economic development. North Macedonian policy makers have not yet managed to design and implement relevant and evidence based policies that could mitigate the effects of the brain drain by stimulating return migration of the highly skilled and possibly attracting foreign highly skilled workers that could contribute to the development of the research industry, science and the economy in general.

"Brain drain" is often said to be a pejorative term, standing for the large-scale emigration of highly skilled and highly educated individuals who have obtained advanced education at a post-graduate level and work in the tertiary sector - scientists, engineers and researchers. They are often motivated to leave their countries by various factors of rejection called push factors; additional reasons for leaving are attractive or pull factors, such as a promising situation in a remote destination.

2 Analyses of the Migration in Macedonia

World Bank recently announced that 626,312 people emigrated from Macedonia at the end of 2013. Below are some data from World bank.

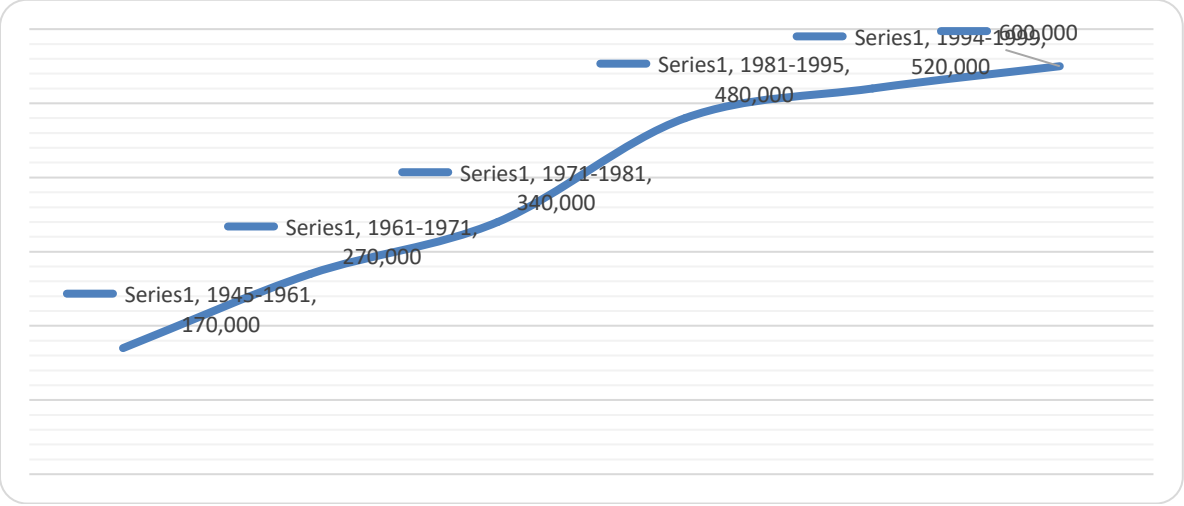

Figure 1. World bank analyses; Source: The Global Economy.com

BRAIN DRAIN INDEX OVERVIEW, 0 (LOW) - 10 (HIGH) TOP 20 COUNTRIES IN EUROPE
The average for 2021 based on 41 countries was 3.65 index points. The highest value is in Albania: 8.3 index points, and the lowest value is in Sweden: 0.7 index points.

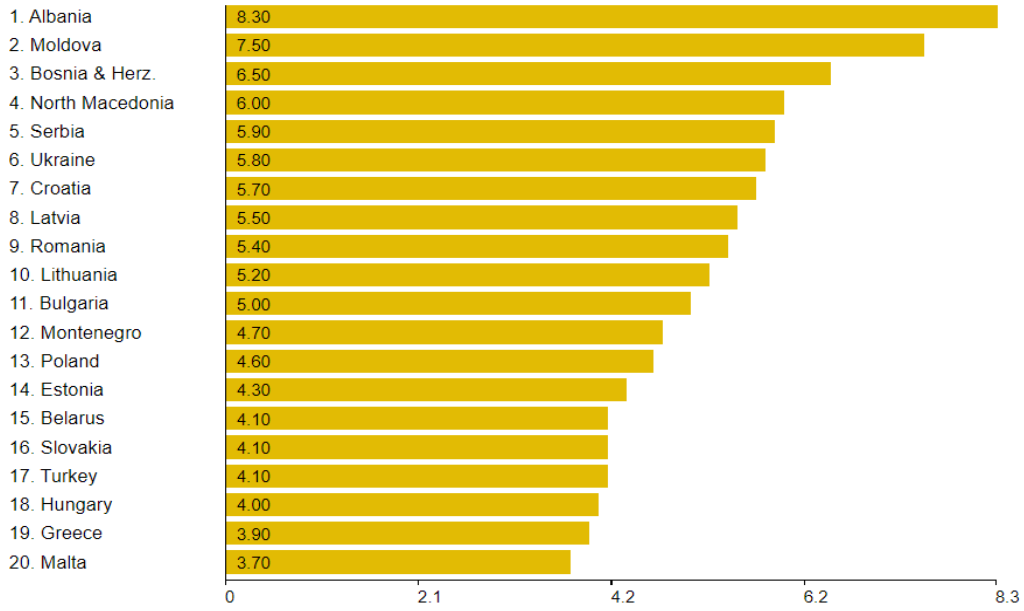

Figure 2. The average for 2021; Source: The Global Economy.com

The average value for North Macedonia was 6.01 index points with a minimum of 4.9 index points in 2018 and a maximum of 7 index points in 2007. The latest value from 2021 is 6 index points. For comparison, the secular average in 2021 based on 173 countries is 5.25 index points.

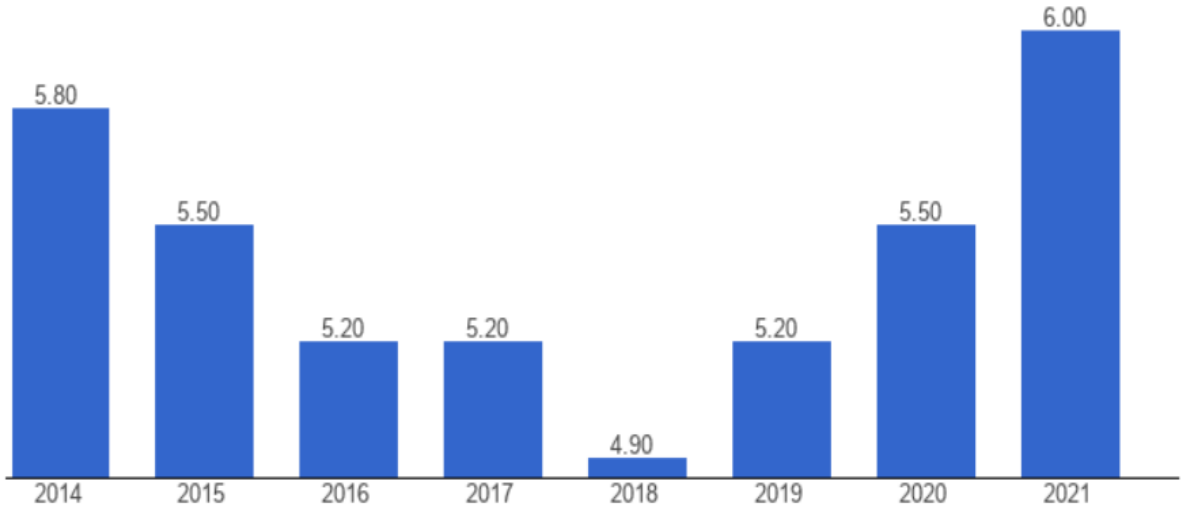

Figure 3. average value for North Macedonia, Source: The Global Economy.com

Most important reasons for "running away" from macedonia abroad are:
Unemployment, - 19.4% Unemployment, and close to 30% of youth Unemployed. They have been working for 4 years and more.
The rate of poor people from the total population is 21.8%. Almost 45,000 citizens lived on the threshold of poverty.
Unstable political situation - political crisis
Unfavorable conditions for personal development. I have the opportunity for education, training and development in

work and career.
Severna Macedonia is in 87th place with 39 index points in the fight against corruption

Analyses of the Length of Unemployment
The length of unemployment causes migration

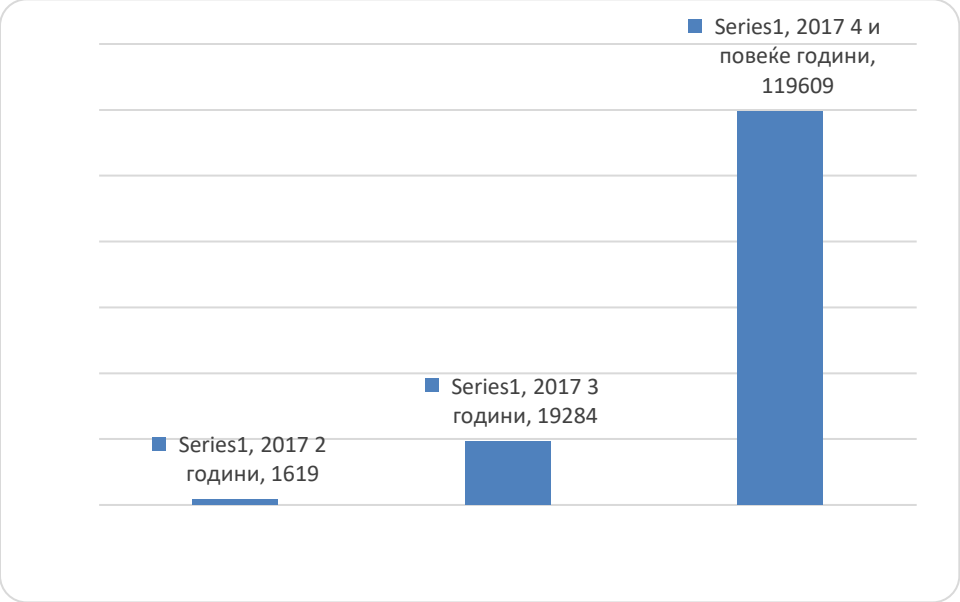

Figure 4. average value of migration 2017

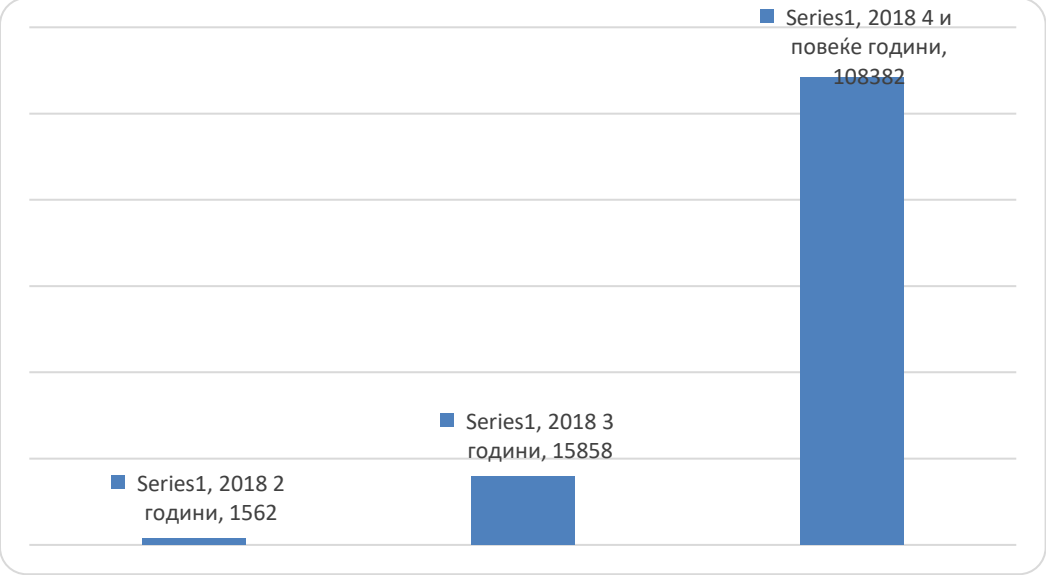

Figure 5. average value of migration 2018

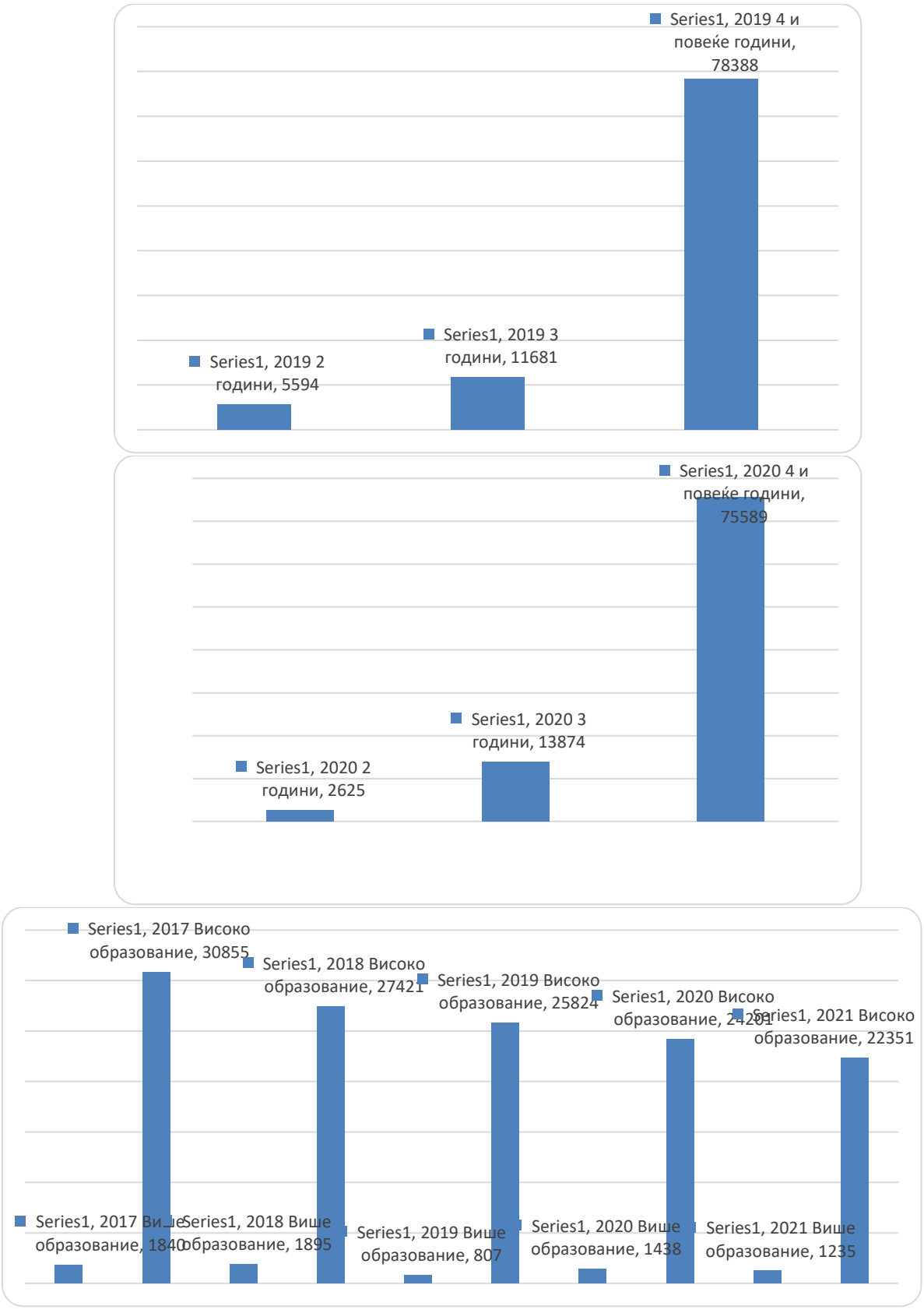

Figure 6. average value of migration 2019,2020,2021 Comparison

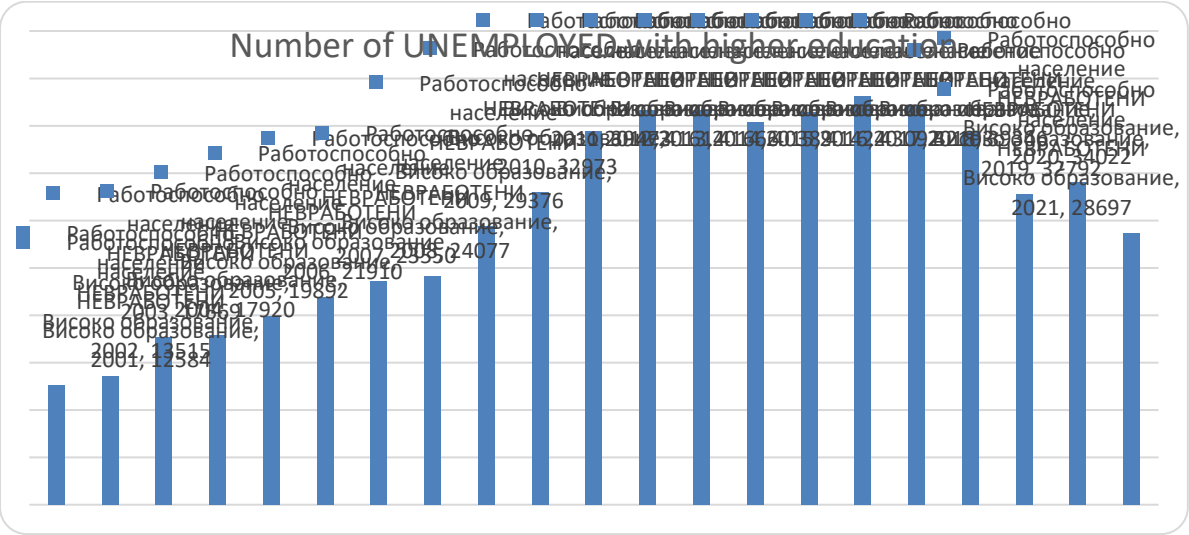

Figure 7. Number of UNEMPLOYED with higher education

What is the loss to GDP with the young man's departure?
Instead of in his own country, the emigrant works on the social product of another country.

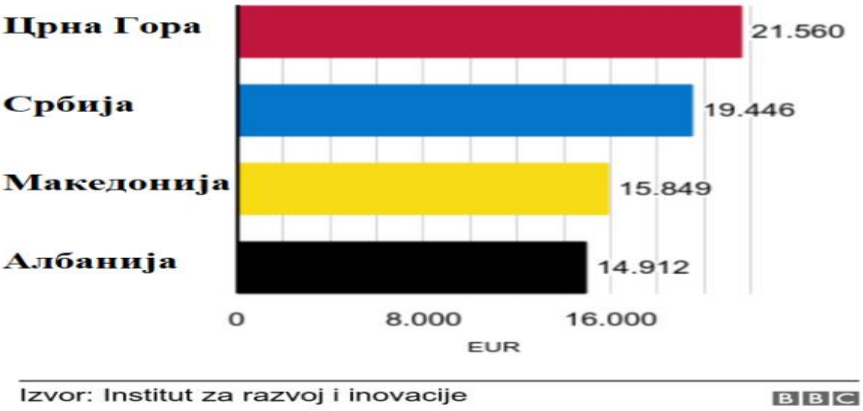

Figure 8. Loses in GDP of Western Balkan countries

3 Conclusion

The research study provides a review analysis of brain drain, causes, loses and has tried to fill the vacuum of qualitative research work on some of the reasons for and aspects of the flow of highly skilled migrants from North Macedonia. First, it surveyed the roots, manifestations and effects of the process of brain drain. Then, it analyzed the different fields and loses of North Macedonian institutions, arguing that there has not been a coherent, solid evidence-based policy, strategy or plans to alleviate the detrimental effects of the gradual diminution of human resources caused by brain drain. The original contribution of the paper lies in its field research component, which investigated causes, loses and proposes a strategy how to solve the problem and reverse brain drain.

Apart from the future lost contribution to the social product, when emigrating, the young person also takes with him what was invested in him until then. Both countries and families invest in education - until the young person leaves the country, it is an investment. When you compare the amount of how much the countries of the Balkans invest in education, and how much Germany invests, it can be concluded that the countries where young people go get experts and ten times "cheaper" than those that the countries themselves educate.

Professional engagement of intellectual emigration representatives in higher education and private sector

Increasing the intellectual exchange with foreign countries by encouraging cooperation with educated individuals from the Republic of Macedonia who live and work abroad with Macedonian scientific and research institutions and development companies.

Based on the discussed framework, obviously there is an Emergence of Brain Drain Research. Strongly is encouraged further research on this topic, active participation in addressing Brain Drain and mapping out the national and international plans on the conversion to Brain Gain..

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Strengthening of Social Dialogue as a tool of creatingmore and better Workplaces

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ABSTRACT

Supporting the participation of institutions in social dialogue advances policy making, but at the same time encourages the practice of regular consultations of Economic-Social Councils (ESC) at the national and local level. This paper aims, through several indicators, to determine the importance of social inclusion for strengthening the capacities for Occupational Safety and Health (OSH) in the Union of Defense and Security (SOB), followed by social dialogue between stakeholders. Through the realized trainings for SOB members, the especially low value of only 22.2% for the OSH awareness among the employee's indicator, increased to a value of about 48.6%. Also, the educational workshops contributed to the increase in the value of the Education of SOB members on OSH indicator, from 11.2% to 56.4%. Important progress has also been achieved in the education of future OSH trainers, where the value of 4.3% for this indicator was increased to 81.5%. Also, the initially measured value of 2.8% for the indicator of legal awareness of the participants, notices progress up to 41.2% for availability of information, after using the services of the legal clinic.

The results analyzed and the progress achieved in all indicators show that social dialogue creates more transparent conditions for social partners, followed by better education for giving quality advice and delivering services based on the demand for creating more and better workplaces.

KEYWORDS

social dialogue, quality indicator, workplace, SOB members, occupational safety and health

1 Introduction

National mechanisms supported by the International Labor Organization (ILO), are a successful tool for improving tripartite social dialogue to create better workplaces, increasing the capacities of employers and employees to effectively engage in social dialogue at all levels [1].The ILO had the great privilege to host a round table in March 2020 aimed at identifying innovative ways to boost the roles of the social partners and social dialogue in the new world of work [2].

Supporting the participation of institutions in social dialogue for improving workplace conditions advances policy making, but at the same time encourages the practice of regular consultations of Economic and Social Councils (ESC) at the national and local level. It creates more transparent conditions for social partners, followed by better education to provide quality policy advice and deliver demand-based services.

In order to maintain and develop the infrastructure of social dialogue, it is necessary to establish a stable practice of the Government and social partners. Despite some progress in raising awareness of the benefits of social dialogue on work safety, one of the main problems at the local level is that the use of local ESCs as an effective tool for self-management is still very limited. Thus, the influence of trade unions and employers' organizations is very small and their capacity remains weak [3].

This paper is a part of implementation of the ILO project "Strengthening the capacities for Occupational safety and health (OSH) in the Union of Defense and Security (SOB)", which aimed to improve social dialogue as a means of creating more and better workplaces in North Macedonia[4]. In this direction, three specific components were characteristic:

- Strengthening the participation of the ESC in the shaping of the national agenda for economic and social reforms, which enables the improvement in OSH by facilitating the necessary changes in the legal and institutional frameworks;
- Increased participation of local ESCs in the formulation and implementation of local employment policies and addressing the problems of lack of safety and quality of workplaces, simultaneously supported and monitored by theILO;
- Increased effectiveness of trade unions and employers' organizations whose visibility, relevance and capacity are supported and promoted by the ILO.

So, the main challenge in this research was raising the level of awareness and education of OSH among the SOB members whose workplaces are of increased risk, but also expanding this trend among the members of other unions.The only possible risk for the successful implementation of the project was the possible lack of interest and involvement in the planned activities by the SOBmembers, which turned out to be very unlikely[5].

2 Materials and methods

2.1 Quality indicators

Quality indicators (QIs) can be understood as data or structured sets of data that have a close relationship with the level of qualitative and quantitative results obtained in a certain area. They are a unique value that characterizes a certain property of a given option. Moreover, quality indicators can be used as tools to monitor and control efficiency of the quality management system. The results collected serve as a basis for implementation of corrective measures and continuous quality improvement [6].

According to the tripartite quality model, each of the QIs can be classified as a Status Indicator (SI), a TargetIndicator (TI) and a Progress Indicator (PI). A basic feature of these indicators is that they should possess multiple attributes very precisely.In addition to the objectivity (measurability) they should have, relevance and potential for use, reliability and validity are also of paramount importance. The very definition of the indicator offers the possibility of quick and simple insight into the level of quality [6]. So, the calculation of quality indicator (QI) can be obtained from the following formula:

$$QI = \left(\frac{Number\ of\ employees\ positively\ stated}{Number\ of\ respondents}\right) x100$$

This paper aims, through several QIs, to determine the importance of social inclusion for strengthening the capacities for OSH in the SOB, followed by social dialogue between stakeholders. The level of achievement of the results can be determined based on the corresponding current value of the following indicators:

QI 1:*OSH awareness among the employees.* As a result of the implemented activities, the level of awareness among the employeescan be assessed based on their involvement in educational workshops, and the labor rights debatesin the field of OSH. The questions asked, as well as the answers given to the indicated problems were also relevant. Consequently, this contributes to a more accurate assessment of the level of understanding of OSH concept.

QI 2:*Education of SOB members on OSH*. The indicator reflects the level of OSH education of the SOB members, which can be analyzed based on the data in the anonymous questionnaires that were individually filled out after the completion of each of the lectures.

QI 3:*Education of future OSH trainers.* The indicator offers measurability to assess the engagement and education of future trainers based on their involvement during the training.

QI 4: *Utilization of the legal clinic.*The indicator monitors the degree of utilization of legal clinic and is calculated on the basis of processed data from the number of cases that applied for legal assistance. This indirectly enables an assessment of seriousness of the approach to labor rights from OSH and other rights from employment.

Table 1. Outcome for QIs depending on input and output indicators

Outcome		
Quality Indicator		
Input 1.1	**Input 1.2**	**Output 1.3**
Status indicator (SI)	Target indicator (TI)	Progress indicator (PI)
Low level of OSH awareness	Raising the level of awareness through more effective involvement and	Significant progress in raising the level of

	strengthening the capacities of social dialogue between social partners in the country.	awareness among the SOB members.
Input 2.1	**Input 2.2**	**Output 2.3**
SI	TI	PI
Average level of OSH education	Advancement of SOB members education because of a better understanding of the basic goal of OSH concept, which is based on creating better workplaces - without injuries, diseases and accidents at work.	A higher level of education among the SOB members, and ability to recognize OSH problems.
Input 3.1	**Input 3.2**	**Output 3.3**
SI	TI	PI
Absence of practice for continuous education in the field of OSH	Training of future OSH trainers in order to ensure continuity in awareness and education about the values and benefits of the correct implementation of OSH among employees.	Enabled future trainers, who will continue the OSH educational activities among the members of SOB in the future.
Input 4.1	**Input 4.2**	**Output 4.3**
SI	TI	PI
Lack of legal information and advice about clarifying the OSH labor rights and other labor rights	Constant availability of information and free legal advice and actions related to labor rights, which is provided through the operation of the legal clinic, which will continue to work even after the end of the project.	Improved awareness of SOB members about labor rights and OSH legal rights and obligations.

3 Results and discussion

In the contemporary circumstances, sustainable development concepts pose more OSH issues, and the costs of safety and health hazards and diseases have to be seriously considered [5]. According to the ILO, workplace safety is not only a simple concern for the health of employees, but a complex multidisciplinary approach of experts from different fields[7], to assess and recognize real risks and tackling them in a balanced way [8]. These risks if not addressed in time, may cause more damage in the near future [9]. Usually, the omissions that do not converge to the intended outcomes, occur within the rules and regulations of the

institutions [10].

The data for this paper were collected through trainings, workshops and an anonymous survey, that were part of the implementation of a project from the ILO Program, funded by the EU [4]. The project involved members of SOB, so that in the field of OSH were organized and conducted multiple trainings during 2020/2021 in: Regional Basic Organizations (RBO) Crisis Management Center, RBO Veles and Prilep, RBO Kumanovo, RBO Ilinden, RBO 8043 and RBO TRC, with a total of 97 people present (76 men and 21 women) [5].

QI 1: In the current situation of the SI, which resulted in a low level of awareness of OSH issues of only 22.2%, significant progress was made to about 48.6% through the initiation of dialogues and exchange of information between the SOB members and OSH experts. On the other hand, the measured value of 78.1% of the TI regarding the strengthening of social dialogue capacities was projected based on the involvement in the educational workshop, discussions on labor rights, and the logic of questions asked and answers given to the indicated problems. In this way, a step forward has been made towards a better understanding of the importance of a safe workplace and seeking better working conditions, primarily through the protection of workers' health.

QI 2: Education on SOB members on OSH indicator for which a rather low value of only 11.2% was measured, after holding all the planned trainings, progressed to a value of 56.4%. This was achieved by actively engaging in discussions and elaborating on all the shortcomings in their work: inadequate and dilapidated personal protective equipment (PPE), poor hygienic conditions, poor sanitary infrastructure, insufficient protection against exposure to noise, chemical and other hazards when handling a weapon. The measured TI value was 97.9%, so the training participants clearly indicated that they are in favor of workplaces with zero occupational injuries.

QI 3: Particularly important is the progress achieved in the Education of future OSH trainer's indicator, whose initial value for continuing education was 4.3%. By the implementation of trainings for future trainers, a value of 81.5% for this indicator was reached, that was close to the projected goal of 89.3%. For the future, a very good practice for continuing the educational activities for OSH among the SOB members, has been developed.

QI 4: In the Utilization of the legal clinic indicator, where a level of utilization of the legal clinic and legal awareness of only 2.8% was found, particular progress is registered. From the processed data, a total of 40 cases applied for legal aid, and some of them ended up with representation in court. Thus, the value of PI reached 41.2%. The measured value for TI of 93.0% was based on the exceptional availability of information at all times and for the entire period of implementation. This indirectly generates the sustainability of the project and a positive assessment of the seriousness of the approach to the protection of labor rights from OSH, as well as for other rights from labor relations. After this, the concept of offering free legal advice at the legal clinic resulted in a lot of interest from SOB members.

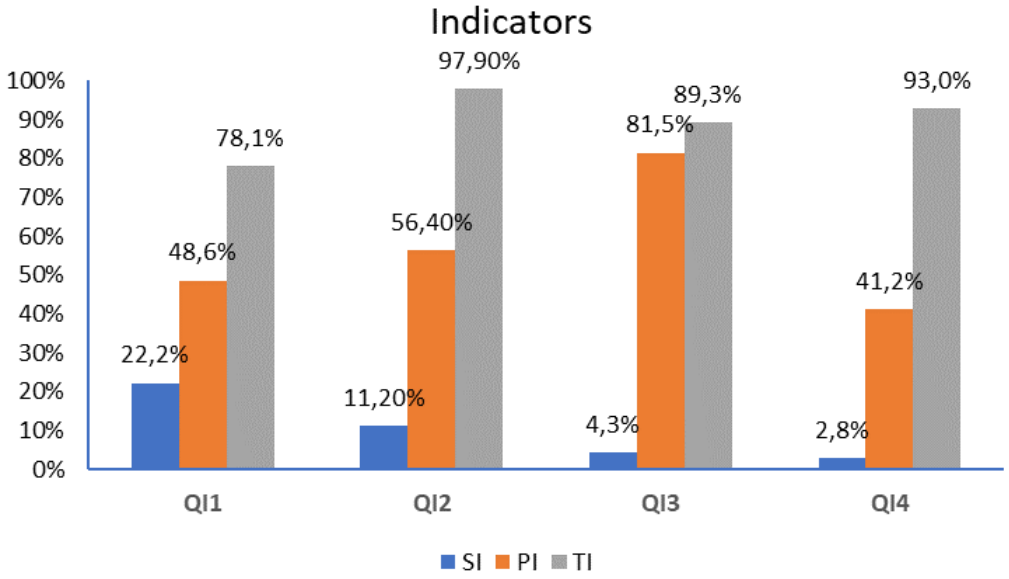

Figure 1. Qis according to the tripartite quality model

From the analyzes of all four QIs, it can be seen that the TI indicators diverge from the PI indicators, which have been reached in the implementation of the project. However, at all values of the achieved progress there is a significant improvement compared to the initial SI value.

4. Conclusion

The joint efforts of the national constituents are aimed at strengthening the institutional capacities and the role of trade unions and employers' organizations in the creation of policies to improve the efficiency of the OSH concept. Capacity building for national institutions that have significant responsibilities in creating and implementing occupational safety strategies is ensured through the effective use and transfer of knowledge, skills and tools.Implementation of practical approaches and tools in OSH are closely related to reduce incidents, poor health, illnesses, and injuries at work. In this regard, quality indicators are developed to enable a more detailed analysis of the causes and to provide guidance for increasing safety at workplaces.

The data for this paper were collected through trainings, workshops and an anonymous survey, which were part of the realization of a project from the ILO Program, funded by the EU. Through the realized trainings for SOB members, the especially low value of only 22.2% for the OSH awareness among the employee's indicator, increased to a value of about 48.6%. Also, the educational workshops contributed to the increase in the value of the Education of SOB members on OSH indicator, from 11.2% to 56.4%. Important progress has also been achieved in the education of future OSH trainers, where the value of 4.3% for this indicator was increased to 81.5%. Also, the initially measured value of 2.8% for the indicator of legal awareness of the participants, notices progress up to 41.2% for availability of information, after using the services of the legal clinic.

The results analyzed show that the progress achieved in all indicators, although it does not completely coincide with the values of the set goals, is still a great progress in relation to the initially found situation.Hence, social dialogue creates more transparent conditions for social partners, followed by higher awareness and better education for giving quality advice and delivering services based on the demand for creating more and better workplaces.

The data in this study can be used to develop strategies for reducing the risks of dangerous incidents, injuries

and exposure to hazardous substances, during training and operations of military personnel.In 2020, RNM became the 30th member of NATO, so the cooperation of the Ministry of Defense and the Army of RNM with NATO, regarding the Program for the Advancement of Defense Education, began to be implemented and is focused on the priorities in the development of military education.

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Analyses Of the Digitalization Process and its impact on changing of the Formal Definition of Computation

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ABSTRACT

This research study aims to delve into the current state of the digitalization process and its impact on the official definition of computation. While we are able to explain a computation. Can we determine what it is computing, though? The definition of computing has evolved over time and is constantly changing. The definition of computation has undergone significant changes over time, with the current understanding of computation encompassing both natural

and artificial processes, not limited to just mathematical functions performed by computers. Daily activities, such as simple arithmetic, and complex processes such as cell division, which involves copying and processing genetic information, can be considered computations. The study uses a triangulation approach, combining qualitative and quantitative research methods, to examine the definition of computation, including the definitions of the alphabet, strings, and languages. The study draws on the traditional Turing machine model, which has been widely accepted as a reference model due to its ability to simulate other known computing models. The study presents arguments and discussions, and provides recommendations on the definition of computation. As a result, this research study displays the formal definition of computation, which includes the definitions of the alphabet, strings, and languages. The triangulation technique, which integrates qualitative and quantitative methodology, is the research methodology used. Arguments are made and discussed and recommendations have been provided.

KEYWORDS

digitalization, formal definition of computing, non-numerical computations, Turing machine model, processing information, computation

4 Introduction

Nowadays, we live in a time where almost everything is driven by software, and the entire industries are reshaped from the ICT and requirements of knowing ICT is becoming a necessity. Information and communication technology changes the meaning of social relationships and the nature of how work is done.

According to (Denning, 2010) the question “what is computation?” at the very least, is older than computer science, it is one of those issues that will never have a conclusive answer because fresh discoveries and developing understandings frequently give rise to new questions regarding established models.

It is comparable to the central issues in other disciplines, such as the unanswerable questions of "what is life?" and "what are the fundamental forces?". The advances of Artificial intelligence and use of robotics is increasingly prevalent in work on computational thinking (S Amri, C W Budiyanto and R A Yuana, 2019).For instance, the modularity features of Lego robotics allow students to build their understanding of the abstraction of sophisticated robotics parts.

Organizations in the educational sector that embrace computing are more likely to integrate computational thinking into the core curriculum.The informal and productive learning environment that has been made popular by robotics competitions over the past ten years has the potential to spur students' interest in mathematics and science and encourage them to pursue careers in the fields of science, technology, engineering, and mathematics. Children who receive programming instruction also develop their computational thinking skills and ideas, which helps to encourage and improve computational thinking.

Most people think of a computation as the action taken by a computational agent on its inputs

while being guided by an algorithm.Due to the fact that a suitable Turing machine can replicate all other known computational models, the traditional Turing machine model has long functioned as the primary reference model (Robert W. Cojfin, Harry E. Goheen, and Walter R. Stahl, 1963).

Because the number of steps required to perform a Turing machine algorithm predicts the computation's running time on a digital computer, the Turing model is a useful abstraction for the majority of computers (Soare R. I., 2009).The natural, interactive, and continuous information processes that are prevalent today, however, do not fit the Turing model as well (Van Leeuwen, 2001).Better forecasts of running time and space are made by other models whose structures more closely resemble the information processes at play.The usage of models built on transforming representations is possible (Peter Wegner, Dina Goldin, 2003).

Nowadays, computation is seen as both a natural and an artificial process.This poses a significant threat to the established definitions that link computation to computers (S Amri, C W Budiyanto and R A Yuana, 2019).

5 Purpose of the Study

The goal of the research project is to evaluate the current condition of the digitalization process, analyze it, and determine how it affects the official definition of computation. The research objective of the study is to investigate into several important research questions by providing answers and arguments:

Researching the impact of digitalization process today in general, and asses its impact. Researching the adaptation aspect of the digitalization process by students and teachers. Research on how computation term has changed with the digitalization and development of ICT.

6 Research Methods

The triangulation technique, which integrates qualitative and quantitative methodology, is the research methodology used.Focus groups and questionnaires were employed as a quantitative research tool.

H1 – Hypothesis set is as follows: The formal definition of computation is impacted by the digitalization process, which can also aid in defining computation in its contemporary context.

Nowadays, computation is seen as both a natural and an artificial process.The historical definitions that link computation to computers are severely challenged by this. Therefore the main research questions are:

What it is computing and how can we tell?

Which mechanical procedures used to assess mathematical functions are referred to as

computation?

What are the key definitions of emerging computing?

What are the primary metrics used to evaluate and communicate computation?

How may the computation definition be made better?

What are the principal difficulties in computing?

7 Literature Review

Over time, the definition of computer science has been a moving target. These stages reflect increasingly sophisticated understandings of ***computation***.

In the 1930s, Kurt Gödel, Alonzo Church, Emil Post, and Alan Turing independently gave us the first definitions of computation. Gödel defined it in terms of the evaluations of recursive functions. Church defined it in terms of the evaluations of "lambda expressions", a general notation for functions. Post defined it as series of strings successively rewritten according to a given rule set. Turing defined it the sequence of states of an abstract machine with a control unit and a tape (the Turing machine). Influenced by Gödel's incompleteness theorems, Church, Turing, and Post discovered functions that could not be evaluated by algorithms in their systems (undecidable problems). Church and Turing both speculated that any effective procedure could be represented within their systems (the Church- Turing thesis). These definitions underlay the earliest formal notions of computing (Scott, 1967). In the time that these men wrote, the terms "**computation**" and "**computers**" were already in common use, but with different connotations from today. Computation meant the mechanical steps followed to evaluate mathematical functions. Computers were people who did computations. In recognition of the social changes they were ushering in, the designers of the first digital computer projects all named their systems with acronyms ending in "-AC", meaning automatic computer—resulting in names such as ENIAC, NIVAC, and EDSAC (Soare R. I., 2016).In the late 1980s, the computational science movement, claimed computation (and computational thinking) as a new way of doing science (RajeevAlur, David L.Dill, 1994). Supercomputers were their main tools. But now computation was more than the activity of machines; it was a practice of discovery and a way of thinking. Finally, in the 1990s, scientists from natural science fields started to claim that information processes exist in their deep structures.

7.1 Analyses of Numerical computation

The most common computations are the numerical operations that we all perform on a daily basis, such as adding up costs, multiplying a room's length by breadth to determine its surface area, and so forth.In their working life, the majority of people today face even more opportunities to perform numerical computations.Anything that can be quantified requires basic arithmetic, which is so essential that it makes up a large portion of instruction in the first several years of school.The abacus and other mechanical tools for numerical computation have been in use for at least 2000 years, and maybe much longer (Cooper, 2017).

We rarely give simple arithmetic operations on tiny numbers any thought; instead, we frequently just recall the answer that has become internal to us as a result of repeated practice.However, as soon as we deal with larger sums, mental calculation turns into a routine task based on learnt rules (Gaßner, Computation over algebraic structures and a classification of undecidable issues, 2017).We turn to pen and paper for a more trustworthy record of the intermediate findings in our computations when operations grow too complex to handle in our heads.The rules for arithmetic can therefore be expressed as mechanically executable rules for manipulating symbolic sequences.

7.2 Analyses of Non-numerical computation

Once we reject the notion that computing is only about numbers, it will be simple to recognize other actions that fall under the computation category.One illustration is the use of algebraic operations to solve equations.The fact that computers can complete the task is the practical proof.Computer algebra systems, which emphasize algebraic

manipulations, are software programs that carry out such operations (Gaßner, Computation over algebraic structures and a categorization of undecidable issues, 2017).The validation of proofs is one of mathematics' more unexpected uses of computing.A proof is a series of deductive steps, each of which establishes a statement's truth by reference to other claims that have already been proven to be true using a limited number of deductive logic principles.This entails expressing the proof as a series of symbols in some formal language.This string of symbols is converted into a "true" or "false" assertion regarding the veracity of the proof by the "proof checking" process.We discover a large variety of disciplines where computing is used to textual material after we leave the restricted realm of mathematics.

By conducting a calculation that transforms the input data (the text and the word to be located) into the output data (the place in the text where the word appears), a word can be found in a text (Olivier Bournez, Amaury Pouly, 2018).Graphs are a different type of data that are becoming more and more crucial for scientific computation, particularly when used to explain networks.A check for cycles is an illustration of a calculation on a graph.By doing so, the input data (a graph) are transformed into output data (a list of all cycles in the graph).

7.3 Analyses of the roles of computation in scientific research

The most visible role of computation in scientific research is its use as a tool. Experimentalists process their raw data, for example to correct for artifacts of their equipment. Theoreticians compute numerical predictions from a model, in order to compare them to experimental results. Both experimentalists and theoreticians make heavy use of computation for understanding their data, in particular using visualization techniques (Denning, 2010).

Computers are physical devices that are designed by engineers to perform computation. Many other engineered devices perform computation as well, though usually with much more limited capacity. The classic example from computer science textbooks is a vending machine, which translates operator input (pushing buttons, inserting coins) into actions (deliver goods), a task that requires computation. A vending machine does more than just calculate, of course, and as consumers, that additional behavior is what interests us the most.However, processing input and subsequent calculation is a crucial part of how the machine works.We are familiar with machine-oriented models for structures over the real numbers, such as the real RAMs introduced on the basis of the idea in (Gaßner, An introduction to a model of abstract computation: the BSS-RAM model, 2019).Many natural systems that arise have the same characteristics.The procedure of cell division, which occurs in all biological creatures and entails the copying and processing of information stored in the form of DNA, is a well-known example.Of course, living things are more complex than machines.

Information processing is closely entwined with other processes in living organisms.A distinguishing feature of human engineering that cannot be found in nature is the identification of computing as a separate phenomenon and its manifestation by constructed devices that conduct a precise computation any number of times with the least amount of environmental dependency conceivable.However, concentrating on the computational aspects of life and developing computer programs to model information processing in living things has greatly advanced our understanding of how they work.

7.4 Analyses of Formal Language Theory

The fundamental concepts and hypotheses in the field of computational complexity, which aims to investigate diverse computational models in order to comprehend their relative computational strength and categorize computational issues according to the computational resources they require (Cooper, 2017).Remember that choice problems are typically the computational issues one studies in theoretical computer science (Gallier, 2010).When faced with a decision-making situation, one expects a boolean response to the input.Instances of the input are often encoded as strings across a symbol alphabet.

No matter how we view a language, we are typically considering two things:

- The **syntax**, i.e., what are the “legal” strings in that language (what are the “grammar rules”?).
- The **semantics** of strings in the language, i.e., what is the meaning (or interpretation) of a string.

Unfortunately, the semantics is significantly more challenging to deal with but is typically much more interesting than the syntax!In the recognition point view, we normally assume some sort of "black box" M (an automaton) that receives a string w as input and outputs two possible answers: those for which the expected answer is "yes" or "true" and those for which the expected answer is "no" or "false."

As a result, a decision problem is frequently associated with a language or a group of strings, specifically those for which the problem requires a "yes" response (Viswanathan, 2018).Given this meaning of machines and problems, we often state that a machine M solves a problem L (or rather accepts/recognizes) if L = L(M), that is, if M responds "yes" to exactly the inputs that the problem requires the answer to be "yes."

7.5 Analyses of Alphabet, Strings, and Languages

According to (John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, 2006) an *alphabet*Σ is a finite set of elements. A (finite) *string* over Σ is a (finite) sequence$w = w_0 w_1 \cdots w_n$ over Σ (i.e., $w + i \in \Sigma$, for all i). The length of a string$w = w_0 w_1 \cdots w_n$, denoted $|w|$, is the number of elements in it, which in this case is $n + 1$. The unique string of length 0, called the *empty string*, will be denoted by ε. For a string $w = w_0 w_1 \cdots w_n$, The symbol w[i] is used to represent the ith symbol in the string w i.The concatenation of the strings u=a 0 a 1 a n and v=b 0 b 1 b m results in the string uv=a 0 a 1 a n b 0 b 1 b m.
We shall occasionally use I to signify the set of strings of length i. The set of all (finite) strings over is denoted by *.A language A is made up of a number of strings, or A *.
Concatenation of languages A and B results in AB = uv | u A, v B.
In the case of a language A, A 0=, and A i=u 0 u 1 u n | j.ujA signifies the i-fold concatenation of A with itself.
Finally, according to Robic (2015), a language A's Kleene closure is A*= (i0)Ai.

8 Findings and Results

The work's anticipated conclusions and justifications include enough details on the variables that affect computing as well as how they relate to the digitalization process.Here is an illustration of a computer calculation.
Let $M = (Q, \Sigma, \delta, \mathrm{q}_0, F)$ be a finite automation and $w = w_0 w_1 \cdots w_n$ be a string over Σ. We say that M**accepts**w if there is a sequence of states $r_0 r_1 \cdots r_n$ in Q such that the following hold (Mikhail J. Atallah, Marina Blanton, 2010):

1. $r_0 = \mathrm{q}_0$
2. $\delta(r_i, w_{i+1}) = r_{i+1}$ for $0 \leq i < n$
3. $r_n \in F$

- Condition (1) informs that the machine starts its computation in the start state
- Condition (2) informsthat as long as input is available the machine goes from state to state according to its transition function δ.
- Condition (3) informs that the machine accepts its input if it ends up in an accept state. (Stefan D. Bruda, Selim G. Akl, 2003)

We can conclude that a machine M recognizes the language A if $A = \{w | M\ accepts\ w\}$(Sipser, 2013).

9 Conclusion

The research study provides a review of the published literature as well as an analyses of the emerging trends of different definitions of computing.In this research study we gave sophisticated understandings of computation. How computation is seen as a natural process

as well as an artificial one. There were mention the most familiar computations: the numerical computations and the non-numerical computations. We mention how experimentalists and theoreticians make heavy use of computation for understanding their data. How computers are physical devices that are designed by engineers to perform computation. we gave a well-known example how is used computation in nature science. Finally, was shown the Formal Model of Computation where were defined the Alphabet, Strings, and Languages which are the basics for Formal Definition of Computation. Are algorithms really at the heart of computer science, or is the more fundamental and overarching concept of representation the mind? Science discovers information processing processes for which algorithms are unknown. Are there no algorithms at all for some of these information processes? This model solves the vexing question: "What is information?" No. It deals with the objective part of the information (representation and its attribution to the referring person) but does not rely on the subjective aspects of the information (individual observers). You can proceed without solving the observer problem. This definition of computation also supports a clear definition of computational thinking. Computational thinking is a problem-solving approach that poses problems as information processes involving computer models (which may need to be invented or discovered) and seeks algorithmic solutions. Pioneers in the field used the term "algorithmic reasoning" to describe how computer scientists' thought processes differ from other sciences The term "computational thinking" came into common use to describe the way computer scientists approached problem solving, calling it a new paradigm in science and this is the most often use of the term.digitalization has enabled the development of new types of computers such as smartphones and wearable devices that can perform a variety of tasks beyond traditional mathematical calculations. These devices use sophisticated algorithms and software to process, store, and analyze vast amounts of data, enabling new forms of computation that were not previously possible.Additionally, the widespread availability of digital devices and the Internet has enabled new forms of distributed computation, where tasks can be divided and executed across multiple computers, potentially located in different parts of the world. This has led to the development of cloud computing and other forms of distributed computing that have revolutionized the way we think about and use computation.In conclusion, digitalization has greatly expanded the definition of computation and has made it possible to perform a wider range of tasks and solve more complex problems than was previously possible.

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Learning mathematics using digital tools
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APSTRACT

Today, in the modern way of life, digitalization of the educational system enables the development of logical thinking among students, enrichment of knowledge, improvement of skills, attitudes and values (Ma et al., 2014), on the one hand, but also professional development and motivated teachers (Chen, Wang, Kirschner, and Tsai, 2018) [1], on the other hand. This research, by surveying 88 teachers in primary education in the Republic of North Macedonia in the subject of mathematics, analyzes and presents a concise picture of the effects of using digital tools in the subject of mathematics on the teaching process and learning in mathematics.

With a standard-type survey with a Likert scale, the teachers reported on the research variables (factors) the frequency of using digital tools in mathematics teaching, then the type of tools (Dynamic Mathematical Tools – Intelligent Systems and Hypermedia Systems in Mathematics), thepurposeof using digital tool (addition or replacement) and the influence of these three factors on the efficiency of the use of digital toolsin the teaching process (learning) in the subject of mathematics.

[1]Chen et al., (2018). Chen, J. Wang, M. Kirschner, P.A. and Tsai. C.C. ″The role of collaboration, computer use, learning environments, and supporting strategies in CSCL: A meta-analysis‟. Review of Educational Research, 88 (6) (2018), pp. 799-843

The results showed that the use of digital tools in mathematics is significantly present among the surveyed teachers and on the other hand they declared that there is a significant improvement in the teaching process (learning) in mathematics when digital tools are used daily and two-three times a week and as an addition of teaching methods but not as a substitute.

Key words:*Digitization; Mathematics; Digital tools; Intelligent systems; Hypermedia systems; Teaching methods;*

1. Introduction – Digitalization and education

Society should ensure the satisfaction of the needs of the current generation without jeopardizing the future generations in meeting their needs, and thus it is necessary to look - a step forward - and meet the needs of students and teachers.

Sustainable development in education implies the integration of key issues in teaching and learning. Thus, the stimulation of critical thinking among students, the solving of logical tasks based on analyses, the motivation for undertaking activities and solving problems, enable sustainable development in education. Technology should support teachers, not take their place. As powerful and engaging as a digital presence is that teachers and students remain the heart and soul of the classroom.

Introducing and assimilating a new tool into the classroom is not easy, so achieving that balance can sometimes be more challenging than you expect. For example, introducing an online graphing calculator can sometimes be difficult in the classroom, however, at least some of that difficulty can be removed if the teacher learns how to use the tool, anticipates the operational difficulties students will encounter, and then he carefully includes it in the teaching. That approach lays the groundwork for a good explanation of concepts and also saves valuable classroom time.

Technology provides additional opportunities for students to see and interact with mathematical concepts. Students can explore and discover through games, simulations and digital tools.

1.1 Digital Tools in Mathematics and types of digital tools

Conceptual development in school mathematics can be supported by digital tools: " *relationships that are key to mathematical understanding are highlighted, more tangible and manipulative. The computer screen gives teachers and students the opportunity to make explicit what is implicit and draw attention to what often goes unnoticed* " (Hoyles, 2018, p. 12) [2].

They can support conceptual exploration and conjecture, including for example with geometry, functions or data sets, and offer immediate feedback. However, the effect sizes in terms of improvement in conceptual engagement reported in experimental field studies are significant, but only small to moderate (Drijvers, 2018).

For practicing math skills / building experience, digital tools have a lot to offer, such as variation and randomization of tasks, automated and intelligent feedback, and a personal environment in which mistakes can be made safely and learned from (Drijvers, 2018) [3].

They can provide insight into evidence of student thinking and practice as it is captured digitally, supporting formative (as well as summative) assessment. Through digital technologies, combining

[2]Hoyles, C. (2018). ″Transforming the mathematical practices of learners and teachers through digital technology‟. Research in Mathematics Education, 20:3, 209-228, DOI: 10.1080/14794802.2018.1484799

[3]Drijverset al., (2014) Drijvers, P. Doorman, M. Kirschner, P. Hoogveld, B. and Boon , P. ″ The effect of online tasks for algebra on student achievement in grade 8Technology‟ . Knowledge and Learning, 19 (1–2) (2014), pp. 1-18, 10.1007/s10758-014-9217-5

traditional face-to-face with online teaching and learning can offer the best of both worlds, bringing together the collaborative responsive element along with expanded thinking opportunities, both of which are valuable for learning mathematics. Such developmental forms of education may assume greater maturity of the learner, but may also foster independent learning skills in students (Golding at al., 2021).

Digital tools are already playing a much expanded role in new applications and increasingly in the construction of mathematical knowledge that, in turn, should influence the school curriculum. The school curriculum, however, remains stubbornly resistant to change and rather backwards; more influenced by well-established mathematics and traditional methods than by exciting new ideas and new technologies. Especially tools with adaptive features, such as intelligent tutoring systems, can be expected to have a positive impact on student performance (Ma et al., 2014).

Intelligent tutoring systems additionally have adaptive features: they can present new content taking into account students' prior knowledge. In addition, they allow individual adjustment of the difficulty of the task or the pace of presentation of new content to the needs of the student. In addition, they provide differentiated feedback or advice in order to support optimal learning processes (Nattland & Kerres, 2009) [4].

Hypermedia systems are not designed to teach learning units in a structured way, but serve as non-linear hypertext systems that are commonly used as encyclopedias in educational settings, providing information linked through hyperlinks (Hillmayr at al., 2020) [5].

The use of intelligent tutoring systems or simulations such as dynamic mathematical tools is significantly more useful than hypermedia systems. At a descriptive level, the effect size will be greater when digital tools are used as a supplement to other teaching methods, not as a substitute (Hillmayr at al., 2020).

2. Research methodology

The paper contains data about the digitalization process in the subject of mathematics, first as a need, and then as a challenge and trend in the new era, offering quick access to a lot of information, its processing, selection of information, as well as a quick and easy check of acquired knowledge among students .

The research includes fifth to seventh grade teachers, selected in order to see the piloting of digitalization in the past school year, among other things, the experiences and benefits of the process, looking at different aspects.

2.1 Purpose of study

Based on the above, the purpose of the research is derived, which is to analyze the situation in primary education in the subject of mathematics according to the level of use of digital tools in teaching, the types of tools, the purpose or purpose of the use of these tools and the impact of this use of digital tools on the teaching process and learning in mathematics.

2.2 Research techniques, methods and sample

The research was conducted using the Survey technique (closed-type questions with a Likert scale), while Survey sheets were used as research instruments.

The analysis was made using quantitative methods with a percentage representation of the answers given according to the Likert scale using descriptive statistics of numerical and percentage values as well as

[4]Nattland, A. and Kerres, M. (2009). ″Computer-based Methods imUnterricht [Computer-based Methods in Class]‟. K.-H. Arnold, U. Sandfuch, J. Wiechmann (Eds.), HandbuchUnterricht (2nd ed.), Julius Klinkhardt, Bad Heilbrunn, Germany (2009), pp. 317-324

[5]Hillmayra, D. Ziernwald, L. Reinhold, F. Hofer, S. Reiss, K. (2020). ″The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis‟. Computers & Education, Volume 153, August 2020, 103897. Computers & Education

conclusive statistics with the Pearson correlation coefficient and t-test for potential differences of arithmetic means.
A total of 88 teachers of the mathematics subject were surveyed, including teachers from different ethnicities, from primary schools in eastern and western Macedonia and several primary schools in Skopje.

2.3 Research hypotheses

Based on relevant research findings by Drijvers (2018), Golding at al. (2021) [6]and Hillmayr at al. (2020) and the methodological framework of the research, we state the three main hypotheses:

X1. The use of digital tools in the subject of mathematics is significantly present in primary education in RS. Macedonia

X2. The use of digital tools in the subject of mathematics has a significant impact on the improvement of the teaching process and learning of mathematics

X3. The use of digital tools in the subject of mathematics as an addition to teaching methods significantly determines the efficiency of the teaching process and learning of mathematics in contrast to the use of digital tools as a substitute for teaching methods

3. Findings and results

After summarizing and processing the data from a total of 88 surveyed teachers in the subject of mathematics, it results that over 45% of them use digital tools several times a month in the teaching process, over 22% two-three times a week against 19% who do not use them at all and 12.5% of whom

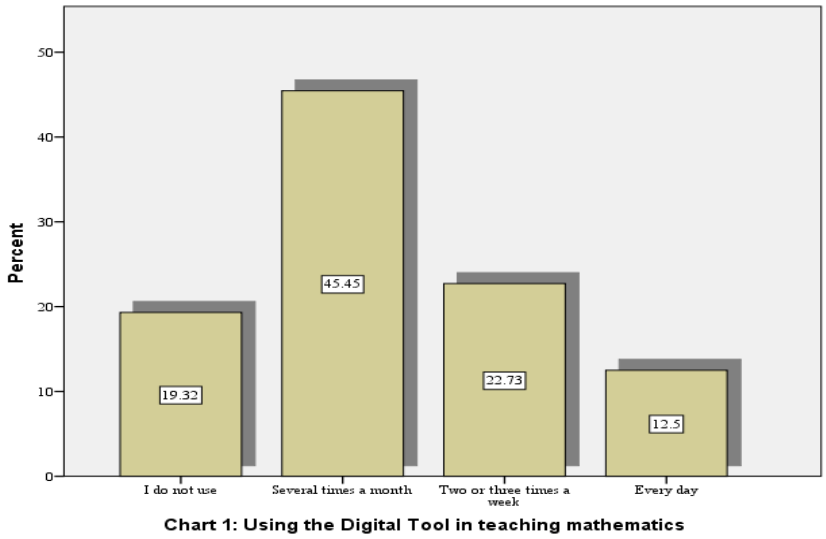


Chart 1: Using the Digital Tool in teaching mathematics

every day (every lesson) they use some kind of digital tools (Chart 1).

On the other hand, as we stated above, the Intelligent Systems which according to Nattland and Kerres (2009) can present new content taking into account the students' previous knowledge and allow individual adjustment of the difficulty of the task or the pace of presenting new content to the needs of the student, which also provide differentiated feedback or advice in order to support optimal learning processes, according to the processed data it results that 62.5% of teachers use some digital tools of this kind – intelligent dynamic mathematical systems (Table 1).
Also in Table 1, 37.5% of the teachers stated that they use Hypermedia systems which, by definition, are

[6]Golding, J., Barrow, E., and Grima, G. (2021). ″Power Maths: implementation, response and learning in a pandemic″. Autumn. London: Pearson UK.

not designed to teach learning units in a structured way, but serve as non-linear hypertext systems that are commonly used as encyclopedias in educational settings, providing information related to via hyperlinks according to Ma et al. (2014) [7].

Table 1: Type of digital-mathematical tool used by teachers

	Frequency	Percent
Dynamic Mathematical Tools – Intelligent Systems	55	62.5
Hypermedia systems in Mathematics	33	37.5
Total	88	100.0

Teachers were also asked to declare the purpose or purpose of using the digital tool, whether they use it as an addition to other methods or to replace the previous methods in the mathematics teaching process. After data processing, it resulted that about 66% of teachers use digital tools as an addition to other methods versus 34.1% as a replacement for previous teaching methods after teaching mathematics (Table 2).

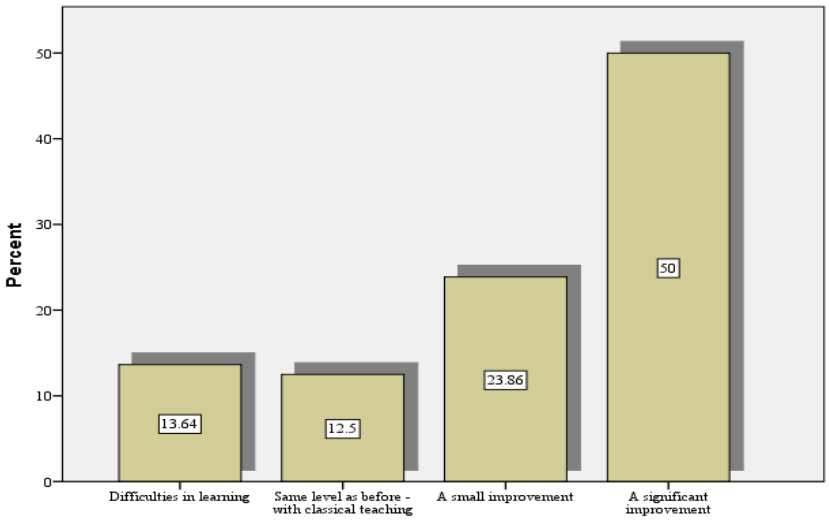
Table 2: Use (purpose) of using the digital tool (addition or replacement)

	Frequency	Percent
In addition to other methods	58	65.9
As a substitute for other methods	30	34.1
Total	88	100.0

As a dependent variable of the research in the research methodology itself, the effect or efficiency, the success of using digital tools on the overall teaching process or learning was emphasized. According to the methodological and teaching principles themselves, teachers are those relevant and competent evaluators of the efficiency of the teaching process and the efficiency of learning, according to their previous experiences in classical teaching without digital tools and now with their co-optation in the teaching process, the teachers have declared about the efficiency of using digital tools in teaching mathematics.

[7]Ma et al., (2014). Ma, W. Adesope, O.O. Nesbit, J.C. and Liu, Q. ″Intelligent tutoring systems and learning outcomes: A meta-analysis‟. Journal of Educational Psychology, 106 (4) (2014), pp. 901-918, 10.1037/a0037123

Accordingly, in Graph 2, half of them or 50% stated that the overall teaching process and learning in the subject of mathematics improved significantly with the use of digital tools against 23.9% who stated that there was a slight improvement. On the other hand, 13.6% stated that after using digital tools, learning became more difficult compared to 12.5% who stated that there was no improvement or that teaching mathematics is the same as before with a classical style.
After presenting these descriptive statistics, which showed us that digital tools are significantly used in



Graph 2: The effect of using the digital tool in the teaching process (learning)

the teaching process of mathematics in primary education in Macedonia, according to the methodological framework of the research, the dilemma of the ratio (correlation) of the three factors of the research (Using a digital tool (how often), Type of digital - mathematical tool and The use (purpose) of using the digital tool (for addition or replacement) with the main research variable (The effect of using digital tools in the teaching process (learning)). Tuck for that purpose , according to methodological scientific logic, Table 3 shows the Pearson correlation coefficient between these variables.

Table 3: Correlation (Pearson's Correlation) of the Effect of Using Digital Tools with Frequency of Use, Type of Tool and Use (Purpose)

		Using a digital tool (how often)	Type of digital - mathematical tool	Use (purpose) of using the digital tool (addition or replacement)
The effect of using digital toolsin the teaching process (learning)	R	. 453 **	-.052	-.358 **
	p	.0 0 7	.632	.001
	N	88	88	88

A legend . * p < .05** p < .01

According to the values of the correlation coefficient (R) there is a relationship between the use of a digital tool (how often) and the effect of the use of digital tools in the teaching process (learning), and a significant positive correlation R = .453 with p<0.01 in other words, with using digital tools in the subject of mathematics increases the effect and efficiency of the teaching process and learning in that subject. Furthermore, there is no correlation of Type of digital - mathematical tool with the Effect of using digital tools in the teaching process (learning) p >0.05 but on the other hand there is a small significant negative correlation of Use (purpose) of using the digital tool (supplement or replacement) with the Effect of using digital tools in the teaching process (learning) and that R = -.355 with p <0.01 in other words the

improvement of mathematics learning after using digital tools follows depending on the purpose or purpose of using the tool itself whether it is to supplement or to replace the teaching methods in the subject of mathematics.

To clarify this finding in more detail, in Table 4 (t-test) follow the statistical conclusive analyzes for the potential differences in the efficiency (effect) of the use of digital tools according to Using a digital tool (how often) - Table 4 and according to Use (purpose) of using the digital tool – Table 5:

Table 4: Potential differences (One way anova) of the Effect of using digital tools according to Using a digital tool (how often)

The effect of using digital tools in the teaching process (learning)	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F	Sig.
					Lower	Upper		
I do not use	17	2.06	1,088	.264	1.50	2.62		
Several times a month	40	1.99	1,137	.180	1.51	2.24		
Two or three times a week	20	2.30	1,031	.231	1.82	2.78	2,754	.006
Every day	11	2.64	.809	.244	2.09	3.18		
Total	88	2.10	1,083	.115	1.87	2.33		

According to the values in Table 4 , the efficiency according to the use of digital tools for *Every day* has an arithmetic mean M=2.64 with SD=.809 for *Two-three times a week* M=2.30 with SD=1.031 for *Several times a month* M=1.99 with SD=1.137 and for *I don't use* M=2.06 with SD=1.088 further, are these differences of arithmetic means statistically significant and how are they potentially grouped, according to F =2.754 with p<0.01 we conclude that there are significant statistical differences between arithmetic means or in other words the efficiency of using of digital tools in the teaching process is higher among those teachers who use digital tools *Every day* and *two-three times a week* (Group 1) and the efficiency is lower among those who use them *several times a month* (Group 2). Efficiency is not our priority in this research according to those teachers who do not use us.

Table 5: The potential differences (Independent sample t-test) of the Effect of using digital tools according to the Use (purpose) of using the digital tool

	UsageOnDigital tool.	N	Mean	Std. Deviation	t	Sig. (2-tailed)
The effect of using digital tools in the teaching process (learning)	In addition to other methods	58	2.38	.988	3,552	.001
	As a substitute for other methods	30	1.57	1,073		

According to the values in Table 5, the efficiency according to the use of digital tools as a *supplement* to teaching methods has an arithmetic mean M=2.38 with SD=.99 against the efficiency according to the use of digital tools as a *substitute* for teaching methods with an arithmetic mean M=1.57 with SD=1.07 further are these differences of arithmetic means statistically significant, according to t =3.55 with p<0.01 we conclude that there are significant statistical differences between arithmetic means or in other words the efficiency of using digital tools in the teaching process is greater among those teachers who use them as *Addition* to other methods (M=2.38) versus those teachers who use digital tools as a *substitute* for other methods in teaching mathematics.

Conclusion

The analysis of the research data indicates the fact that digitalization in the subject of mathematics is significantly present and shows a positive statistical trend of growth, with the result that

62.5% of teachers use some digital tools from Intelligent Dynamic Mathematical Systems and 37.5% of teachers declared that they use Hypermedia systems. On the other hand, according to the findings of relevant research on the influence of the type of digital tool itself on the efficiency of the teaching process in mathematics in primary education, it resulted that about 66% of teachers use digital tools as an addition to other methods against 34.1% as a replacement of previous teaching methods after teaching mathematics. As the main goal of this research, how much impact does the use of digital tools have on teaching and learning mathematics in primary education in Macedonia, with conclusive statistical methods of Pearson's correlation and T-test for potential differences, it resulted that half of the teachers or 50% declared that the overall teaching process and learning in the subject of mathematics improved significantly with the use of digital tools against 23.9% who declared that there was a slight improvement. On the other hand, 13.6% declared that after using digital tools it made learning more difficult compared to 12.5% who declared that there was no improvement or the teaching of mathematics is the same as before with a classical style. According to these findings, we conclude that the three hypotheses of the research are sustainable and are confirmed.

From all this, we can conclude that in the primary education in the Republic of North Macedonia in the subject of mathematics, the use of digital tools and content is necessary with the new changes in the educational process, which means it is not a trend, but a need for both teachers and students. Learning mathematics with the help of digital tools encourages the digitalization of learning materials, which enables faster access to information and its processing. This is the only way to face the new era and respond to new challenges in the educational process, especially in the teaching of mathematics.

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Defining indicators of sustainable development in the food industry

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ABSTRACT

The paper explains the way of the research that was done using the AHP methodology to reveal the indicators that contribute to sustainable development in the food production industry. The concept of sustainable development is based on the general goal that strives to achieve economic and technological development without damaging the environment. The research was developed in the Republic of North Macedonia, concentrated in the region of Tetova

and Pollog, where all the relevant institutions with an impact on the development of the industry were interviewed.
The Government of the Republic of North Macedonia, through the National Council for Sustainable Development, reaffirms its commitment to the realization of Agenda 2030 of the Organization of United Nations (UN). The Analytic Hierarchy Process (AHP) is a method for organizing and analyzing complex decisions, using mathematics and psychology. It was developed by Thomas L. Clocks in the 1970s and has been refined ever since. It contains three parts: the ultimate goal or problem we are trying to solve, all the possible solutions, called alternatives, and the criteria by which you will judge the alternatives. AHP provides a rational framework for the required decision by quantifying its criteria and alternative options and relating those elements to the overall objective. Stakeholders compare the importance of the criteria by comparing the criteria in pairs.

KEYWORDS: Sustainable development, AHP methodology, criteria, alternatives, EC-expert choice

1 Introduction

The method of research through the EC (Expert Choice) software provides real results, which represents a complex process of completing the entire cycle of research. (1). Defining the hierarchy of the problem, determining the indicators as well as clarifying them with appropriate comparisons of their values for the Republic of North Macedonia and the EU in the direction of the sustainable development of Macedonia is of special importance. The idea of the research starts from the main goal, "Identification of the indicators for sustainable development". Which is furthermore developed in three main group factors, economy, social and environmental, third step is research of criteria and sub-criteria that are specified for the level of development of R. of N. Macedonia and generally are analyzed as targets of the United Nations and the European Union. The indicators that are part of the research are considered important for the achievement of the main goal and are also part of the national strategy for sustainable development of the country.
When determining the appropriate factors, i.e. criteria, sub-criteria and indicators, i.e. in the definition of the problem as well as in the process of its solution, the boundary of the project is considered at the level of the Republic of North Macedonia in a generalized, general context with an emphasis on the Planning Region of Polog in the Republic of North Macedonia and the food industry of meat, bread and milk. The greater number of indicators that are taken into account and that are important for detecting and developing indicators for sustainable development in the food industry and comprise the national strategy for sustainable development.
As previously explained, the AHP method and the EC software were used to solve the problem. (2)

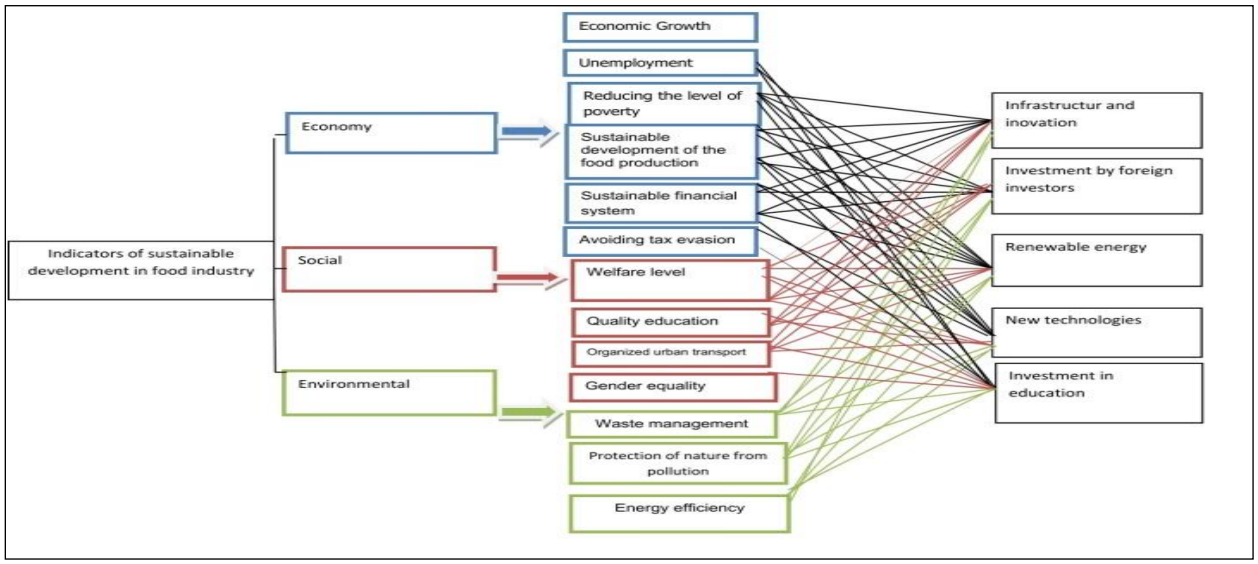

Figure 1 hierarchy of research structure

A total of 20 experts from different fields (academic community, ministries, local government, companies

and independent consultants) expressed their opinions, ie preferences.

The indirect approach in determining the weighting factors through pairwise comparison and determination of preferences are one of the clear advantages of AHP, as well as the possibility of identifying non-serious participants by checking for inconsistency. On the other hand, in the case where there are a large number of comparison pairs for which the participants have to declare, it is very important that the participants are really motivated and concentrated. Therefore, taking into account this complexity, it is recommended to use various workshops in order to fill in the questionnaires, or direct interviews.

1. Methodology of research

During this research, a form of direct interviews (question by question) was used with the majority of participants, while the rest received the questionnaire by e-mail, and answered it after previously received clarifications, as well as comments and questions from their side (3). The questionnaire contains questions according to the principle of preference when comparing pairs, and they are grouped into 4 hierarchical levels. Preferences are determined according to Saaty's scale. The model of the questionnaire is shown in Figure no. 2.

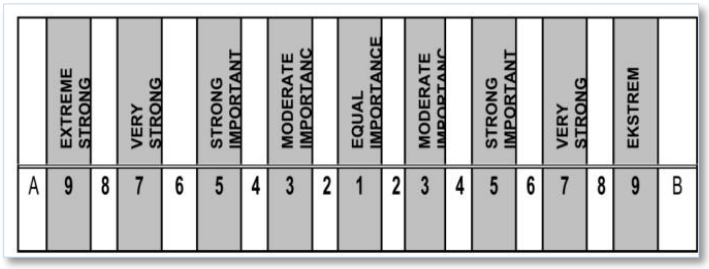

Figure 2: Example of indirect determination of weighting factors through comparison of pairs (AHP) through the development of a direct interview questionnaire (Source: Sutter, 2003)

2. Processing the results using EC

For the calculation of the weighting factors of each of the indicators, the AHP method is used as previously explained. By using the EC software, the weighting factor of the indicators of each participant in the examination is calculated, that is, the weighting factors of all participants are aggregated, which correspond to the elements of the matrix A.

Equation I

$$A = [aij] = \begin{bmatrix} \frac{w1}{w1}, \frac{w2}{w2}, \dots \frac{w1}{wn} \\ \frac{w2}{w1}, \frac{w2}{w2}, \dots \frac{w2}{wn} \\ \dots\dots\dots\dots\dots\dots\dots, \\ \dots\dots\dots\dots\dots\dots\dots, \\ \frac{wn}{w1}, \frac{wn}{w2}, \dots . \frac{wn}{wn} \end{bmatrix}$$

Where $w>0$ и $\sum_{i=1}^{n} wi = 1$

The processed results with the EC (expert choice) software give us quantified values that are easy to compare and to create a priority scheme of activities to achieve the goal. Where L represents the number of hierarchical levels. The sum of the determined weighting factors from each hierarchical level should

correspond to the following expression::

$$\sum_{j=1}^{n_i} w_j = 1$$

At the same time, the software also performs a consistency check in order to exclude from the analysis inconsistent answers, that is, participants (4).

Adhering to this theoretical knowledge, the specific objective of researching the indicators for sustainable development of the food industry in the specific region was formed and the structure of our research was formed.

The research indicators are based on the three basic development pillars:

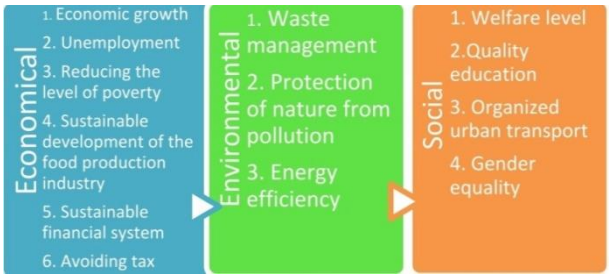

Figure 3: Research indicators of the three groups of factors

When we analyze the processed results of all indicators, it can be observed that the weighting factor of the group of environmental indicators is the highest ranked, as can be seen in the attached image:

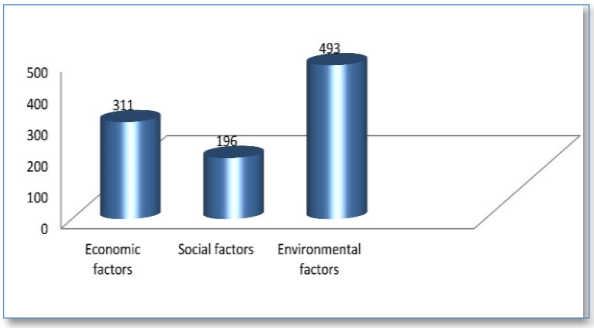

Figure 4: Groups of factors according to value weight

The processed results with the EC (expert choice) software give us quantified values that are easy to compare and to create a priority scheme of activities to achieve the goal, which in this case is 0.05 and gives us reliability and confidence in the results obtained.

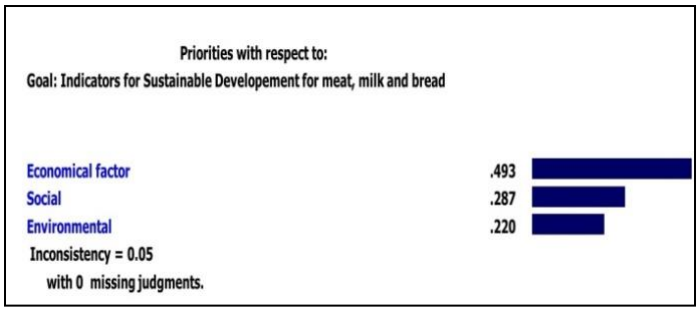

Figure 5 Prioritized group of factors with consistency rate

With the help of the ES software, the consistency rate of the answers can be checked, which shows how serious and concentrated are the answers in the questionnaires in picture no. 6, the value weights for all the indicators that were obtained after the completion of the tests that were declared individually by experts

from several functions and professions that are related to the strategic functioning of certain sectors of production are shown.

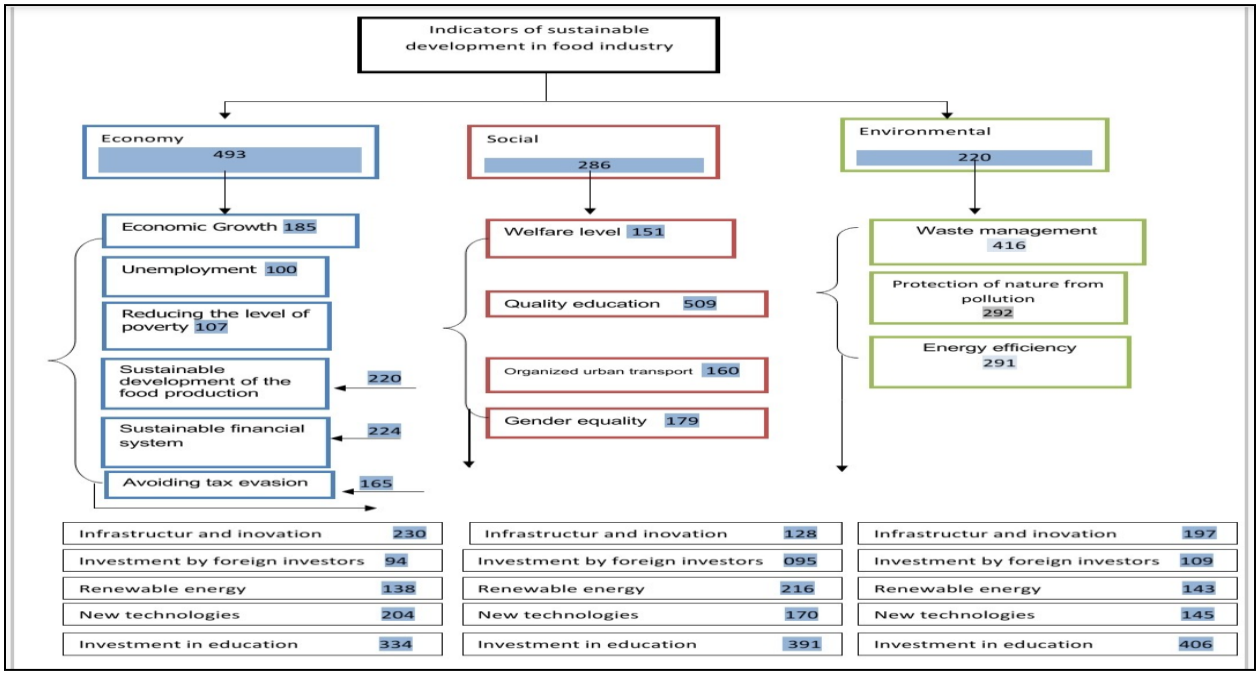

Figure 6: Hierarchy of the problem whith the highest values for the waghting factors

In Figure 7, we show the indicators with a higher value weight in each group of sustainability factors
The indicator "waste management" is dominant according to the value weight compared to all other indicators that belong to the group of factors from "Environment", and in the same direction it lets us know that when creating sustainable strategies it should be taken into account that the importance of this indicator is of special importance for achieving efficient and sustainable production in the food industry.

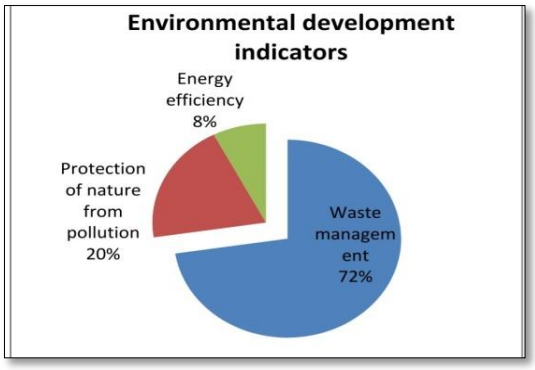

Figure 7 Indicators from the group of environmental factors

3. Determination of alternatives and their ranking

In order to evaluate the possibilities for sustainable industrial development through the indicators that are presented in the model (picture no. 7) in further research, as a subgroup of indicators they will be analyzed as alternatives. Considering the country's level of economic development, competitive conditions, workforce, technological development and wider circumstances, we set the following alternatives as

optional factors for development:

1. Infrastructure and innovation, A1
2. Investment by foreign investors, A2
3. Renewable energy, A3
4. New technologies, A4
5. Investment in education, A5

Accordingly, the five alternatives are compared according to the same model with the third level of indicators. Multi-criteria decision-making software is also used to rank the alternatives, where we get the weighting facts through the EC tool, for each particular alternative.

Alternative 1	Infrastructure and innovation	113	3
Alternative 2	Investment by foreign investors	021	5
Alternative 3	Renewable energy	047	4
Alternative 4	New technologies	200	2
Alternative 5	Investment in education	619	1

Table 1: Ranking of alternatives

The results show (table no. 1) that Alternative 5 – Investments in Education has the highest importance, that is, the value of the weighting factor is at a significantly higher level compared to the other alternatives. Alternatives: New Technologies, Infrastructure and Innovations, Renewable Energy, Foreign Investments are
of great importance and complement each other to achieve Sustainable Development of the Food Industry. According to the indicators that emerged from the answers given by the experts when filling out the questionnaires using the EC tool, in picture no. 7 it can be seen that alternative no. 5 "Investment in Education" is ranked highest in each of the three groups of factors

4. Conclusion

After analyzing the processed results, we conclude that we have consistent results and that the respondents had a clear picture of the topic and the essence of the questions and answered them seriously, based on sustainable development goals, where the most is expected precisely from education, which should urgently turn to achieving sustainable goals. The use of technologies that enable energy efficiency requires newly educated personnel to raise awareness of the need for sustainability and real possibilities.

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IDENTIFICATION AND CONSTRUCTION OF SOME SPECIAL CLASSES OF SELF-COMPLEMENTARY GRAPHS

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Abstract
A self-complementary graph is a simple graph that is isomorphic to its complement. Thus, a graph G is self-complementary if there is an isomorphism from G to G^c. Due to the special structure of these graphs, they are rare in number compared to arbitrary simple graphs with the same number of vertices.The main goal of the paper is to identify self-complementary graphs through the definition and analysis of their basic properties, especially the existence of an isomorphism between two such graphs. However, the paper also contains results related to the construction of self-complementary graphs, and some of their more complex properties are listed.
Furthermore, the emphasis in this paper is also the construction of some special classes of self-complementary graphs, especially those with 8 vertices,with the fact that the text is accompanied by figures in order to better observe of their properties.
The last part of the paper contains a smaller number of assertions about the 3-cycles and paths in self-complementary graphs.

***Keywords**:*Self-complementary graphs;sequence of degrees;isomorphism; graph construction.

1 Introduction

We will first state the definition of complementation as a special unary operation on simple graphs. We emphasize that all the graphs that we will mention in this paper will be simple.

Definition 1. Complement G^c of a simple graph G is a simple graph with the same set of vertices $V(G)$ as G, where two vertices are adjacent in G^c if and only if they are not adjacent in G, i.e.

$$\forall u,v \in V(G) \text{ is valid } uv \in E(G) \Leftrightarrow uv \notin E(G^c).$$

A self-complementary graph G is a graph that is isomorphic to its complement, i.e. it is a graph for which $G \cong G^c$ holds.

It is important to note that although G and G^c are isomorphic graphs with the same set of vertices, they are different though. In fact, they have no common edges. Therefore, G and G^c have the same properties due to isomorphism, but an arbitrary subset of the set of vertices will generally have different properties in G compared to properties in G^c. Now we will state the basic properties of self-complementarygraphs.

Proposition 1. If G is a self-complementary graph with n-vertices, then $|E(G)| = n(n-1)/4$ and $n \equiv 0$ or $1 \pmod 4$.

Proof. Since the union of the graph G with n-vertices and its complement G^c is a complete graph K_n, that is

$$|E(G \cup G^c)| = |E(K_n)| = \binom{n}{2}.$$

Since G is a self-complementary graph, it holds

$$|E(G^c)| = |E(G)| = \frac{1}{2}\binom{n}{2} = \frac{n(n-1)}{4}.$$

The number of edges is an integer, so we conclude that the number of vertices n is either integer divisible by 4 or when dividing by 4 gives a remainder of 1.

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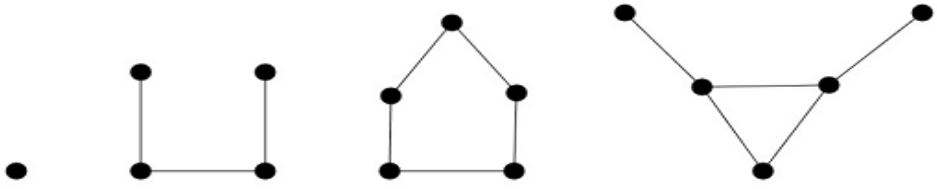
The above proposition can be effectively used to prove that some graphs are not self-complementary, thus: just need to count all vertices and edges.If at least one of the obtained numbers does not fulfill the properties of Proposition 1, we immediately conclude that the graph is not self-complementary. Proposition 1 is also very useful in finding graphs that are self-complementary but have a very small number of vertices (graphs where the number of vertices at most 7).For $n < 7$, the only self-complementary graphs have 1, 4 and 5 vertices with 0, 3 and 5 edges respectively, i.e. we have only four self-complementary graphs and they are shown in Fig.1. The complete graph K_1 is also known as a trivial graph, graph P_4 is a path with 4 vertices, graph C_5 is a cycle with 5 vertices, and the A-graph is also known as "*Bull graph*" (Fig.1).



K_1 P_4 C_5 A-graph

Fig.1: Elementary self-complementary graphs

In the following, we present a basic property about the connectivity of self-complementary graphs:

Proposition 2. Every self-complementary graph is connected.

Proof. The assertion of the proposition is a consequence of a more general result about the connection of complements of graphs.

Lemma 1. At least one of the graphs G and G^c is connected.

Proof. If G is connected, we have nothing to prove. It is possible that the G^c will be a disconnected graph, as is the case with, for example, the complement of the complete graph K_n, or else the complement will be a connected graph, such as, for example, the complement of the cycle C_n with $n \geq 5$ vertices. Assume that G is not a connected graph and show that the G^c is a connected graph. Let u and w be two arbitrary vertices of the graph G. If u and w are not connected by an edge in G, then they are connected by an edge in G^c so we have paths (of length one) in G^c between every such two vertices in G. If uw is an edge in G, then u and w are not connected by an edge in G^c.However, u and w are in the same connectivity component of the graph G, so in G^c there will be at least one vertex v from each of the remaining connectivity components such that uv and wv are not edges in G, but will be edges in G^c, i.e. there is a path uvw in G^c for every two adjacent vertices u and w from G.

Now it is clear that from Lemma 1 it immediately follows that every self-complementary graph is connected.

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2 Degree sequences in self-complementary graphs

Some more elementary properties of self-complementary graphs related to the corresponding degree sequences will be shown:

Proposition 3. Let G be a self-complementary graph with n vertices. The sequence of degrees $(d_1, d_2, ..., d_n)$ of G is symmetric with respect to $(n-1)/2$, i.e. it holds

$$d_i + d_{n-(i-1)} = n-1, \qquad (i = 1, ..., n).$$

In particular, the following assertions apply:

(i) if $n = 4k, (k \in \mathrm{N})$, exactly half of the vertices of the graph G have even degree, and exactly half of the vertices have odd degree;

(ii) if $n = 4k+1, (k \in \mathrm{N})$, then G contains at least one vertex of degree $(n-1)/2 = 2k$.

Proof. Let v be an arbitrary vertex of the self-complementary graph G and let its degree be equal to d. Then, according to the definition of the complement of the graph G, $d_{G^c} = n-1-d$ necessarily holds.Therefore, if $q = (d_1, d_2, ..., d_n)$, where $d_1 \geq d_2 \geq ... \geq d_n$, a sequence of degrees in G, then $n-1-d_1 \leq n-1-d_2 \leq \cdots \leq n-1-d_n$ so $q' = (n-1-d_n, n-1-d_{n-1}, ..., n-1-d_1)$ a sequence of degrees in G^c .However, since G is self-complementary, the sequences q and q' must be equal, that is, $d_i = n-1-d_{n-(i-1)}, \quad (i = 1, ..., n)$ must hold, so we conclude that

$$d_i + d_{n-(i-1)} = n-1, \qquad (i = 1, ..., n).$$,

Before we present interesting results about sequences of degrees of self-complementary graphs, it is necessary to define and explain the meaning of graph antimorphism.

Definition 2. The isomorphism ϕ of a given graph G to its complement G^c is called anantimorphism. The mapping ϕ is a permutation of the set of vertices $V(G)$ such that:

$$v, w \in V(G),\ vw \in E(G) \quad \Leftrightarrow \quad \phi(v)\phi(w) \in E(G^c) \quad \Leftrightarrow \quad \phi(v)\phi(w) \notin E(G).$$

If the set of vertices V^* is fixed under the permutation ϕ, i.e. $\phi(V^*)=V^*$, then the equivalences from the definition hold even if we restrict the ϕ to V^*. This is a very important observation because from it we conclude that V^* induces a self-complementary subgraph of the graph G with antimorphism $\phi\big|_{V^*}$, i.e. it holds:

$$\phi(V^*)=V^* \;\Rightarrow\; \left|V^*\right|=4m \text{ or } 4m+1 \text{ for some } m. \qquad (1)$$

It is worth mentioning here that in a general sense, subgraphs or induced subgraphs of a self- complementary graph G are not themselves self-complementary graphs.One such simple example of a subgraph is the complete graph K_2.Therefore, one cannot perform the characterization of self-complementary graphs by means of non-property subgraphs or non-property induced subgraphs.

Furthermore, the notion of antimorphism will be useful to prove two lemmas that talk about the parity of the number of vertices of a certain degree in a self-complementary graph.The first Lemma refers to the counting of vertices of some degree that is different from the number $(n-1)/2$, and the second Lemma about the number of vertices whose degree is exactly equal to that number.

Lemma 2. In a self-complementary graph G with n-vertices, the number of vertices of given degree d, where $d\neq(n-1)/2$, is an even number.

Proof.Assume that the self-complementary graph G has exactly r-vertices of degree d and let $d\neq(n-1)/2$ hold.Then we know that G has exactly r-vertices of degree $n-1-d$, so every antimorphism maps these vertices into each other.Therefore, we conclude from (1) that we have $2r$-vertices that induce a self-complementary graph, and since $2r$ is an even number, it only makes sense when it is $2r\equiv 0(\mathrm{mod}\,4),\ \text{i.e.}\ r\equiv 0(\mathrm{mod}\,2)$.,

Lemma 3. In a self-complementary graph G with $4k+1$ vertices, the number of vertices of degree $2k$ is equal to $4m+1$ for some m.

Proof. If the self-complementary graph G with $4k+1$ vertices has r-vertices of degree $2k\ [=(n-1)/2]$, then every antimorphism must map them into itself, so according to (1) $r=4m$ or $r=4m+1$ holds for some m. However, if $r=4m$, then according to Lemma 2 the number of vertices of each degree would be an even number, which is impossible. Therefore, we conclude that $r=4m+1$ is valid for some m, i.e. the vertices of degree $2k$, in a self-complementary graph with $4k+1$ vertices, is oddly many.,

About the structure of antimorphisms, it is worth state and prove a well-known and above all applicable result [1],[2]:

Theorem 1. Every cycle of the antimorphism ϕ has a length divisible by 4, except in the case of a fixed vertex when $n=4k+1$.

Proof. If $(v_1,v_2,...,v_r)$ is some cycle of the antimorphism ϕ on the graph G, then according to(1) we have $r=4m$ or $r=4m+1$. Let $(v_1,v_2,...,v_r)$ be a cycle of ϕ where $r=4m+1$ for some $m\geq 1$. Then we have

$$v_1v_2\in E(G) \;\Leftrightarrow\; v_2v_3\notin E(G) \;\Leftrightarrow\; \cdots \;\Leftrightarrow\; v_{4m+1}v_1\in E(G) \;\Leftrightarrow\; v_1v_2\notin E(G),$$

so we got a contradiction with the assumption that v_1 and v_2 are adjacent in the graph G. Therefore, every odd cycle must be a fixed vertex. Moreover, antimorphism cannot fix some two different vertices x and y, because then would be valid

$$xy\in E(G) \;\Leftrightarrow\; \phi(x)\phi(y)\notin E(G) \;\Leftrightarrow\; xy\notin E(G).$$

This means that all cycles must have a length that is a multiple of 4, except possibly a cycle that is a fixed vertice. It is obvious that the total number of vertices is even or odd depending on the occurrence of that one odd cycle. Well, from that we get the claim. ,

3 Construction of self-complementary graphs

A particularly important question when studying self-complementary graphs is to establish how numerous such graphs are, that is, how the number of non-isomorphic self-complementary graphs with n vertices depends on n. In the following, we will explain how some self-complementary graphs are constructed and how many non-isomorphic self-complementary graphs with n vertices are there for some special n.
Studying the problem of counting self-complementary graphs with n vertices [6], it was discovered that there are exactly 10 self-complementary graphs with 8 vertices and their uniqueness was proved [8].

We start by constructing a self-complementary graph G with 8 vertices. Namely, from Proposit- ion 1 it has 14 edges, so it follows that the sum of the degrees of the vertices in G is equal to 28. Using the results about degree sequences of self-complementary graphs, we conclude that there are only 6 different ways in which we can form a sequence of degrees of the vertices in G. The following table shows these cases, where we assumed that $V(G)=\{v_1,v_2,v_3,v_4,v_5,v_6,v_7,v_8\}$:

v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8
1	1	1	1	6	6	6	6
1	1	2	2	5	5	6	6
1	1	3	3	4	4	6	6
2	2	2	2	5	5	5	5
2	2	3	3	4	4	5	5
3	3	3	3	4	4	4	4

Let us show that the first two sequences, $(1, 1, 1, 1, 6, 6, 6, 6)$ and $(1, 1, 2, 2, 5, 5, 6, 6)$ cannot be degree sequences of a simple graph.Because if we wanted to construct a graph with a sequence of degrees $(1, 1, 1, 1, 6, 6, 6, 6)$, then we would connect the vertex v_8 of degree 6 with, for example, the vertices $\{v_2,v_3,v_4,v_5,v_6,v_7\}$. But the vertex v_7 is also of degree 6 so we need to connect it with 5 vertices because it is already connected by an edge to v_8. We can only connect it with vertices v_1, v_5 and v_6, because the remaining vertices, excluding v_8, are of degree 1 and they are already connected to v_8. Therefore, v_7 cannot be of degree 6, so such a graph cannot be constructed.Using a similar argument, we conclude that there is no simple graph with a sequence of degrees $(1, 1, 2, 2, 5, 5, 6, 6)$.The following was established for the remaining cases:

(C1): $(1, 1, 3, 3, 4, 4, 6, 6)$ there exists only one self-complementary graph;
(C2): $(2, 2, 2, 2, 5, 5, 5, 5)$ there exist two self-complementary graphs;
(C3): $(2, 2, 3, 3, 4, 4, 5, 5)$ there exist three self-complementary graphs;
(C4): $(3, 3, 3, 3, 4, 4, 4, 4)$ there exist three self-complementary graphs.

If we did not know beforehand the number of self-complementary graphs with 8 vertices, then each of these cases would have to be studied separately to show that there are no more than the specified number of such graphs. Now it is enough to study these ten graphs and show that no two are mutually isomorphic. In the following, we will deal with the proof of non-isomorphism, in which we will present each graph graphically in such a way that it is easiest to see its properties.
Observing the graphs in Figures 2,3,4,5 it is easy to conclude that they are self-complementary. It remains to note that no two of them are isomorphic.Let's notice the following: the graph in Fig.2 is a unique simple graph with a sequence of degrees $(1, 1, 3, 3, 4, 4, 6, 6)$, and at the same time, self-complementary. Let's prove the nonisomorphism of other graphs that have the same degree sequences.

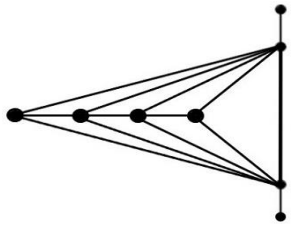
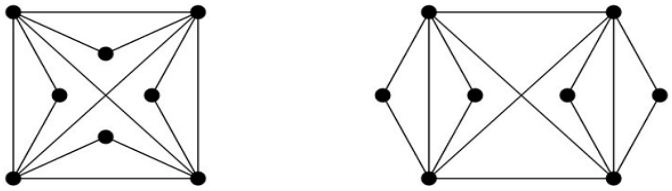


Fig.2: Case (C1): (1, 1, 3, 3, 4, 4, 6, 6)

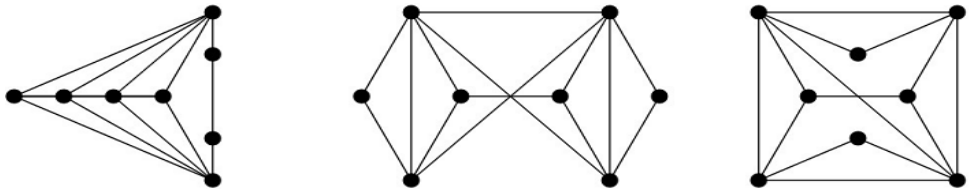
Let's observe at the graphs from case (C2) shown in Fig.3. The graph in Fig.3 (i) is Hamiltonian, while the graph in Fig.3 (ii) is not Hamiltonian, so these graphs cannot be isomorphic.



(i)(ii)

Fig.3: Case (C2): $(2, 2, 2, 2, 5, 5, 5, 5)$

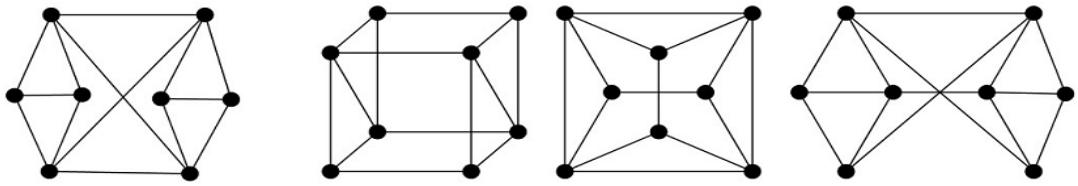
Case (C3) is presented in Fig.4.In the graph in Fig.4 (i), the two vertices of degree 5 are not adjadjacent, while in the graphs in Fig.4 (ii)i.e. in Fig.4 (iii), the vertices of degree 5 are adjacent, and therefore graph 4 (i) is not isomorphic with these graphs. It remains to show that graphs 4 (ii) and 4 (iii) are not mutually isomorphic. In graph 4 (ii), vertices of degree 4 are connected to vertices of degree 2 and vertices of degree 3, whereby these vertices are connected to the same vertex of degree 5 as the vertex of degree 4. It is noticeable that graph 4 (iii) does not have this property, so we conclude that these two graphs are not isomorphic.



(i) (ii) (iii)

Fig.4: Case (C3): $(2, 2, 3, 3, 4, 4, 5, 5)$

Now let's observe at the graphs from the last case. In graph 5 (i) each vertex of degree 4 is adjacent to two adjacent vertices of degree 3. In graphs 5 (ii) and (iii) each vertex of degree 4 is adjacent to two non-adjacent vertices of degree 3. In graph 5 (iv) two vertices of degree 4 are adjacent with two adjacent vertices of degree 3, while the remaining two vertices of degree 4 are adjacent to two non-adjacent vertices of degree 3. Now let's also note that in graph 5 (ii), two adjacent vertices of degree 4 are each adjacent to the same two vertices of degree 3, while graph 5 (iii) does not have this property, so these two graphs are not isomorphic.This shows that no two graphs among the 10 listed are mutually isomorphic.



(i) (ii) (iii) (iv)

Fig.5: Case (C4): $(3, 3, 3, 3, 4, 4, 4, 4)$

4 Constructions of some special classes of self-complementary graphs

We will present three simple methods for constructing self-complementary graphs.In the first two methods, it will be illustrated how a self-complementary graph with n vertices can be built from a self-complementary graph with $n+4$ vertices, while the third method will build self-

complementary graphs with $n = 4k$, i.e. $n = 4k+1$ vertices from two copies of an arbitrary graph G with k vertices and twocopies of complement G^c.

Construction 1
The procedure is as follows:

- Let us take an arbitrary self-complementary graph G with n vertices and a path $P_4 = v_1v_2v_3v_4$.
- Let's connect the vertices of the path P_4, which are of degree 2, with each of the n vertices of the graph G.

This procedure results in a self-complementary graph $(G, P_4)_1$. The following figure shows a self-complementary graph $(C_5, P_4)_1$:

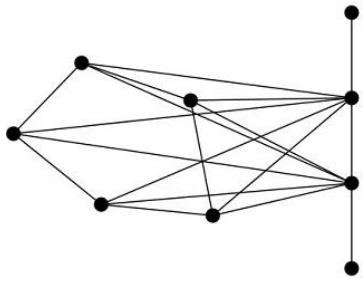
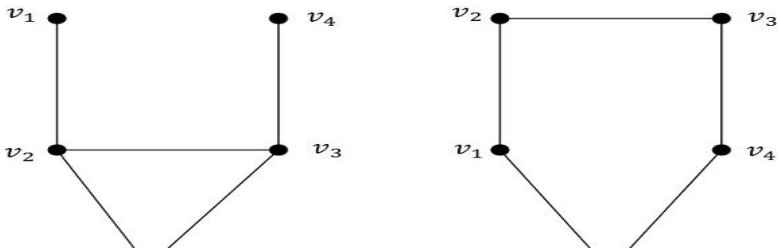


Fig.6: A self-complementary graph with 9 vertices formed by cycle C_5 and path P_4

It is worth mentioning that the graph in Fig.2 was obtained in this way. Here we started from the self-complementary graph P_4, so we connected all its vertices with the vertices of degree two in the new P_4 and thus obtained a self-complementary graph with 8 vertices. In Fig.7, the general form of the graph $(G, P_4)_1$ is shown on the left.

When complementing the graph $(G, P_4)_1$, a graph will be obtained in which the graph G will be G^c, the vertex v_2 will be connected only to the vertex v_4, the vertex v_3 will be connected only to the vertex v_1, the vertices v_1 and v_4 will be connected by an edge , and each of them will be connected to all vertices of the graph G^c. The resulting graph is self-complementary.

Now let's take $G_0 = P_4$ and form $G_1 = (G_0, P_4)_1$ and continue to form graphs G_i according to the rule $G_i = (G_{i-1}, P_4)_1$, then we can generate an infinite family of self-complementary graphs with $n \equiv 0 (\mathrm{mod}\, 4)$ vertices containing exactly two vertices of degree one. Analogously, if we start, for example, from C_5, we can generate an infinite family of self-complementary graphs with $n \equiv 1 (\mathrm{mod}\, 4)$ vertices that also contain exactly two vertices of degree one.



G G

Fig.7: $(G, P_4)_1$ **and** $(G, P_4)_2$

Construction 2
The procedure is as follows:

- Let us take an arbitrary self-complementary graph G with n vertices and a path $P_4 = v_1v_2v_3v_4$.

- Let's connect the vertices of the path P_4, which are of degree 1, with each of the n vertices of the graph G.

Let us denote the self-complementary graph obtained by this procedure by $(G, P_4)_2$.On the right in Fig.7, the general shape of the graph $(G, P_4)_2$ is shown, where v_1 and v_4 denote the vertices of the path P_4, which are of degree one.Let's notice that the graph in Fig.4 was obtained exactly in this way.We started from the self-complementary graph P_4 and connected all its vertices with the vertices of degree one in the newly added graph P_4 and thus obtained a self-complementary graph with 8 vertices, i.e. we obtained the graph $(G, P_4)_2$.

When complementing the graph $(G, P_4)_2$, we will get a graph in which the graph G will be in the place of the graph G^c, the vertex v_1 will be connected only to the vertices v_3 and v_4; vertex v_4 will be connected only to vertices v_2 and v_1; vertices v_2 and v_3 will not be adjacent, but will be connected to all vertices from the G^c graph. The resulting graph is self-complementary.

And using this construction, we can generate infinite families of self-complementary graphs with $n \equiv 0,1 (\mathrm{mod}\, 4)$ vertices, with the property that they do not contain vertices of degree one.

Construction 3

The procedure is as follows:

In this point, we will describe methods for constructing self-complementary graphs with $n = 4k$ $(n = 4k+1)$ vertices that use an arbitrary simple graph and its complement.

- Take a path P_4 and an arbitrary simple graph G with $k \geq 1$ vertices.
- Let's replace the vertices of degree two in P_4 with copies of the graph G, and replace the vertices of degree one in P_4 with copies of the graph G^c.
- If the two vertices v and w in P_4 were connected by an edge, after replacement, all the vertices of the graph replacing the vertex v will be connected by an edge to all the vertices of the graph replacing the vertex w.

The self-complementary graph obtained by this procedure let's denote with $(G, G^c, P_4)_1$ (Fig.8 left). It is noticeable that this graph has $4k$ vertices, and for $k \neq 1$ there are novertices of degree one in it. (For $k = 1$ we have P_4).

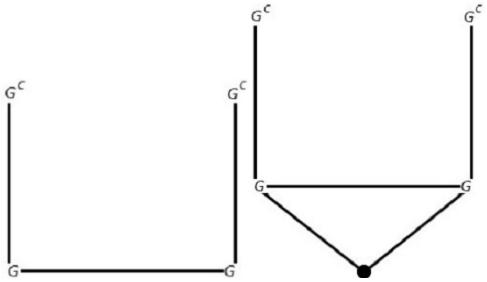


Fig.8: Construction 3

In order to obtain, with this construction, a self-complementary graph with $n = 4k+1$ vertices, we need to add another step (fourth step) to the previously described procedure, namely:

- Let's add a new vertex and connect it to all vertices in both copies of the graph G.

We will denote such a self-complementary graph by $(G, G^c, P_4)_2$ (Fig.8, right).It is noticeable that this graph has $4k+1$ vertices, there are no vertices of degree one, except in the case of $k = 1$ when the resulting graph is an "A-graph".

In the final part of this paper, which is also in the continuation of the topic presented above, we will elaborate on the existence of some special subgraphs of self-complementary graphs, such as paths and cycles.

Let us mention that we have shown how larger self-complementary graphs can be generated from smaller self-complementary graphs, but the question of identifying the self-complementarity property of a graph using some smaller self-complementary graphs arises. For example, self-complementary graphs are rich with subgraphs of type P_4. In this regard, it is shown [7],[10]that every connected graph, whose complement is also connected, must contain an induced subgraph P_4.

Theorem 2.[1](Self-complementary graph decomposition theorem [Gibbs 1974])

A self-complementary graph with $4k$ or $4k+1$ vertices contains k disjoint induced subgraphs P_4.

To find the graphs of type P_4 we need to know that the graph is self-complementary, and also to know the explicit isomorphism from the graph G to its complement G^c. Moreover, by removing one of the subgraphs of P_4, we will not necessarily obtain a self-complementary subgraph with $n-4$ vertices. Therefore, Theorem 2 does not help in finding an efficient test for self-complementarity.

It is known from Ramsey theory that if a graph with at least 6 vertices does not have a 3-cycles (also known as a triangle), then its complement will have one. It immediately follows from this that self-complementary graphs with at least 6 vertices contain 3-cycles. We will state the following theorem about the number of 3-cycles in a self-complementary graph:

Theorem 3.[8](Rao 1979) The number of 3-cycles $\tau(G)$ in the self-complementary graph G depends only on the sequence of degrees d_i and is equal to:

$$\tau(G)=\frac{1}{2}\sum_{i=1}^{n}\binom{d_i}{2}-\frac{n(n-1)(n-2)}{24}.$$

□

On the existence of Hamiltonian paths and Hamiltonian cycles in self-complementary graphs, the following theorem is valid:

Theorem 4.Let G be a finite graph with $n\geq 3$ vertices and a sequence of degrees $d_1\leq d_2\leq\ldots\leq d_n$ such that

$$d_i\leq i<\frac{n}{2}\Rightarrow\ d_{n-i}\geq n-i.$$

Then G has a Hamilton cycle.

□

5 Conclusions

Due to their distinctiveness, recognition and abundance, self-complementary graphs are widely applicable in various fields, and at the same time a challenge for researchers. First of all, proving self-complementarity is a complex and sensitive procedure. After categorization, the construction and counting of self-complementary graphs are also complicated and slow. The formulas that connect the number of self-complementary graphs as a function of the number of vertices are not simple, i.e. they are asymptotic when the number of vertices is $n=4k$ and $n=4k+1$.

The existence of paths and cycles in self-complementary graphs continues to be a research challenge in this area.We have briefly stated only some fundamental results with three theorems that are partially effective.

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ANALYSIS OF SURVEY REGARDING OSH KNOWLEDGE IN AGRICULTURE IN DEBAR, NORTH MACEDONIA

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Abstract: Agriculture is one of the most important economic components of a society, unfortunately accompanied by many casualties related to occupational risks and hazards. The main object of this research is to present the current state of knowledge regarding safety and health at work in agriculture among farmers in the city of Debar. Research is done through questionnaires, observation and interviewing of farmers, in order to interpret a part of the safety and health at work is presented to people who deal with agriculture, based on the basic knowledge of safety and health for agriculture. There are many dangers found on farms. Most of them are ignored, which can cause the farmer to suffer later in terms of ill health, possible injury or death.

Key words: *occupational safety and health; agriculture; awareness; analysis; farmers.*

INTRODUCTION

Numerous studies in the field of agriculture worldwide, indicate the high risk associated with this sector in the field of occupational safety and health (OSH),[1].While considering farming as a very important activity in the human society and development, farmland accounts for 47% of the European territory and ½ of the territory of the Republic of North Macedonia, where agricultureas asector, accounts for 11% of the national GDP,[2,3].

Being a farmer is not an easy job, in fact, according to statistics published by the National Institute for Occupational Safety and Health (NIOSH) in the United States of America,it is one of the most hazardous occupations. Agriculture ranks among the most hazardous sectors wherefarmers are at very high risk for fatal and nonfatal injuries; and farming is one of the few industries in which family members (who often share the work and live on the premises) are also at risk for fatal and nonfatal injuries,[4,5].

Farming is considered to be amongst the most hazardous occupations because farmers are exposed to a wide range of occupational hazards, on a daily basis. The daily job of a farmer usually consists of labor-intensive physical activities which often happenin unfavorable conditions, [6]. According to F.K. Ewete, it has been postulated that occupational health and safety issues in agriculture arise not only because of existing hazards, but also because of illiteracy, ignorance, lack of use or understanding of personal protective equipment, inadequate or non-existent training, and/or misinformation, [7].

MATERIAL AND METHODS

Research was conducted on a number of workers in the agricultural sector and their family members in the region of Debar, North Macedonia. The study population consists of 30 respondents where interviewees were divided into 3 groups: Owners, Family members and Workers. Further, the data were analyzed and divided into different subgroups according to: age, occupation, exposure and level of OSH awareness.

This study was conducted over a period of 30 days, during the months of July and August 2022. The questionnaire was divided into four parts to collect information related to the socio-demographic profile, knowledge, behavior and perception. Also included are questions regarding chemical risks that come as a result of work, and awareness of chemical exposures, ergonomic risks, occupational risk due to sun exposure, as well as the health consequences of these risks and the use of personal protective equipment.

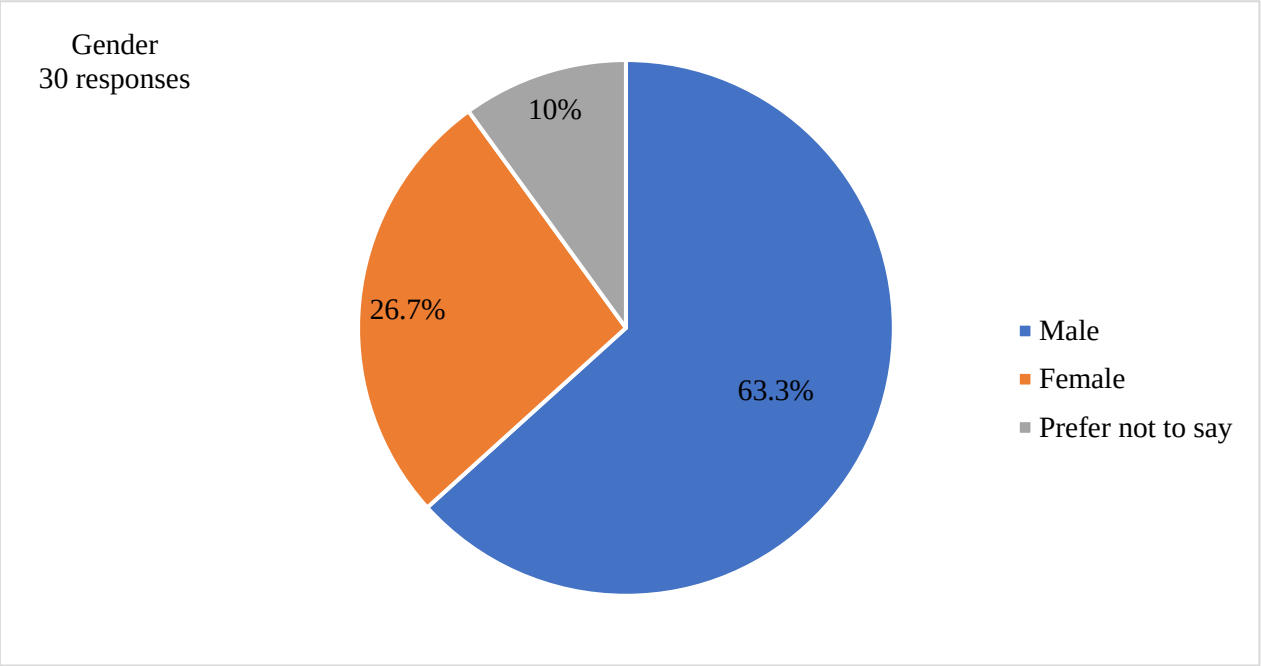
RESULTS AND DISCUSSION

Respondents Socio-Demographic Profile

The purpose of the research is to understand the level of education, behavior and perception of the workers towards the various risks that come from work in agriculture, as well as the evaluation of awareness about OSH. The results in this study are presented in tables and graphs which are based on the objectives of the study.

Based on the data obtained from questionnaires and interviews, the survey included 30 interviewees aged from 0 to over 61+ years old. From the results obtained in Figure 1, we can see that the largest number (63.3%) of workers were male and only 26.7% belonged to the female gender and 10% chose not to define their gender.

Figure 2. ***Gender distribution***



The age distribution from the findings is given in Figure 2. It shows that the labor force in agriculture is relatively middle-aged. This comes from the fact that the majority of respondents (33.3%) belong to the age group of 46-60 years, 30% belong to the 19-30 years old group, followed by the age group of 31-45 years with 23.3%, while the lowest percentage of participants in the agricultural activities are people at ages 0-18 years and people older than +61 years old with 6.7% for each group respectively.

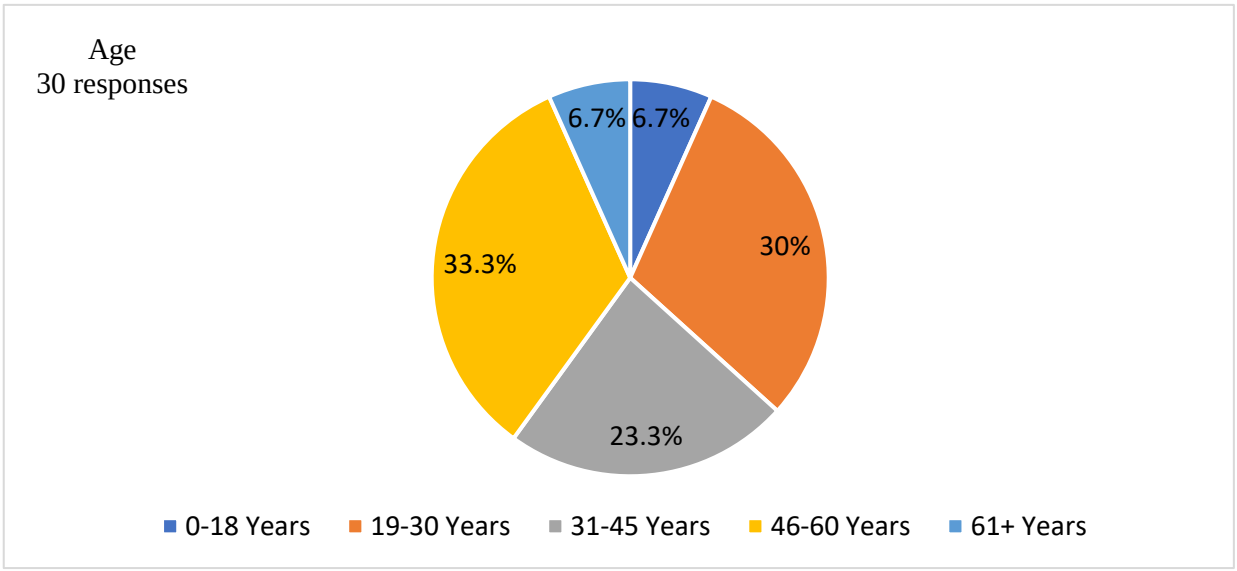
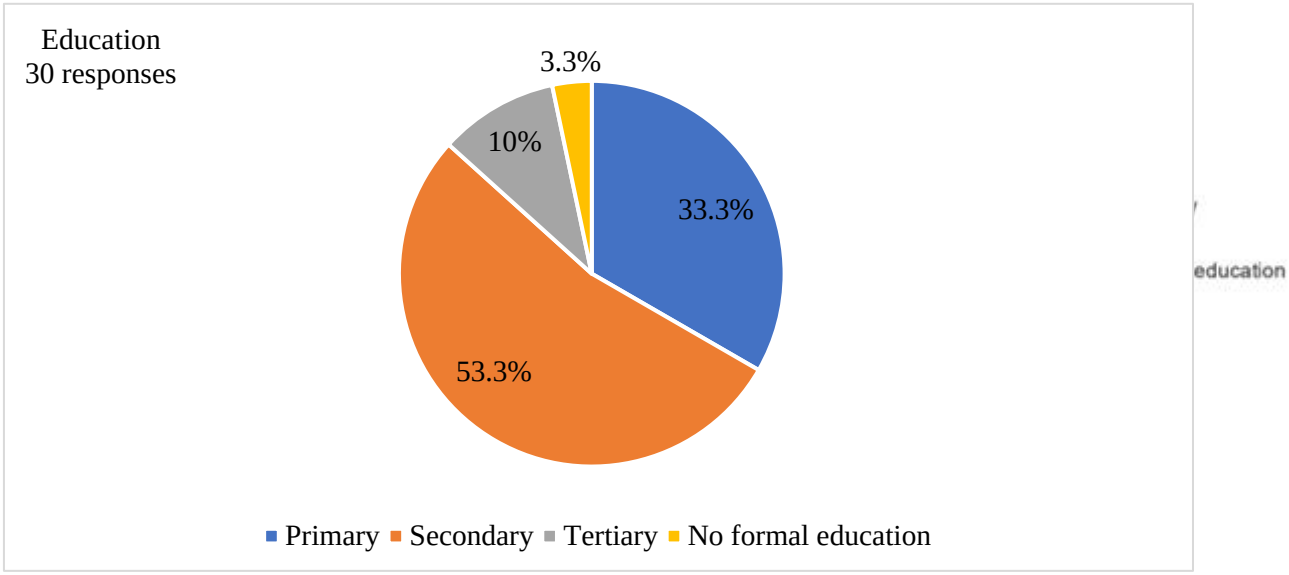


Figure 3. ***Age distribution***

From the results in Figure 3, it is noted that the respondents who have not completed any formal education participate with a lower percentage (3.3%), but also the participants who have achieved tertiary education belong to the minority group with only 10%. The majority of farmers have high school education (53.3%) participationwhile 33.3% of the surveyed farmers had only primary education.

Figure 4. ***Education level***

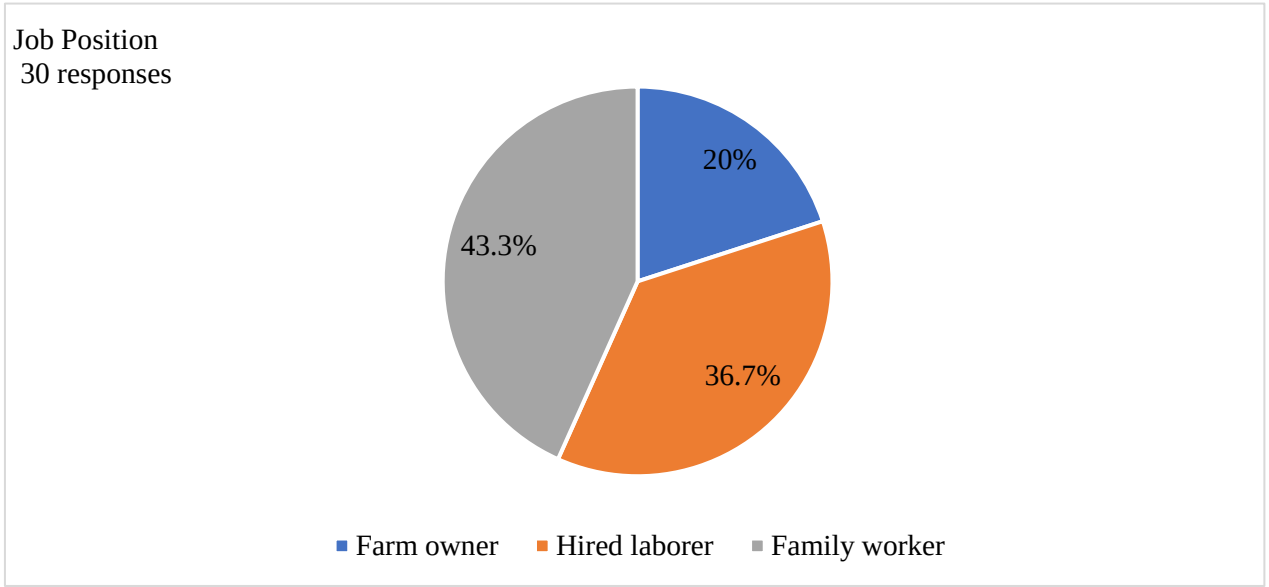


The results presented in Table 1, based on the answers from the respondents, shows that 50% have work experience from 0 to 5 years, followed by those with 16+ years of work experience with 26.7%, and 23.3% of participants with 6 to 15 years of work experience.

Table 1. ***Work Experienceof interviewees***

The most common job position (43.3%) among the respondents was family worker, 36.7% of the results in Figure 4 indicate that they are hired workers and 20% indicate that they are farmers or owners themselves.

Figure 5. ***Job Position***



Understanding individual worker characteristics such as age, gender, education level, and work experience helpsto put the study in context.The evaluation of these characteristics was the key factor for this study as these factors can influence workers in the decision whether they will be more careful or not while performing their activities.

Knowledge

Different studies show that farmers lack necessary knowledge in matters of safety and health at work and as a result fail to comply with the legislations and regulations for OSH, [8]. According to the results presented in Figure 5, we see that the majority (93.3%) of the respondents had no knowledge regarding the Law on Safety and Health at Work in North Macedonia and only 6.7% of the respondents had knowledge.

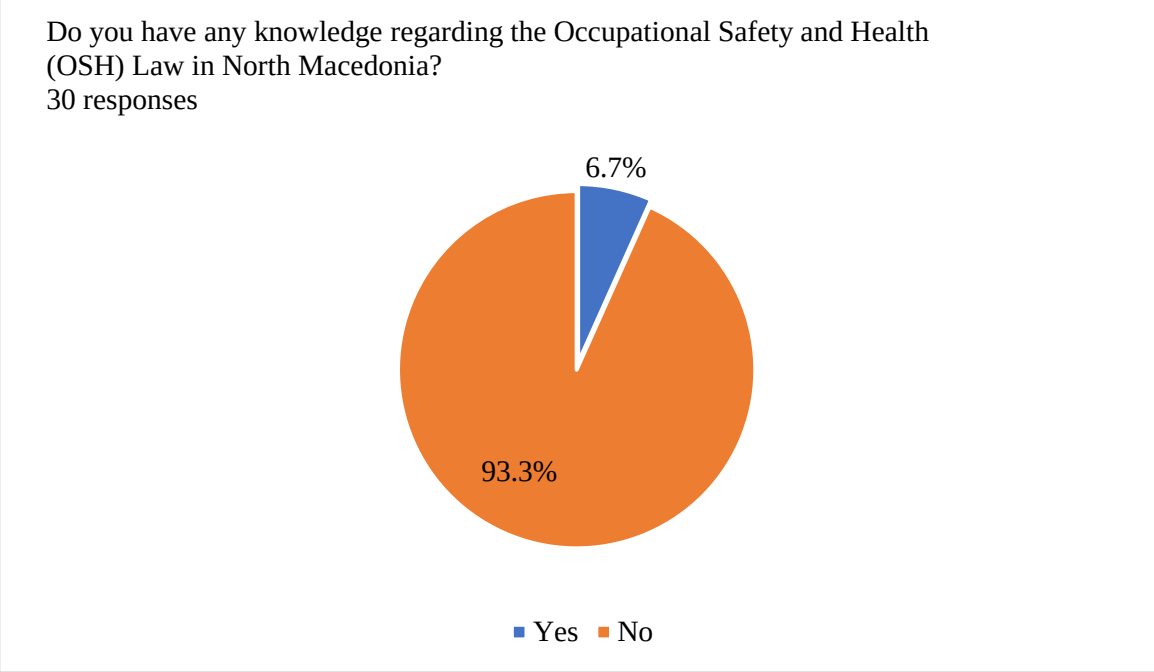


Figure 6. ***Knowledge about the OSH Law in North Macedonia***

Do you know the ill effects that working in the sun can have on your health?		**Do you know how to reduce/prevent the sun's harmful effects on your heath?**
Yes	80%	83.3%
No	20%	16.7%

According to the answers received from the respondents, shown on Table 2, we can see that 55.2% affirmed that they have knowledge of the bad effects that lifting heavy objects and working in difficult positions can have on your body and 44.8% had no knowledge.Meanwhile, when asked about whether they know how to reduce/prevent muscle pain/discomfort caused by the work, 73.3% had no knowledge and only 26.7% claimed to know how.

Table 2. ***Questions about Ergonomic illnesses and prevention***

Do you know of the ill effects that lifting heavy objects and working in uncomfortable positions can have on your body?		**Do you know how to reduce/prevent muscle pains/discomforts caused by your job?**
Yes	55.2%	26.7%
No	44.8%	73.3%

Table 3shows the knowledge of farmers about the harmful effects of chemicals during use or exposure. 60% of respondents answered that they had knowledge and 40% had no knowledge of the negative effects of chemicals. Regarding the consequences of reusing chemical bottles, 73.3% had no knowledge and only 26.7% had knowledge. Only 33.3% knew how to reduce/prevent the harmful effects that chemicals can have on health and 66.7% did not know how to prevent the harmful effects that chemicals can have.

Table 3. ***Chemical exposure and prevention***

	Do you know the ill effects that chemical use/exposure can have on your health?	Do you know the consequences of re-using empty chemical containers for domestic purposes?	Do you know how to reduce/prevent the harmful effects that chemicals can have on your health?
Yes	60%	26.7%	33.3%
No	40%	73.3%	66.7%

The part where the workers were more knowledgeable about the risks (Table 4) was about the harmful effects that the sun can have on the health of workers, where 80% answered that they had knowledge and 20% did not. As for whether they knew how to reduce the harmful health effects of the sun, the majority (83.3%) answered that they knew and 16.7% responded that they had no knowledge.

Table 4. ***Working in the sun and prevention of the harmful effects***

From the responses in Figure 6 of the respondents, we see that 60% of the respondents had knowledge of what could cause you to slip, trip or fall in their workplace and 40% had no knowledge. As for what theywould do in case of an accident or emergency (Figure7), 66.7% had no knowledge and 33.3% had knowledge

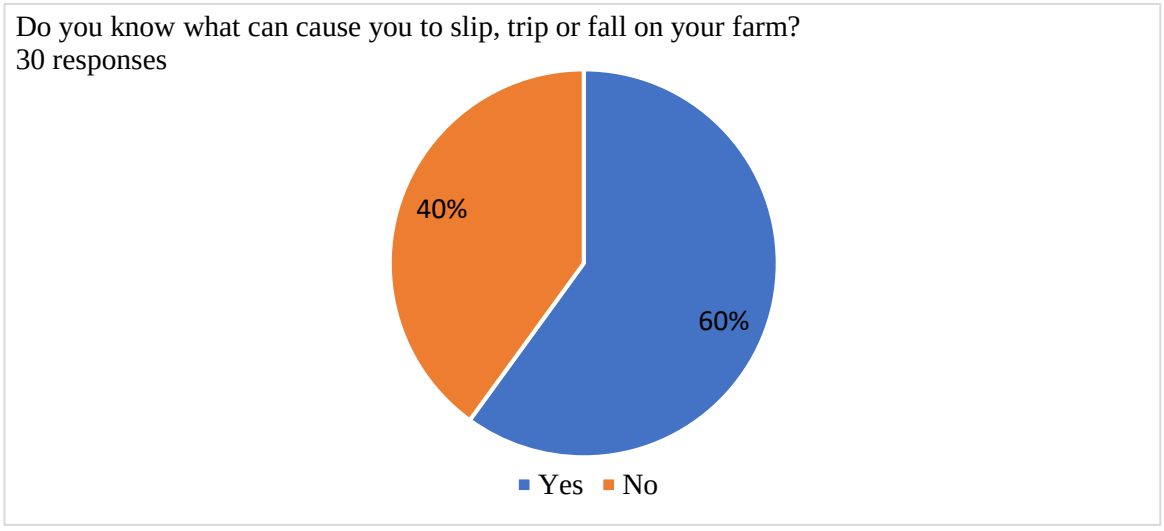


Figure 7. ***Slip, trip and fall causes***

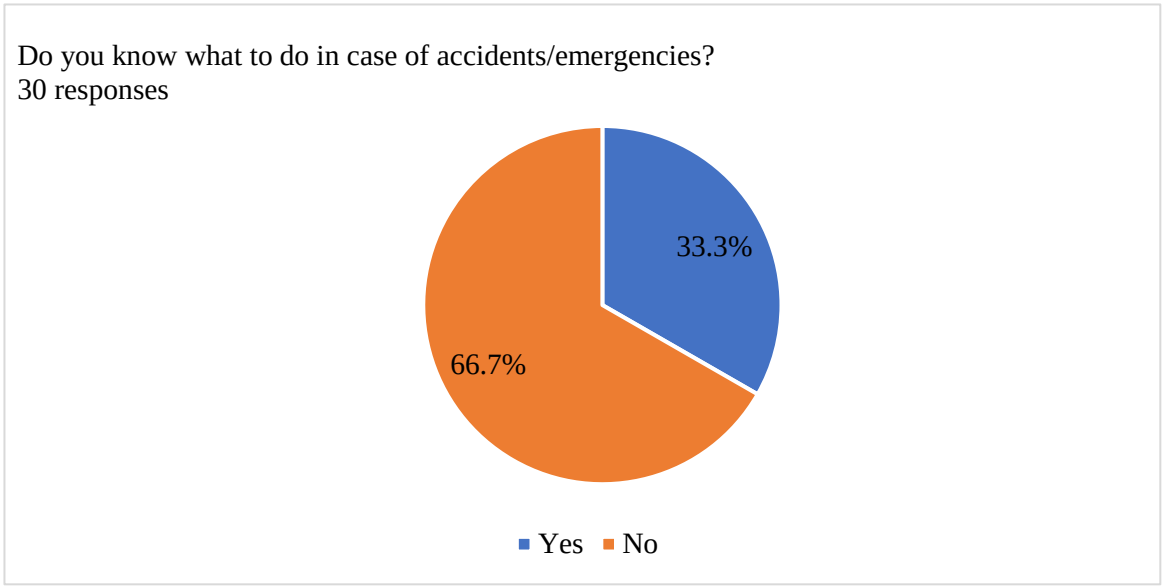


Figure 8. ***Response to accidents/emergencies***

Attitude and Perception

Based on the employees' attitudes towards safety and health, it is observed that the majority of respondents (56.7%) had a neutral opinion about the importance of personal safety when compared to their daily work, where instead of answering that their personal safety is the most important thing, they could not put their safety in front of their occupation, which means that they would accept to continue working in a high-risk environment, regardless of the risks involved. As for the workers' attitude towards safety in general, the majority remained neutral to the questions posed to them.

Table 5. ***Attitude and Perception questions***

	Questions	SA[1]	A[2]	N[3]	D[4]	SD[5]
Attitude	My personal safety is more important than anything else	0%	33.3%	56.7%	0%	10%
	Because I have been doing my job for many years, I believe I can skip some safety steps	10%	30%	26.7%	26.7%	6.7%
	If I saw someone doing something unsafe, I would say something directly to him/her	3.3%	50%	46.7%	0%	0%
	People should take personal responsibility for each other's safety	3.3%	20%	66.7%	0%	0%
	Safety is a high priority for me when I am doing my job	6.7%	26.7%	56.7%	6.7%	3.3%
Perception	My job is dangerous	0%	30%	63.3%	3.3%	3.3%
	I could get easily hurt while doing my job	0%	63.3%	30%		6.7%
	My health can be threatened while doing my job	0%	10%	76.7%	10%	3.3%
	The OSH Law is not useful	0%	13.8%	51.7%	31%	3.4%
	The OSH Law is not effective at reducing injuries and illnesses	0%	10%	56.7%	30%	3.3%

[1] Strongly Agree; [2] Agree; [3] Neutral; [4] Disagree; [5] Strongly Disagree

CONCLUSIONS

Agriculture is considered one of the professions with a high degree of danger, especially in developing countries such as North Macedonia, where more work is needed in the field awareness and education of workers regarding OSH. From the obtained results, the majority of agricultural workers were men, which means that females have a lower participation in this sector. Also, the majority of the respondents belonged to the family workers category, who contributed to family farms, it should be noted that the majority of the interviewees that were women, belonged to this category of workers, often, as the wives of farmers, or as their daughters.

Most of the respondents had completed high school, but a significant number had completed only primary school and the number of

uneducated workers is low. According to the findings there is a correlation between the level of education and knowledge of farmers in terms of safety and health at work, since most of the respondents had no knowledge of the Law of safety and health at work in North Macedonia, the lack of knowledge about the laws may affect adversely the accidents rates.

From the conducted analysis, it is observed that there is a lack of attention regarding personal health.Farmers often choose to ignore their health compared to their occupation, and the idea of collective safety during daily workis missing, where employees, in addition to themselves, must also take care of the well-being of their colleagues and not look up only for themselves. The fact that 43.3% of the interviewees belonged to the category of family members is particularly worrying, because some of them might be under the age of 5, and are involved in agricultural work. This gives the answer to why injuries and even fatal accidents occur very often, where children are the victims.

It is worth noting that the farmers had satisfactory knowledge about working in the sun and preventing the harmful effects of working in the sun, as a result of the knowledge passed down from generation to generation, but there is still a need for professional training on this topic.

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Organizational culture and Leadership as predictors of motivation in an organization

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ABSTRACT
Leadership and organizational culture are two areas that have been in interest of a lot of authors. Empirical findings show link between leadership, culture and performance in an organization; however, this paper will examine the influence of leadership and culture in employees' motivation in business entities in North Macedonia. This study sampled 390 organizations with a view to analyze the influence of these two concepts in employee's satisfaction at their work. There are evidences that relationship between leadership and performance is mediated by the organizational culture but regarding to our responses, employees showed a higher motivation influence from their leaders than from the organizational culture. Likewise, employees who rated their organization as being high in performance orientation trusted their superiors more than employees who rated their organization as being low in performance orientation and organizational culture.

Keywords:
Organizational culture; leadership; performance; motivation, employees, North Macedonia.

1. Introduction

Researchers have examined the links between leadership styles and performance (Howell & Avolio, 1993) and between organizational culture and performance (Deal & Kennedy, 1982) which resulted in a strong relationship.
Organizations with constructive cultures have group norms that promote achievement, participation in decisionmaking, teamwork, social support, constructive interpersonal relations, and self-actualization. In these organizations, employees are encouraged to interact with fellow-workers and approach tasks in ways that will help them meet their higher-order satisfaction needs. (Simosi & Xenikou, 2010). It is generally accepted that an
organization's culture develops, to a great extent, from its leadership while, at the same time, organizational culture has also an impact on the development of its leadership (Bass & Avolio, 1993) Despite the link between these two areas, leadership and organizational culture as an important part of organizational theory, little critical research has been addressed in understanding the link between these two
concepts and their impact in employees' motivation. On the other hand, empirical literature has provided a positive relationship between employee motivation and organizational effectiveness or performance. If the leadership approach toward employees is increased by empowering and recognition, their motivation to work and productivity to achieve organization's goals will improve, as well as their accomplishments and organizational performance. Also, empirical evidence suggests that the relationship between leadership style and performance is
mediated by the form of organizational culture that is present (Ogbonna & Lloyd , 2000).
This paper aims to examines the relationship between leadership and organizational culture and their implication in employee's motivation toward work and productivity in organizations. The paper begins with a brief review of the literature on organizational culture and leadership. This is followed by a discussion of the methodology adopted for the study and the presentation analysis of responses to a mailed questionnaire exploring the links between the two concepts and performance. The evidence demonstrates that the relationship between leadership
and employee's motivation is mediated by the nature of organizational culture. Referring to (Lawal and Outwashes') research we can see the link between leadership, employee's motivation as important part of organizational culture and organization performance. Employees who rated their organization as being high in performance orientation trusted their superiors more than employees who rated their organization as being low in
performance orientation. (Lawal & Oguntuashe, 2012). So importance of Leadership in Organizational Culture is indisputable because by a successful organizational culture defining the mission of an organization and motivating employees to achieve that mission, leadership builds the foundation of company culture. On the other hand, leaders have a big impact on company culture by setting the agenda, prioritize work, manage, lead, and delegate. Regarding to our study we can conclude that strong leaders provide a sense of vision, purpose,
mentorship, and inspiration to those they lead and strong Organizational culture depends on a leader's ability to communicate the company's core values, mission, and goals. The final part of the paper has the conclusions and recommendations.

2. Literature Review

Several studies indicate that leadership significantly influence employee innovative behavior. Employees exhibit intuitively their personal attributes like personality, aptitude, intelligence, creativity, knowledge, and skills in most situations; so, in an organization leaders certainly bring these attributes to bear in influencing their followers toward goals and objectives of the organization. Another empirical study of Australian executives regarding the relationship between leadership and organizational culture, indicated that transformational leadership and transactional contingent reward were more salient predictors of culture than culture was of leadership. (Sarros, Gray, & Densten, 2002). This means that leaders demonstrating contingent reward behavior are likely to inspire feelings of honesty, faith and trust to their followers which is manifested in all aspects of their relationship with each other (Aronson, 2001) which motivates them toward productivity and organizational efficiency.
Sarros J. (2002) show that leadership is a stronger predictor of culture while Block (2003) indicates that immediate supervisors have a greater influence on employee perceptions of culture than do higher leadership levels. Frederick Taylor‘s (1911) theory, organizational leaders would forge a culture that places high priority over productivity and performance at the expense of the wellbeing of the human worker doing the work. Fortynine percent of CEOs are concerned about developing the leaders who will succeed them as part of their human resources strategy and talent recruitment process. Because various ways in which work-related well-being can be defined Warr (2002). Leader behavior (e.g., leader consideration, supportiveness, receptiveness of employees' needs, leader–member exchange) has been examined as an antecedent variable in regard to affective and normative commitment. (Mathieu & Zajac, 1990)
Egan , Yang and Bartle (2004).in their study on effects of organizational learning culture and job satisfaction have examined the relationship of organizational learning culture, job satisfaction, and organizational outcome in the United States with a sample of information technology (IT) employees. From the results they found that learning organizational culture is associated with IT employee job satisfaction and motivation to transfer learning. Also, turnover intention was found to be negatively influenced by organizational learning culture and job satisfaction (Egan , Yang , & Bartle, 2004).
One of studies that shows a significant connection between elements of organizational culture and employees' motivation is the one by Mahal and Prabhjot (2009) .They think that organizational climate as a important element of organizational culture has a potentially rich, but generally unrealized role in the development of an organization as well as to raise the motivation of employees. Researchers perceive problems arising from significant culture and different climate affecting the management and leadership decisions and motivational level among the employees. Among 100 adult employees working in Ranbaxy with the help of various questionnaires, Mahal and Kaur's have examines the influence of organizational culture and climate on the motivation level. The results show that organizational climate factors such as environment, teamwork, management effectiveness, involvement, reward and recognition, competency, and commitment, have been found to influence the motivation and viewed as a multidimensional construct. The results indicate that all eight variables are positively related to the motivation. The study's recommendation explains that to improve the motivation level among employees one must try to improve the organizational culture and climate. (Mahal & Kaur, 2009)
Another study done in Ibadan Nigeria showed positive and negative correlation between leadership style dimensions and organizational performance. It was also found that leadership style dimensions jointly predict organizational performance, which counted for 23% variance of performance. The study concluded that transformational and democratic leadership style should be employed by the Banks' management in order to wax stronger in a global competitive environment. (Ojokoku, Odetayo, & Sajuyigbe, 2012).

2.1. Organizational Culture

The word "culture" is defined in different ways, however what defines it as organizational culture means the common system of attitudes, beliefs, values and behavior in the organization. (Robert Gilbson, 2002). Hofstede called organizational culture the "collective mental program." Meanwhile Schein says that culture is a very complex concept which can explain everything and nothing. People in a company think, feel, value and act, guided by ideas, meanings and beliefs of a cultural (common social) nature. Culture within an organization therefore consists of the beliefs, norms and values that a certain group of people share and can be seen as a challenge for businesses operating internationally (Edgar H Schein, 1984). Schein (2010) in elaborating the concept of culture concludes that: if one understands the dynamics of culture in the organization, individuals within it will find it easier to cope with stress and worries while dealing with previously unknown situations. But there are findings that organizational culture and performance are clearly interrelated (Richard , Brief, & Guzz, 1990). Through organizational culture employees understand the history of their organization as well as the way they operate in that organization. Employees while recognizing the organization understand its values, norms and rules, which leads them to common sense with other employees and motivates them to achieve the goals of the organization and increase the performance of the same. This proves the fact that the organization achieves effectiveness when, despite personal differences, employees

share
the same values and the same goals and quality at work in order to advance the organization.
It is evident that in most organizations the working atmosphere is much more motivating in cases where we have an organizational culture that respects the basic principles of employee development, leaders contribute to increasing the reputation of both employees and the organization in order for people within it to feel valued and give the best. Regarding to this Sharma's paper on impact of organizational culture on job satisfaction of the employees that was conducted in three Information Technology companies in Maharashtra (India), with an sample of 220 IT professionals. The findingsof this paper reveal that organizational cultural values such as fairness, growth opportunities and reputation of organization have a positive effect on the job satisfaction, whereas organizational traits like aggressiveness have a negative influence on job satisfaction (Sharma, 2017).
Based on all these studies, our research will reflect a real state of the relationship between organizational culture and employee motivation in the organization. Given that the performance of an organization depends on many elements but one of the main ones is employee productivity, this hypothesis raised in our study will help us understand more about this relationship of these two variables. Hence our second hypothesis was formulated, and inferential statistical tool was used to analyze the data specifically Pearson product moment correlation was used to examine the relationship between organizational culture and employee' motivation. Based on the literature review we can suggest the following hypothesis:
H1: Organizational Culture has significant impact in predicting employee motivation?
Other studies that were focues on manager's prespective about the topic showed that they thing that on human resource management specified several factors having direct impacts upon individual and organizational effectiveness. Research data in Biswas's study on organizational culture and transformational leadership was collected from 357 managers/executives of different organizations in India and the research was found to have important bearing upon human resource development and the performance of individual employees. The study explores the effect of organizational culture and transformational leadership on individual's intention to quit his/her present organization. (Biswas, 2009)

2.2. Leadership as predictor in motivational

Researches have shown findings that the failure to communicate by leaders or misunderstandings in the organization can lead to disruption or failure of the work process, which means loss for the business. In Buhler and Worden's study of internal leadership communication, it is stated that with more than 100 employees had not a proper communication style or misunderstandings during internal communication, which resulted in increased
financial costs with a load of $ 420,000 per year, which has affected the profitability of the enterprise. (Buhler SPHR, 2013). This loss can be serious demotivation for employees and also a big demange for the organization in achiving the performance efficency.
Leaders have been identified as providing direction, inspiration, and guidance in the organization. Regarding to some emipirical data good leaders exhibit courage and confidence in the workplace. They identify the strengths and talents of their people and build teams committed to achieving the organizational's goals. The impact of leader behaviors on motivation levels of employees was examined in lot of studies and researches. Some researches has shown that communication competence and leadership style were used to predict specific employee outcomes.
In Mikkelson, York, & Arritola's (2015).' research has been concluded that supervisors communication competence and leadership style were used to predict specific employee outcomes. In the study, 276 participants working in various industries completed measures of communication competence and leadership styles about their direct supervisor along with measures of their job satisfaction, motivation, and organizational commitment.
So the concludion as it was predicted, effective and appropriate communication were both positively related to satisfaction, motivation, and organizational commitment. But the leadership styles showed that have been crucial in employee's motivation. Relations-oriented leadership styles were positively related to all three employee outcomes as well. In the end, regression analysis determined that effective communication and relations-oriented leadership were the best predictors of satisfaction, motivation, and organizational commitment (Mikkelson, York, & Arritola, 2015).
Pool in (1996). has reached results from 125 adult Americans between the ages of 20 and 46 years
where he has examine the predictive values of substitutes of leadership, leadership behavior, and work motivation in relation to job satisfaction. The results revealed that all but subordinate substitutes were significant predictors of job satisfaction. In the stepwise analysis, task substitutes, organizational substitutes, consideration leadership behavior, initiating structure leadership behavior, and work motivation were significant and together accounted for 54% of the total variance of job satisfaction. In both the stepwise and independent analyses, work motivation (expectancy theory) and consideration leadership style affected levels of job satisfaction more than any other variables (Pool, 1996).
Reagarding to this what we want to achieve is to ascertain whether there is a direct link between the way we lead, or the leaders and the motivation of the employees in the organization. Hence our first hypothesis was formulated and inferential statistical tool was used to analyze the data specifically Pearson product moment correlation was used to examine the relationship between leadership and employee' motivation. Based on the literature review we can suggest the following hypothesis:

H1: Leadership is a predictor of employee' motivation?
Fiaz, Qin, Amir, and Saqib (2017) in their paper for Leadership styles and employees' motivation has been showing that the positive relationship between democratic leadership and employees' motivation comes out to be insignificant, which depicts the bureaucratic and decentralized nature of the organization. The research findings are in line with the theoretical assumptions for autocratic and laissez-faire style, but inconsistent with democratic leadership style. Autocratic leadership style is found to be more dominant and exhibits significant negative relationship with employees' motivation, whereas democratic and laissez-faire leadership styles are shown to
positively predict motivation of employees. (Fiaz, Qin, Amir, & Saqib, 2017) .Therefore our hypothesis could show us the relationship between leaders or their leadership style and employees in the organization, analyzing whether leadership has an impact on employee satisfaction, whether it is a predator of employee motivation to achieve the goals of the organization.

2.3. Organizational Culture and Leadership influence in organizational performance

However, Schein in his book "Organizational Culture and Leadership" explains culture from the objective to the subjective, as is the character and personality of the employee. He says that by understanding culture we will be able to understand ourselves and individual characteristics, noticing the forces that influence and defining us for who we really are. Then we realize that our personality and character is reflected by the group we stand with, or the one we belong to within the organization. Organizational culture is not just about us in but also within us, it about the leadership. Hofstede, Neuijen, Ohayv and Sanders argue that organizational culture is as important within an organization as structure, strategy, and control, which are very important managerial elements of leadership and should be consistent in theory and practice of organizations (Hofstede, 1990).
According to research by Slijepčević, Bovan, and Radojević, leaders need to be willing to listen to ideas and alternatives from employees and then discuss them. Their research shows that leaders have had informal and unstructured communications about work with their employees, bringing more subjectivity, increasing the level of emotionality at work, empowering and stimulating them to be more productive in achieving goals, creating work atmosphere and motivating them for a better business performance. (Slijepčević, Bovan, & Radojević, 2018).

3. Research Methodology

This paper aims to explore the importance of organizational cultures and leadership in motivating employees in business organizations in the Republic of Northern Macedonia. The main research question is: Do organizational culture and leadership influence the employee's motivation and the performance of organizations in the Republic of Northern Macedonia? The research's approach is the main part of choosing the methodology, which is done as a plan consisting of the vehicle assumption for the detailed method for data collection, analysis, and interpretation. In this paper, the research approach will be divided into two categories: the data collection approach and the data analysis or processing approach. The methods in the paper are used as follows: Method of analysis and synthesis; Method of induction and deduction; as well as the survey method. This chapter describes the methodology used to conduct research related to data collection, sampling, questionnaire formulation, survey process and data processing methods. Focusing on research methods will help us reach conclusions, gather information, and interpret it. The methodology is a meaningful approach, which supports the researcher in answering the research questions to test the hypotheses raised to achieve the research goals.
Our paper has a descriptive research and is based on the collection of primary data. The research method is the deductive method, starting from the existing theories to the conclusions based on the research results. The primary data source was collected from the questionnaire which was constructed of three parts related to communication and organizational culture. The data were processed with STATA 13 program and were analyzed through descriptive analysis. During the analysis, the correlation coefficient calculates whether there is a linear relationship. The correlation coefficient is denoted by "r" and takes values from -1 to +1. The coefficient that has been used in our research is the Pearson coefficient which seeks the answer to the question of whether there is an important relationship between the two variables. If, r = -1; there exists a complete negative linear relationship, if r = 1; there exists a complete positive linear relationship and if r = 0; there is no relationship between the two variables.

3.1. Data Collection

Questionnaires and interviews were used as a method of collecting primary data for the research. The survey was conducted through direct and online contact, always based on the target groups such as employees, owners, CEOs, department managers. Communication with respondents is made in such a way that the target groups could express their opinion on the issues raised, their perception in the workplace, the advantages and disadvantages of organizational culture, the relationship with leadership at work as well as impressions for the work environment, all this is done while maintaining complete anonymity. The questionnaire was sent to private

and public institutions as well as to credible organizations as well as established communities to support the private and business sector in the RNM.

While collecting data from respondents, to them was given the opportunity to express themselves more freely through open-ended questions, which made a primary contribution to the qualitative analysis of the research. Out of 390 surveys, 58.8% were women and 41.5% were men, of which 37.8% are in leadership positions and 62.2% are administrators or employees.

4. Results

Based on the research conducted, most of the employees in business entities in the Republic of North Macedonia, say that they are not fully aware of the organization where they work. Employees face lack of timely internal communication or slow communication, which delays the work process and creates dissatisfaction. From the perspective of employees and their responses is confirmed the fact that the leaders of organizations in the RMV, do not regularly inform employees about the overall functioning of the organization which reflects on the effectiveness and efficiency of the organization. The majority of respondents of our research about 42 percent are employees, administrators or any other position in the organization. We can say that out of the total respondents about 35 percent of them have been in leadership positions, while 68 percent of employees in various sectors in the organization.

Based on statistics on how satisfied the employees are with their leaders, it results that 33 percent of the respondents are sufficiently satisfied with the leaders in their daily communication and behavior in the organization, motivating them and influencing their satisfaction. Theirs. 28.25 percent of them to be very satisfied, 26.25 percent to be partially satisfied, while about 12 percent dissatisfied with the same.

Hypothesis H2: Leadership is a predictor of employee' motivation

Testing of hypothesis H1a results that the value p = 0.008, given that p <0.05, and in our case the value p is less than 0.05, the 95% reliability criterion is met, and the hypothesis is accepted. Based on the test it turns out that there is a strong link between the communication of managers or leaders with employees and the success of the organization.

Table 1 – Results Hypothesis H2

TEST					
Pearson chi2(72)	=	104.044	Pr	=	0.008
Cramér's V	=	0.2945			
gamma	=	0.1345	ASE	=	0.082
Kendall's tau-b	=	0.0676	ASE	=	0.042
Fisher's exact	=	0			
Evaluation					
Pearson chi2(72)	=	104.044	**>**	92.81	**= Chi SD -**
Pr	=	0.008	**<**	**0.05 reliability coefficient 95%**	

Organizational culture is a system of values and beliefs that makes employees feel valued, feel important in achieving the goals of the organization. However, about 43 percent of employees in the RMV are not motivated by the approach of organizations and the work culture really feels undervalued. Only 30 percent of them say that organizations pay attention to the work atmosphere, creating unique values, collectivity, and cooperation between employees towards its goals. According to them, work culture and sense of cooperation of leaders are factors that influence the motivation of employees. The results show that a significant number of employees in various organizations in the country, have the impression that their organizations have no interest in promoting organizational behavior and investing in human resources, which reduces the satisfaction of their performance in the organization.

As one of the basic elements of organizational culture are the knowledge of the vision, mission, goals, and objectives of the organization by the working staff. In our case only 36.25 percent of respondents are moderately informed about the goals and objectives of the organization, while 27, 50 percent say they are fully informed about them. Limited amount of information has 1/8 of the respondents respectively 13.25 respondents.

Hypothesis H1: Organizational culture is a predictor of employee' motivation

Based on the results from the testing of hypothesis H2 it results that the value p = 0.515, given that p <0.05, and in our case the value p is greater than 0.05, the reliability criterion of 95% is not met and the hypothesis is not

accepted. Based on the test, it results that in the organizations in the Republic of Northern Macedonia there is no strong connection between the organizational culture and the performance of the employees.

Table 2 - Results Hypothesis H1

Evaluation					
Pearson chi2(4)	=	2.6583	**<**	9.4877	**= Chi SD -**
Pr	=	0.515	**>**	**0.05 reliability coefficient 95%**	

5. Conclusion

Organizations in RNM must raise awareness at all hierarchical levels, about the importance of effective leadership communication. On the other hand, leadership of organizations should increase employee motivation, sharing important information about the company's strategic planning; when employees will be informed about the goals, mission, and vision of the company. They should communicate clear objectives and their contribution to the realization of the same, motivating them as winners of the success of their organization. This opens opportunities for open discussion, generation of ideas, creativity at work and strengthens the connection. employee-leader.

Leaders of organizations in the RMV should increase awareness of organizational culture, its advantages and impact on the organization. They need to create a common system of values and beliefs that makes employees feel valued, motivated, feel important and contributing to the realization of the goals of the organization.

As hypothesized both organizational culture and leadership were found to be significantly and positively related to employees' motivation in RNM. A possible interpretation of our finding could be that, in more recent years elements of organizational culture and leadership like clarifications of employees' responsibilities, empowerment, creating space for their professional growth, communication, shared vision, mission and goals of organization, performance criteria and expectations of leadership can be key factors in employee motivation, job satisfaction, and their productivity toward organizational success.

The results obtained from this survey in business subjects in RNM can be further material to future research in order to see the effectiveness of leadership ,work culture and leadership styles in an organization and to analyze what will be most suitable for the current organizational conditions to be able to increase work motivation that affects the performance of employees in RNM. Also regarding to these problematics can be raised other variables that support the research because the more interesting the research variables are the wider results can obtain the development of organizational development and success.

TEST		
Pearson chi2(4) = 2.6583	Pr = 0.617	Pr=0.515
likelihood-ratio chi2(4) =	3.2619	0.0815 Pr =
Cram鯡s V =	0.0815	
gamma =	0.1369 ASE	0.178
Kendall's tau-b =	0.0281 ASE	0.037
Fisher's exact =	0.714	

The impact of this research is based on analyzing the importance of factors such as organizational culture and leadership and also to prove that the role of leadership in the formation of organizational culture to display work motivation on employees is important in organizations in North Macedonia. Leadership role on conducting the goals of the organization is one of the important points to encourage motivation in workplace, that's why leadership has to ensure the culture that exists in the organization to be accepted and understood by all employees to be united in achieving the organizational goals. Overall, we can say that this research has an important impact in explaining that, leadership provides a role in shaping an understanding of the organizational culture of the company so that it can encourage motivation to work on employees. Thus, our approach shows that there is an interconnection between these two factors as influencers in the environment and satisfaction in the company. This interaction will make a greater contribution to team communication and collaboration and will encourage to accomplish the mission and vision of organization.

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